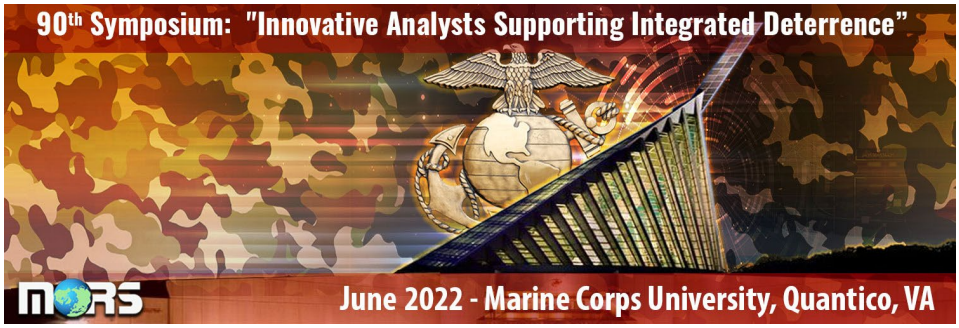

Contents

Demo

60140 - Moving from Data to Decision FASTER with JMP Pro 16 – Machine Learning for NON-Coders

Start Date: 6/14/2022	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Dr. Thomas A. Donnelly		
Abstract: This demo will show how to quickly and robustly create and test Machine Learning models using JMP Pro 16. The focus isn't just on cranking out the best predicting model fast, but also on looking at competing models that may better help decision makers understand the data, process, and risks. Interactive visualization with multiple models helps decision makers appreciate the sensitivities of factors, the trade-space among responses, and the uncertainty quantification of the final prediction(s). Creating "Honest Assessment" data subsets (train, tune, & test) whenever possible, or using penalization criteria protects you from overfitting the data. Cycling through actual vs predicted plots – for the held out "test subset" – for the array of fit models visually shows their relative performance as does the provided table of statistical metrics. The Model Screening platform - new in JMP 16 - allows the simultaneous fitting of more than a dozen machine learning models including the popular XGBoost algorithm with built in DOE to optimize the tuning of parameters. And, when you are satisfied with your model, share it with the coders in your organization. JMP can output the model in any of these computer codes: Python, C, SQL, JavaScript, or SAS. Although not flashy, data prep is often 60-95% of the analytic workload! Pulling data from a wide range of file formats, seamlessly drawing in structured tables across multiple pages in PDFs, connecting to databases or REST APIs, pulling tables off webpages - JMP can get data in from virtually anywhere. Data cleanup of outliers (multivariate?), missing data (imputation?), recoding of typos/merged-field-values (automate w/scripts), exploring suspicious data patterns (hacking? fraud?), automating repetitive drag-and-drop steps with JMP 16's new action recorder, ALL allow users to do in minutes what previously took them hours or even days! Whether you are an engineer, scientist, tester, or analyst, whether you work in a lab, on a range, or in the program office, if you have data that needs to be turned into information, knowledge, and understanding –so it can be presented to decision makers quickly – so they can take action sooner – then come see how JMP Pro 16 can help your organization move from data to decision faster. Classification: UNCLASSIFIED Working Group: Demo		

61361 - OptDef – Optimization, Design of Experiments & Analytics for Simulation Models

Start Date: 6/14/2022	Start Time: 3:30 PM	End Time: 4:00 PM
Authors: Dr. Benjamin G. Thengvall; Shane N Hall, PhD		
Abstract: OptDef software greatly increases simulation analyst effectiveness and efficiency by providing optimization, design of experiments (DoE), and analytics capabilities for constructive Department of Defense (DoD) simulation tools. OptDef wraps simulations and provides an intuitive		

user interface to set up, execute, and analyze the results of a simulation study. It is free for US government use. OptDef is a cross-platform, Java application with a plug-in interface that is already integrated with AFSIM (Advanced Framework for Simulation, Integration and Modeling), STORM (Synthetic Theater Operations Research Model), EADSIM (Extended Air Defense Simulation), SEAS (System Effectiveness Analysis Simulation), JMPT (Joint Medical Planning Toolkit), BMD I-Sim (Ballistic Missile Defense International Simulation, KIDD (Kinetic Impact Debris Distribution Model), G6, and a number of other custom DoD simulation models. Its architecture allows integration with additional simulation tools with limited effort.

OptDef allows an analyst to choose multiple simulation inputs to vary and then apply one or more objectives and constraints. OptDef combines advanced metaheuristic search methods and mathematical programming techniques to drive iterative simulation runs with different simulation input combinations. After the completion of the search, the tool automatically applies different statistical and data mining techniques to provide insight into the influence of the variables on the objectives and to identify good and bad regions of the design space.

In this demo we will describe uses of OptDef and demonstrate product features including automating single and multi-objective optimization, DoE, and batch runs, post-run statistical and graphical analysis tools, and parallel simulation execution.

Classification: UNCLASSIFIED
Working Group: Demo

60145 - JMP 16 Software for Data Visualization & Discovery, and NEW Easier Automation with Action Recorder

Start Date: 6/15/2022	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Dr. Thomas A. Donnelly		

Abstract: This is the 33rd year JMP® software has been bringing dynamic data visualization and analytics to the desktop. Using short case studies this demo will highlight powerful data visualizations in JMP such as animating data on maps (now able to record as GIFs), including images in the data table, analysis of unstructured text data, analysis of streams of sensor data (Functional Data Analysis) as well as showcase enhancements in JMP 16. With the new Graphlets and Hover Labels visually drill down through a data hierarchy such as a work breakdown structure (WBS) to see graphical summaries at each step.
Do in minutes what takes hours in spreadsheet programs. JMP reduces the drudgery of data cleanup - including outlier detection, imputing missing data, and recoding messy data. Watch your graph instantly emerge as you click and drag variables, add data filters, images, maps, and animation. Grab data from almost anywhere – Excel, databases, text, the internet, or new in JMP 15 import tables (even across multiple pages) in PDF documents.
Beyond data exploration and visualization JMP has cutting edge capabilities for Design of Experiments, Reliability, and Data Mining. JMP offers solutions for Real-World DOE problems, efficient computer simulation, and software quality assurance. Machine Learning methods include decision trees, neural networks, and linear, logistic and penalized regression methods. Get near machine learning accuracy with more interpretable models with confidence intervals.
It will be shown how JMP's "graphic for every statistic" can easily be moved into PowerPoint presentations and interactive HTML5 web reports so that viewers can ask "what if?" questions and get immediate answers without having JMP software.

Classification: UNCLASSIFIED
Working Group: Demo

61362 - OptDef – Optimization, Design of Experiments & Analytics for Simulation Models

Start Date: 6/15/2022	Start Time: 3:30 PM	End Time: 4:00 PM
Authors: Dr. Benjamin G. Thengvall; Shane N Hall, PhD		

Abstract: OptDef software greatly increases simulation analyst effectiveness and efficiency by providing optimization, design of experiments (DoE), and analytics capabilities for constructive Department of Defense (DoD) simulation tools. OptDef wraps simulations and provides an intuitive user interface to set up, execute, and analyze the results of a simulation study. It is free for US government use. OptDef is a cross-platform, Java application with a plug-in interface that is already integrated with AFSIM (Advanced Framework for Simulation, Integration and Modeling), STORM (Synthetic Theater Operations Research Model), EADSIM (Extended Air Defense Simulation), SEAS (System Effectiveness Analysis Simulation), JMPT (Joint Medical Planning Toolkit), BMD I-Sim (Ballistic Missile Defense International Simulation, KIDD (Kinetic Impact Debris Distribution Model), G6, and a number of other custom DoD simulation models. Its architecture allows integration with additional simulation tools with limited effort.

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Classification: UNCLASSIFIED
Working Group: Demo

61333 - Automated Machine Learning (autoML): confidence and speed to market

Start Date: 6/16/2022	Start Time: 3:30 PM	End Time: 4:30 PM
Authors: Eric Loeb		

Abstract: This will be a demonstration of DataRobot, the leading platform for autoML. The demo will be pitched to machine learning novices, but questions and participation by advanced data scientists will be welcome. For novices, autoML makes machine learning accessible. No coding or advanced statistical training is required, and models can be built without fear of making mistakes like a coding error or a faulty statistical assumption. For all users, DataRobot is built for large scale industrial machine learning, cutting the often very lengthy time from model development to model deployment.

Classification: UNCLASSIFIED
Working Group: Demo

59732 - Generating Realistic Populations and Agent Behavior

Start Date: 6/16/2022	Start Time: 3:30 PM	End Time: 4:00 PM
Authors: Mr. Joseph Anthony Stoffa; Ashley Fehr		
Abstract: Agent-based modeling and simulation is critical to answering key questions within the Intelligence Community and Department of Defense. Ranging from strategic defense planning to public health and disaster recovery, many use cases involve emergent behavior where the actions of a few individuals can affect the behavior of the whole. Having actionable findings necessitates accurately depicting individuals' motivations and decisions at scale. However, modelers often have limited access to open-source, accurate person-level data. To overcome this limitation and answer scenarios like these, we expand on known agent-based modeling capabilities to show geolocated, goal-directed behavior by synthetically representing a real population making real decisions. Prior work to generate synthetic populations largely utilized aggregate distributions commonly found in census datasets. Other work shows the importance of personality in shaping realistic behavior but has yet to generate representative individual agent personality. Our work builds upon methods in the behavioral and computational sciences by generating a population from available aggregate data for a specific geographic region to model personality effects on agents' cognitive processes. Our goal is to better capture how the real-world population would respond to simulated scenarios. We detail how agents can be grown using representative aggregate data to guide that growth into realistic simulated entities. We generate agents using best-in-class methods within the Synthetic Reconstruction and Combinatorial Optimization classes. Last, we discuss those entities taking motivated actions unique to their geographic areas. We developed the current methods in collaboration with the National Geospatial-Intelligence Agency (NGA). Our work reveals the impact that population realism lends to applications across the Intelligence Community and Department of Defense. Implications for national security include higher fidelity modeled outcomes that inform policy or decisions when it comes to a populace, interventions, or making policies. Classification: UNCLASSIFIED Working Group: Demo		

DWG1 Emerging Operations Research

59843 - Assessing The United States Foreign Military Aid Impact on Conflict

Start Date: 6/14/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Capt Daniel Frank Feze, Student; Dr. Mark A. Gallagher, FS		
Abstract: The Global Fragility Act, H.R.2116 116th Cong. (2019), "directs the Department of State to establish the interagency Global Fragility Initiative to stabilize conflict-affected areas and prevent violence globally, and establishes funds to support such efforts". The United States Agency for International Development (USAID) has identified deteriorating economies, weak or illegitimate political institutions, and competition over natural resources as causes of violence, extremism and instability (USAID, 2021). The agency gives priority to mitigating the causes and consequences of violent conflicts, instability and extremism and funds programs and activities to accomplish that (USAID, 2021). With this study, we aim to quantitatively assess these programs effectiveness at preventing and deescalating conflicts in the short and long term. The method used in this study can also be applied to evaluate foreign assistance effectiveness at meeting other U.S. objectives. We use		

publicly available open-source data from 2010 to 2020. We weight the foreign aid impact as a factor on violent conflicts predictions using a logistic model that predicts with 82% accuracy a country's status the following year. The countries' GDP per capita, population size and voice and accountability ratings are the major factors in the model

Classification: UNCLASSIFIED
Working Group: DWG1 Emerging Operations Research

60037 - Space Sensitivity Assessments Using Multi-Domain Kill Webs in AFSIM

Start Date: 6/14/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Dr. Jason Reiter		

Abstract: In a collaboration effort between AFRL/RV, AFLCMC/EZJA, and SSDP Enterprise Division, a multidomain kill web was developed in AFSIM to analyze the timing needed for data collection, fusion and transmission of Missile Warning (MW) messages from space-based ISR systems to blue high valued air assets (HVAA) to increase blue survivability. The model analyzed differences between legacy GEO/HEO MW architectures and future proliferated, resilient LEO and MEO MW/MT architectures. The specific sensor capability to detect a threat was evaluated outside of the simulation for model simplicity. The timing from detection, through a SATCOM relay to a ground fusion center and back into theater was evaluated. The amount of time data took to fuse and transmit out was varied for each architecture. Upon receipt of a missile warning message, the blue HVAA aborted mission. For the red threat, an airborne ISR platform was used to cue fighters to the location of the blue HVAA. The red fighters pursued the HVAA given data updates from the ISR platform. The fighters fired upon the HVAA when within an acceptable weapon range and outside the blue defended area. The model was able to show with enough missile warning and short fusion timing, the survivability of the HVAA was much greater for long range engagements and immediate detections. If MW was not available or the delay was too great, the HVAA would not be able to abort in time or would have to operate further away from the threat which could have additional CONOPS consequences.

Classification: UNCLASSIFIED
Working Group: DWG1 Emerging Operations Research

60059 - An Adaptive Kill Web Framework for Mission Engineering and Concept Exploration Analysis

Start Date: 6/14/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Christopher Santos		

Abstract: What is a Kill Chain? What is a Kill Path? What is a Mission Thread? How do these relate to a Kill Web? For that matter, what is a Kill Web? Depending on who you ask and what background they have—operational, engineering, or acquisition—these terms may be describing the same thing, or—in other cases—common terms may have very different definitions in different communities. Finally, what are the analytic implications of these terms and their underlying concepts?

What is common about these terms and concepts is the attempt by the Department of Defense to understand and grapple with an increasingly complex warfighting environment. Over the past several decades, the effective projection of military power has become increasingly dependent on complex combinations of capabilities resident in all domains in order to achieve combined effects not possible from individual platforms or services. The combination of effects created by systems across all

domains, from seafloor to space, through cyber and the electromagnetic spectrum, dictates a different approach to concept development, exploration, and analysis.

While the Office of the Secretary of Defense and the services have incorporated Mission Engineering methodologies to into the investment decision process to begin to tackle this new warfighting paradigm, these approaches tend to focus on the applications of singular missions or analyses within the context of a particular mission area. They may not address the full complexity across domains and multiple mission areas across a theater. Furthermore, Mission Engineering focuses on engineered employment options, which may create biases for concept exploration in which potential solutions may not yet be detailed to the engineering level.

The Adaptive Kill Web Framework outlined in this presentation extends OSD's published mission engineering concepts to enable unbiased concept exploration analysis across multitudes of missions and across all domains. Furthermore, it provides a common lexicon to address conflicting or divergent definitions for concepts such as Kill Chains and Kill Webs as well as a consideration of the types of analyses appropriate for a given tier in the Framework.

The Adaptive Kill Web Framework also provides the foundational organizing concepts for the mathematical applications described in the related 90th MORSS presentation (IDs 60062 and 60063), "A Mission Engineering Perspective for Integrating Analytical Methods for Design and Evaluation of Complex Systems," by Raz, et al.

Classification: UNCLASSIFIED
Working Group: DWG1 Emerging Operations Research

60062 - A Mission Engineering Perspective for Integrating Analytical Methods for Design and Evaluation of Complex Systems

Start Date: 6/15/2022	Start Time: 8:30 AM	End Time: 9:00 AM

Authors: Professor Ali Khalid Raz; Prof. Paulo C Costa, Ph.D.; Dr William Forrest Crain, FS; Steven Jones; Dr. Daniel Thomas Maxwell; Christopher Santos

Abstract: Mission Engineering requires integration of multiple complex systems that are designed and acquired independently to satisfy demands of one or more missions. The state of the practice for complex systems and system of systems design and evaluation relies on brittle and static architectures that once implemented are difficult to change. These architectures are typically pre-defined for a given mission need for which a suite of analytical methods is used to optimize performance. In these analyses the role, capabilities, and utilization of constituent systems is rigidly defined and cannot be flexibly adapted to address real-time needs of evolving mission conditions or priorities. Analytical methods (for example, graph theory, multi-utility attribute theory, statistical design of experiments, and deep learning methods, to name a few) that are used for such analysis and evaluation of complex systems take a static snapshot of a complex system which simplifies the problem space but at the same time overshadows evolution of interactions that are the source of emergent behavior in complex systems. From a Mission Engineering perspective, however, a suite of high value architecture solutions that balance timeliness, interoperability, risk, and performance given slight variations in composition are more desirable than a single optimal architecture solution that does not consider the above factors.
Inspired by the concept of a battlefield system-of-systems where the capabilities of individual systems can be flexibly exploited to create real-time adaptable system-of-systems architectures, in this

presentation, we propose integration of multiple analytical methods that facilitate identification, design, and analysis of such dynamic architectures. It is important to note that analytical methods (such as the ones named in previous paragraph) are often deeply rooted in their own theoretical and mathematical formulation that does not easily transcend to other methods for cross-method integration, and therefore, impedes holistic analysis of complex systems. For example, how can outputs of graph theoretical metrics for architecture analysis help shape the formulation of a multi-utility attribute theory model to guide real time decision making and performance characterization of system-of-systems architecture?
In this presentation, we propose a set-based mathematical notation for complex system representation. Building on this mathematical notation, we will demonstrate a work follow for integrating multiple analytical methods for near real-time analysis of complex system architectures which is required to achieve mission engineering's goals.
Note:
a) Another submission by Santos :"A Kill Web Framework for Mission Engineering and Concept Exploration Analysis" (ID 60059 & 60060) can serve as a precursor as it presents a Kill Web formulation in a system of systems context.
b) This presentation is submitted DWG 1 and WG 25 as ID 60062 and 60063, respectively.

Classification: UNCLASSIFIED
Working Group: DWG1 Emerging Operations Research

60244 - Transportation Routing and Group Theory

Start Date: 6/15/2022	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Dr. Bruce W Colletti

Abstract: Here we use the Wolfram Language to treat transportation routes.

Group Theory returns the true population variance of all 2.4 quadrillion uncomputed routelengths in a certain 1-agent m-load Pickup and Delivery Problem (PDP). We swiftly compute the true variance rather than a theoretically hi-quality large sample estimate whose actual unknown quality is doubtful. This talk illustrates a practical use of Algebra in a combinatorial optimization problem that appears in the classroom, DoD, and the transportation industry.

Within the PDP hides a group action that yields the population variance via a quadratic form whose vector depends upon distances and whose matrix M depends only upon m. The matrix is stored in a library for on-demand use by any m-load PDP and its peculiar distances. The true variance is swiftly computed.

This use of Group Theory has not been found in the Operations Research and Applied Mathematics literature, and is distantly rooted in work done by a 2000-2010 AFOSR-funded DoD-University Research Consortium that supported Headquarters, Air Mobility Command. Consortium members had been AMC/XPY (Studies and Analysis Flight), USMA (Systems Engineering), AFIT (Operational Sciences) and The University of Texas at Austin (Graduate Program in Operations Research).

Classification: UNCLASSIFIED
Working Group: DWG1 Emerging Operations Research

60424 - The Persistent Monitoring of Emerging Technologies

Start Date: 6/15/2022	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Richard M. Buchter		
Abstract: Input to war games typically consists of "futuring" assessments- Deep Dives, Delphi Method (panels of experts), and trend analysis- frequently conducted on an annual to multi-year revisit basis to provide trend analysis and forecasting of the deep future. But do these approaches keep pace with the rapidly evolving tech sector to provide the ability to keep ones hand on the pulse of the rapidly developing tech sector? This presentation discusses a different approach, a missing component in futuring, the actual reporting of where science and technology institutions, along with industry, say they are going and when, on a daily to weekly basis that they will be available, tailored to support war game and program office needs alike. This presentation, discusses the development process of the persistent monitoring of emerging technology concept, first presented to the Army's Mad Scientist blog in 2020 (awarded "2020 Army Mad Scientist of the Year"). This approach uses news feeds, press releases, conference presentations, annual reports, etc., for capturing the direct reporting of today's business and scientific advancements. Data is then reduced to a simple chart, in this case a periodic chart format, to present potential advancements based on a time scale of ones choosing. Such an approach allows developers to develop tailored reporting lends itself to a wide variety of needs. Discussion concludes with some thoughts on how to expand the approaches usefulness into wargaming and PM risk analysis. Such an approach elevates awareness of technical opportunities and threats to the status quo and can serve as inputs to the 4GIM (4 Generations of Innovation Model) along its Exceptional Innovation axis supporting the Disruptive Dozen to better understand future threats and opportunity vectors. Classification: UNCLASSIFIED Working Group: DWG1 Emerging Operations Research		

60428 - The 4GIM (Four Generations of Innovation Model)

Start Date: 6/15/2022	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Richard M. Buchter		
Abstract: The Four Generations of Innovation Model (4GIM) is based on consolidating existing and emerging Innovation Theory models. But unlike current Innovation Theory models, it separates extraordinary from status quo innovation. Doing so allows for the discussion of extraordinary innovation approaches that are frequently hidden under such labels as "emerging technology", "future technologies", and "Third Horizon Innovation" that may both pose a threat, and improvement, to existing status quo efforts. Presentation will discuss the four major areas of innovation: status quo, Radical innovation (familiar to the status quo), Revolutionary Innovation (not familiar to the status quo), and Lateral Innovation (repurposed technology from a different status quo effort), and the location of existing Innovation theory within it. The transition boundary between Status Quo Innovation and Extraordinary Innovation will then be briefly explored. The discussion will conclude with a review of the "Disruptive Dozen"- methods employed in above the line extraordinary innovation: Loonshots, Serendipity, Maneuvering, Prizes, Convergence, Experimental, Creative Desperation, Basic Research, Buchter's Razor, Skunkworks, Supersizing, and Moonshots (Iron Man to JFK), as well as their potential for disrupting the status quo. Classification: UNCLASSIFIED Working Group: DWG1 Emerging Operations Research		

DWG2 Unmanned Systems

60251 - Counter-small Unmanned Aircraft Systems Analytic Model

Start Date: 6/14/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Dr. Michael Yereniuk; Kenneth Wheeler; Shelby Lardner		
Abstract: The recent acceleration in the roles and numbers of small Unmanned Aircraft Systems (sUAS) used in combat operations pose a new threat to Army maneuver formations. Accordingly, Army Futures Command (AFC) and Futures and Concept Center (FCC) sponsored a 6-month C-sUAS study to inform Program Objective Memorandum 24-28 and C-sUAS Abbreviated Capabilities Development Document (A-CDD). The purpose of the study was to assess operational effectiveness and requirements of future C sUAS technologies by echelon and battlespace geometry in the future. The study team determined there was insufficient time to integrate scenarios into established combat models due to the effort required to develop Threat representations, behaviors, and acquiring data for those models. As a result, the team developed the C-sUAS Analytic Model that represented Friendly and Threat intent, simulated sUAS behaviors and capabilities, as well as C sUAS detection and engagements. The C-sUAS Analytic Model had the capability to quickly assess over 250 scenario situations and gave the study team insights into the effectiveness of Threat sUAS and opportunities for future investment in Friendly C-sUAS technologies. The C-sUAS study team utilized the Visual Application with Data-Collection in R (VADR) model framework as a main interface and environment to show interactions found in the newly developed Counter Information Seeker Computational Research (CISCR) model. The CISCR model is a stochastic, highly-abstracted, time-stepped adjudication model to analyze measures of operational effectiveness. CISCR is set up similar to a two-player information acquisition game: Friendly forces try to understand and destroy enemy sUAS while the enemy forces try to evade and destroy Friendly forces. The study team adapted VADR to provide an interactive vignette map layout with both Friendly and Threat force components at specific coordinates to develop the correct starting placement of the battlespace. The simulation environment is a Voronoi partition placed over the Friendly entities within the area of operation. The model incorporates future Threat sUAS mission roles through assigned behaviors, such as intelligence, surveillance, and one-way attack. It represented emergent swarm-like behavior through the establishment of global communications that allowed one sUAS to provide information to the larger group, enabling other sUAS to act upon that information. With every run, CISCR tracked the sUAS detections, identifications, engagements, and defeats. This allowed the study team to complete quantitative analysis on key operational effectiveness statistics. This presentation will provide an overview of the study, details of the model development and function, and lessons learned. Classification: UNCLASSIFIED // NOFORN Working Group: DWG2 Unmanned Systems		

59834 - Assessing Counter-UAS Detection and Defeat Capabilities in Arctic Environments

Start Date: 6/14/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Mr. William Leonard; Mr. Jed Richards; Christina Rinaudo; Dr. Simon R. Goerger; Dr. David K Wilson		
Abstract: The threat of intrusions by small Unmanned Aerial Systems (UAS) challenges the Department of Defense to evolve its Counter-UAS protection capabilities across all operating		

environments with particular relevance to the Arctic region. This work applies a systems-engineering methodology to integrate Counter-UAS detection and defeat analysis into a geospecific scenario environment (Arctic region), informing the development and employment of Counter-UAS capabilities to detect and interdict UAS intrusions in extreme conditions. This research extends previous capabilities to incorporate additional modalities and attributes (e.g., weather) as a part of the overall model's sensor and defeater selection and placement optimization approach. Furthermore, the model considers both fixed-site and moving targets subject to encroachment by threat UAS. The modeling implementation could facilitate higher-fidelity analysis to inform the design and employment of Counter-UAS systems against a myriad of threat capabilities present in geospecific scenarios. This presentation provides an overview of the overall modeling framework, including recent enhancements and an example use case, to evaluate and interdict threat UAS.

Classification: UNCLASSIFIED // FOUO
Working Group: DWG2 Unmanned Systems

60201 - Soldier Lethality and the Emergence of small Unmanned Aircraft Systems (sUAS) on the Modern Battlefield.

Start Date: 6/14/2022	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Caleb Johnson; Ms. Sara K. Krondak

Abstract: The emergence of sUAS on the battlefield signifies a new and real problem for forces during all phases of multi-domain operations. Troops at all echelons are susceptible to enemy surveillance, and effects delivered by threat sUAS. Military senior leaders acknowledge the threat and have allocated research and development resources towards doctrine, organization, training, materiel, leadership and education, personnel, facilities, and policy (DOTmLPF-P) solutions, to give the force the capability to defeat threat sUAS. The Commanding General, Army Futures Command directed TRAC to study Counter-sUAS (C-sUAS) capability requirements to inform an abbreviated capabilities development document and C-sUAS portfolio investments in a Program Objective Memorandum. Effective C-sUAS capabilities differ depending on battlefield geometry, echelon, and available resources. Emerging C-sUAS technologies provide forces self-defense capabilities against threat sUAS during its mission cycle. Future systems integration is subject to available resources and platform limitations.

The study team incorporated maneuver scenarios operating in various terrains during large-scale combat operations. In order to answer what technologies are possible to develop, the study team gathered a list from the scientific community within the Army. Given the uncertainties associated with emerging and developing technology, the study team organized them into a technological trade space, based on the architectural choices across the detect, identify, and defeat tasks. These methods allowed the study team to elicit combatant command subject matter expert (SME) feedback on desired C-sUAS characteristics.

The technology trade space and SME feedback served as input data for the purpose-built abstract model to determine high payoff mixes, analyzing multiple C-sUAS technology pairings across the echelons studied. Each pairing examined measures of operational effectiveness against a most likely threat scenario to determine the C-sUAS system's ability to deny threat's intent. The analysis is instrumental in providing senior leaders the necessary information to effectively plan and develop future C-sUAS systems.

This presentation will provide an overview of the study methodology.

Classification: UNCLASSIFIED // FOUO Working Group: DWG2 Unmanned Systems

60276 - Ad Hoc Cellular Drone Network Modeled as 3D Facility Location Problem

Start Date: 6/15/2022	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Garett Bearenger Fogel; Prof. Theodore Allen; Dr. David Hillstrom		
Abstract: Drone swarms serve a variety of purposes including security and surveillance, collaborative transportation, environmental monitoring, and ad hoc cellular relay networks. Using ad hoc cellular relay as an example, we developed a novel genetic algorithm with active evaluation to control the behavior of these self-organizing drone swarms, and implemented it within the Advanced Framework for Simulation, Integration, and Modeling (AFSIM). By modeling the network as a 3D facility location problem drones as facilities servicing customers, we can use our genetic algorithm to find the rotary positions or fixed wing routes as well as drone-customer assignments that maximize selected performance measure. The active evaluation allows the algorithm to modify the drone positions or assignments during evaluation to address capacity constraints. A comparison is used to demonstrate the value of active evaluation methods. Drone swarm positioning is implemented as a self-organizing property within AFSIM. For "hyperparameter" or engagement level decision making, we implement a recent efficient global optimization method. We illustrate the benefits of Kriging meta models for supporting decision making relating to drone swarm mission objectives. Classification: UNCLASSIFIED Working Group: DWG2 Unmanned Systems		

60252 - Representing Swarming Technologies in Aggregate Operational Modeling and Simulation

Start Date: 6/15/2022	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Mrs Cara L Lance		
Abstract: Over the last several decades, there has been a proliferation of autonomous systems on the battlefield. A unique feature of these systems is their ability to inter-operate in a manner such that they present an emergent behavior that is not easily understood through an understanding of the constituent systems. This behavior is often termed "swarming" and is increasingly being looked to as a means to gain an advantage on the battlefield. Much modeling and simulation (M&S) research has focused on understanding the nature and capabilities of swarms by representing individual systems and their interactions. This is highly useful and important work; however, the methods used to do this do not immediately translate into M&S that attempt to understand how swarms integrate into larger, operational fights. This is because it is not feasible to represent each individual constituent system of a swarm that may number in the hundreds in a model that is also representing all of the other aspects of a corps operation. As such, there is a need to represent swarms in an aggregate nature to understand how they interact and affect larger operations. This presentation reviews how a team did this by employing the Advanced Warfighting Simulation (AWARS) in support of the Future Vertical Lift (FVL) Cross Functional Team (CFT). The presentation further suggests areas for continued swarm M&S development and needed areas of research. Classification: UNCLASSIFIED Working Group: DWG2 Unmanned Systems		

59671 - Unmanned Aerial System (UAS) Launch and Retrieval System (LaRS) with Autonomous Operations Performance Analysis

Start Date: 6/15/2022	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Daniel O Rice		
Abstract: This research presentation includes the Modeling and Simulation (M&S) analysis results of a trade study that compares the performance of (1) static sensors; (2) fixed location sensors, such as mast sensors and tethered unmanned aerial systems (UAS) sensors; and (3) on-the-move launch and retrieval of UAS sensor assets in accomplishing a static target detection task. We show a 40x improvement of sensor area coverage that is enabled by tactical maneuvering forces using a Tular 3.0 UAS launch and retrieval system for on-the-move UAS sensors deployments. Classification: UNCLASSIFIED Working Group: DWG2 Unmanned Systems		

FS01 Analytic Capability Development

60030 - Analytic Capability Development Focus Session Overview and Introduction

Start Date: 6/14/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Christopher Santos; Chad Kimmel		
Abstract: The MORS membership covers a diverse array of people and organizations with military and civilian backgrounds, the government and private sectors, and academia. The existing MORS Communities of Practice (CoPs), Working Groups (WGs), and Distributed Working Groups (DWGs) are generally focused either on specific analytic techniques, or on the functional applications of those techniques. No MORS entity is currently dedicated to the professional development of the analyst, or to the infrastructure and support an organization must provide to the analyst. This Analytic Capability Development (ACD) Focus Session represents a major milestone in addressing this gap within the greater MORS community. Generally a two-year process, the first iteration of the ACD Focus Session at the 89th MORSS had overwhelming turnout. With another good showing at the 90th MORS Symposium, ideally ACD will become a permanent working group and standing collaboration and information-sharing venue. This ACD Focus Session features presentations from current practitioners and professional development leaders from across the MORS community along the following collaboration pillars: > “Man” refers to the professional development of analysts from a career path, experiential, and mentorship perspective. > “Train” refers to the training and education opportunities available to the analyst. > “Equip” refers to the provision of hardware and cutting-edge software necessary to conduct analysis, as well as advocacy for safe, analyst-friendly IT policies. Help us to formalize this “home” for capability development topics, whether by presenting, attending, or participating in the ACD sessions this week. Classification: UNCLASSIFIED Working Group: FS01 Analytic Capability Development		

60185 - Equipping the Analyst: An Overview of Analytical Tool Construction

Start Date: 6/14/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Chad Kimmel		
Abstract: The development of analytical tools is an important topic in the field of analytics, providing a means to expand analytical applications, advance operations research analysis and extend accessibility to vital analytical results to those outside the analysis community. Analytical tools serve as the link between mathematical algorithms and the applied setting, and they allow the end-user to execute a given algorithm completely independent from the analyst under a number of different 'what-if' scenarios. Analysts can customize analytical tools utilizing widely available software such as Excel, R or Python, creating user-friendly tools with applications across the Air Force Enterprise. This presentation provides an overview of analytical tool construction, including common development steps and important tool development considerations. The general tool construction outline and considerations in this presentation may provide a useful guide during the tool development process. Classification: UNCLASSIFIED Working Group: FS01 Analytic Capability Development		

60095 - How Much AI/ML do I need to Learn?

Start Date: 6/14/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Mr. Jerry L. Schlabach		
Abstract: Artificial Intelligence (AI) and Machine Learning (ML) are powerful new technologies that will disrupt and transform future combat operations. AI/ML and Operations Research (OR) are independent fields of academic study with limited historical overlap, which has led to a significant knowledge gap within the OR community regarding the newer technologies. However, in order to perform Analysis of Alternatives (AoA) studies and Military Utility Assessments (MUAs) of future AI/ML-enhanced systems, OR Analysts will require a basic understanding of capabilities and limitations. This presentation will outline a spectrum of 'AI/ML understanding required for OR Analysis' with respect to typical OR tasks. One implication is that a modest grounding in AI/ML fundamentals, well short of an advanced degree, is sufficient for a large percentage of future AI/ML-focused OR studies. This presentation will suggest some basic elements required for such a modest grounding. The author is a retired Army Military Intelligence Officer with an MS in Computer Science (AI) and twenty-five years of experience in AI-centric Army Acquisition. He is also a co-chair of MORS Working Group #35, "AI and Autonomy." This is a repeat presentation from the 89th Symposium, where it was selected for the Barchi competition for the 90th Symposium. Classification: UNCLASSIFIED Working Group: FS01 Analytic Capability Development		

59699 - Big Data, Data Science and the U.S. Department of Defense

Start Date: 6/15/2022	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: Dr. Roy L Lancaster		
Abstract: My 2014-2019 doctoral research analyzed the skills used by Department of Defense analysts, in order to better understand the application of data science to the DOD. While the technology for producing and analyzing data has grown tremendously, DOD personnel often lack the required data science skills and utilization of the most effective data science software to analyze big data sets. My research and my 35+ years as an analyst played an important role in OPM's decision to		

establish the Data Science Job Series, 1560. My presentation will bring real time and actionable insights on data science and advanced analytics.
I propose to present my doctoral research and abstracts from my dissertation Big Data, Data Science and the U.S. Department of Defense. I am the author and my research has been cleared for pubic release by the DOD.

Classification: UNCLASSIFIED
Working Group: FS01 Analytic Capability Development

59522 - Applying Subject Matter Expert Elicitation Techniques to The Military Decision Board, a Data Value Chain Approach

Start Date: 6/15/2022	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: sean p carey; Dr. Christopher E. Marks

Abstract: Within a U.S. Department of Defense (DoD) joint headquarters, a board is a cross-functional organization
that meets with the purpose of gaining guidance or a decision [U.S. Joint Chiefs of Staff, 2018, p. xiv]. Typically, a board consists of several senior officers in the organization, convened to make decisions or provide
guidance to the military organization. The joint commander and staff rely on the collective experience and
expertise of the board members to weigh relevant information and make decisions in the best interests of
the command in carrying out its mission. Because of the responsibilities and competing time constraints on
senior leaders, time in a board is typically limited and valuable.
Our work focuses on optimizing the time spent in a board to achieve well informed decisions and direction.
Our approach brings together two distinct concepts: the Data Value Chain and Subject Matter Expert (SME)
elicitation. The Data Value Chain is a model workflow that begins by understanding the decision required
and then builds the data and analysis to provide relevant insights [Carey et al., 2021]. Subject Matter Expert
Elicitation is a means to harness and transform relevant portions of SME knowledge into specific quantifying
measures [Marks et al., 2013]. Informed by the data value chain approach, we treat the decision board on
a U.S. DoD joint headquarters as a special case of SME elicitation. We demonstrate a Data Value Chain approach to facilitate the planning and execution of a Resource Allocation Board using Subject Matter Expert Elicitation and DevSecOps enabled technology.
References
Sean Carey, Dr. Christopher Marks, Michael Taberski, and Keith Hattes. The data value chain - a model for enhancing understanding and increasing ROI in systems and processes. 89th MORS Symposium, June
21, 2021.
Christopher Marks, Kirstin Smead, and Jonathan Alt. Enhancing subject matter expert elicitation techniques.

Technical Report TRAC-M-TR-13-048, U.S. Army Training and Doctrine Command Research & Analysis Center, Monterey, CA, June 3, 2013.
U.S. Joint Chiefs of Staff. Joint Publication 3-33; Joint Task Force Headquarters (JP 3-33). U.S. Department
of Defense, Washington, D.C., January 31, 2018.

Classification: UNCLASSIFIED
Working Group: FS01 Analytic Capability Development

59725 - Planning a Cloud Migration Effort: Cost Estimating Considerations

Start Date: 6/15/2022	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Mr. Kyle Connor Ferris		

Abstract: The utilization of cloud computing services allows for real-time data distribution and storage within customizable web-based infrastructures, designed according to the operational needs of a customer. The benefits of cloud solutions include minimal investments in physical hardware and IT infrastructure, customized server scaling to meet operational demands, and the convenience of consolidating data and applications under a standard online architecture.

With the growing prevalence of customizable cloud solutions, the challenge of developing a defensible cost estimate for the migration of legacy data to cloud environments becomes increasingly complex. Organizations must now consider a variety of cost factors: including the adoption of “Cloud First” vs. “Cloud Smart” migration strategies, the viability of Multi-Cloud vs. Hybrid Cloud deployment models to diversify workloads, and the incorporation of edge computing architectures for reduced network latency.

The purpose of this presentation is to demystify the fundamentals of cloud computing, and establish important cost estimating considerations when working to define the purpose and scope of a cloud migration effort. Understanding these fundamental requirements and considerations in relation to associated capability gaps can enhance organizational agility, leading to the development of effective cloud migration strategies that satisfy operational objectives.

Classification: UNCLASSIFIED
Working Group: FS01 Analytic Capability Development

60127 - A little knowledge is a dangerous thing

Start Date: 6/15/2022	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Mr. Kenneth A. Amster		

Abstract: This presentation focused on analysts at the beginning of their career. It consists of a presentation on providing a program office data on probably the most important elements necessary for decision making: effectiveness, risk, cost and schedule.

Classification: UNCLASSIFIED
Working Group: FS01 Analytic Capability Development

59618 - Demonstration of SLANG (Summary Linguistic Analysis kNowledge Guide)

Start Date: 6/15/2022	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Julia Haines		

Abstract: The AF possesses massive amounts of data available in text formats. Surveys, contracts, tech data, and many other data sources provide valuable textual information for decision makers; but it is resource intensive to manually read through thousands of documents to generate information for decisional support. SLANG (Summary Linguistic Analysis kNowledge Guide) is an organically developed, no-cost tool that automates textual analysis, modernizing the approach, so decision makers have access to this information in a condensed, reliable and efficient format. It allows analysts to efficiently and effectively work with text-based data.
This tool was created specifically for the Air Force context, and can address multiple types of text data. Although the tool was initially created for survey-based data, any text-based data, to include lengthy document reviews, literature found in base newspapers or magazines, press releases and web-based commentary, can be analyzed with SLANG.
Given text-based data, SLANG provides one-click sentiment analysis, topic modeling, and linguistic charts, all based on best-practice methodologies.
While conducting sentiment analysis, SLANG gives the analyst the ability to make an informed decision about which of the 8 primary sentiment dictionaries their data best matches. This ensures a higher level of accuracy and reliability when analyzing sentiment scores across a data frame. Additionally, users can upload their own sentiment dictionary with context or domain-specific sentiment associations. While conducting topic modeling, users can define their own topics based on a set of key words and key phrases. Paired with sentiment analysis, they can quickly generate topic-specific sentiment scores or investigate topic-specific questions with their data.
SLANG is an R Shiny App, which means all analysts with access to the R programming language can run it on their machine. The results of the tool can also be downloaded and distributed as an HTML tool, which can run on all machines without regard for software dependencies or cost restrictions. Additionally, data results generated from the tool, such as sentiment analysis scores and topic modeling, can be exported in a holistic data frame for easy further exploration and deeper-dive analysis.
SLANG is meant to be a living tool, which means future versions may incorporate additional capabilities on an as-needed or as-requested basis. Suggestions and feedback may be directed to the tool's primary developed, Julia Haines, at julia.haines.1@us.af.mil.

Classification: UNCLASSIFIED
Working Group: FS01 Analytic Capability Development

60302 - Building data Culture- a Blueprint

Start Date: 6/15/2022	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: MAJ Brian Harris		

Abstract: The 2020 DoD Data strategy outlines a vision for a data-centric organization that uses data at speed and scale for operational advantage and increased efficiency. Similar visions are shared across government and the commercial sector, however McKinsey estimates that 92% fail to scale their analytics. This presentation will outline practical steps organizations can take to meet the essential capabilities outlined in the DoD strategy while increasing governance, agility, proficiency, and community.

Classification: UNCLASSIFIED
Working Group: FS01 Analytic Capability Development

60165 - Squeezing Insights out of 4 Million Air Force Contract Documents

Start Date: 6/15/2022	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Ojustwin Naik		
Abstract: This presentation demonstrates the value of harnessing 4.1 million Air Force Contract documents for supporting U.S. Air Force Logistics and Maintenance use cases. This includes an overview of multiple Air Force use cases such as Audit Support, Category Analysis, and Intellectual Property Rights that were enabled by the Text Mining efforts. Although the presentation will focus on the business value of use cases it will also include a brief overview of the technical infrastructure including tools, techniques (ML/AI), pipelines, and data environment that were developed to support the business use cases. Classification: UNCLASSIFIED Working Group: FS01 Analytic Capability Development		

59985 - SURVEYOR: A DISA BDP as an All-Domain Analytics Platform

Start Date: 6/15/2022	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Mr. Joseph W Kidwell; LTJG Evan J Twarog		
Abstract: The Defense Information System Agency (DISA) Big Data Platform (BDP) was founded in 2014 as a secure solution to collect, store, and analyze large amounts of structured and unstructured data across DoD Information Networks. This Government-Off-The-Shelf solution has brought agencies into the 21st century for data storage; increasing connection amongst DoD information systems and allowing the removal of "on premise" hardware/software from inventories. Historically, the DISA BDP largely evolved as a cybersecurity tool, and many of its current applications pertain primarily to cybersecurity activities. Chartered with establishing an Integrated Data Environment, the U.S. Coast Guard's Data Readiness Task Force (DRTF) implemented the Coast Guard's first DISA BDP, SURVEYOR, and is tailoring the platform to personnel training management use cases. The DRTF is utilizing initial use cases to implement data governance and tagging standards to organize the information and make it easily searchable for analysis. Data tagging enables security standards where users can only see specific data sets based on their authorizations, which enables data sharing across the BDP network. Perhaps most importantly, once in the SURVEYOR data lake, U.S. Coast Guard data from multiple disparate systems can be analyzed together, which provides the necessary foundation for future investments in machine learning. Classification: UNCLASSIFIED Working Group: FS01 Analytic Capability Development		

60444 - Using Linear Programming to Create Optimal Budget Scenarios

Start Date: 6/15/2022	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Cadence Doyle		
Abstract: Within the National Nuclear Security Administration (NNSA), federal program managers rely heavily on their contractors at Department of Energy (DOE) laboratories to plan their budget. Each site is asked to prioritize investments internally, and communicate those priorities back to the program offices. Federal program managers must weigh these competing priorities across all laboratories to make funding decisions. How can the enterprise ensure it is using its dollars to buy down the most amount of risk?		

In this study, we deliver an analytical approach to create optimal budget scenarios. Using an operations research technique, linear programming, we are able to mathematically derive the "optimal" way to spend dollars on the recapitalization of programmatic equipment. Combining the risk score and the procurement cost for each piece of equipment, we translate this business question into a system of linear inequalities. While methods explored in this study do not provide a proposed budget for federal program managers, they do provide a way to have a data-driven discussion with laboratories. This process will enable federal program managers to make portfolio-wide decisions in an informed manner.

Classification: UNCLASSIFIED
Working Group: FS01 Analytic Capability Development

60303 - An Exploration of Challenges and Opportunities in Applying Predictive Analysis within the Department of Defense (DOD)

Start Date: 6/15/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: David Azari, Ph.D.; Zebulon Burroughs; Daniel Crawford		
Abstract: Predictive analysis (PA) uses accessible data to anticipate patterns present in new or different data. This presentation provides a primer and overview of predictive analysis, and summarizes insights from a grass-roots effort to curate PA opportunities across Army Futures Command and DOD organizations. Join this presentation to explore analyst perspectives on common challenges / opportunities within National Security organizations in (1) applying PA techniques and (2) sustaining the resulting capabilities. Classification: UNCLASSIFIED Working Group: FS01 Analytic Capability Development		

60267 - Improving data pipelines via RShiny Dashboards

Start Date: 6/15/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Capt Dylan Hyder		
Abstract: Data pipelines help to aggregate, organize and move raw data from various collection sources to a desired repository. Improving the efficiency of this process can enhance the analytic capacity of an organization. This presentation demonstrates how RShiny dashboards, which are available to the Air Force Analytic Community (AFAC) via the Chief Data Office (CDO) VAULT platform, have been used by the 86th Fighter Weapons Squadron to streamline their data workflow. Classification: UNCLASSIFIED Working Group: FS01 Analytic Capability Development		

59971 - No black boxes: explaining ML model explain-ability

Start Date: 6/15/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Joseph Troy Morgan		
Abstract: Machine Learning models are often accused of being "black boxes", much to the chagrin of any dutiful analytic profession worth the length of their latest code. However, many advanced techniques are now commonly available to be able to explain high level and individual observation/prediction level insight, unfortunately making your explanation of decisions to leadership more complicated than "I don't know why the black box model predicted that." Several methods and examples will be shown and their advantages/disadvantages discussed.		

Classification: UNCLASSIFIED
Working Group: FS01 Analytic Capability Development

60298 - Workforce Retention Modeling with Survival Analysis

Start Date: 6/15/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Craig Nilson		
Abstract: This presentation will provide an overview of how survival analysis is used by the U.S. Coast Guard's Office (USCG) of Strategic Workforce Planning & HR Analytics to estimate retention probabilities over time for service members. It will center on the capability lended by analysis techniques which do not require decades of data, tracking individual careers, for such analysis. It will highlight examples of how the results of survival analysis have been used in the USCG including metrics that assess disparities between demographic groups as well as how policy has been strategically applied to improve the retention of underrepresented groups. Finally, the presentation will briefly explore how the retention probability estimates produced by survival analysis provide a basis for sampling agent survival times in discrete, event-based simulation models. Classification: UNCLASSIFIED Working Group: FS01 Analytic Capability Development		

59758 - Accelerate the Path to Data Dominance - Databricks LakeHouse and DoD Resources Overview

Start Date: 6/15/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Lisa Marcus		
Abstract: Did you know as a DoD analyst, Data Scientist, Data Engineer or Operational Analysts you have access to some of the hottest tools/capabilities in Data, ML/AI and advanced analytics today? Do you know there is self-paced training, coaching, and expertise available to you to assist you? Spend some time with the Databricks Federal DoD team to learn about all the resources available to accelerate and super charge your skills to achieve information dominance and mission impact. Explore where and how you might leverage these open tools and skills development on both Azure and AWS Gov clouds. Explore the use of the LakeHouse Platform, MLFLOW, Delta, collaborative, multi-lingual notebooks, templates for key use cases such as cyber, insider threat, fraud, logistics, predictive maintenance, demand forecasting and more. Propel your skills and insights further to focus on data dominance and digital transformation leadership by taking greater advantage of these resources on Government clouds. Classification: UNCLASSIFIED Working Group: FS01 Analytic Capability Development		

59704 - MILCON Parametric Cost Estimating in R

Start Date: 6/15/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: John H Woodcock, Jr		
Abstract: Military planners are often faced with basing and force posture decisions in support of service or Joint integrated deterrence requirements. These planners typically need to leverage the expertise of real property and installation subject matter experts to assess the various courses of action (CoAs) that they develop. However, DoD provides planning factors and a well-established methodology for conducting a rough order magnitude estimate that is suitable for the 'what-if' and		

sensitivity analysis military planners often need. This process can be largely automated to assist them with developing feasible, cost-effective CoAs. The aim of this presentation is to introduce some of the publicly available MILCON and sustainment data, the estimating methodology, then propose a concept for a questionnaire-based tool that can assist military planners with CoA or scenario development.

Classification: UNCLASSIFIED
Working Group: FS01 Analytic Capability Development

59947 - Air Force VAULT Platform: Enabling Distributed Analysis and Data Driven Decisions

Start Date: 6/16/2022	Start Time: 8:30 AM	End Time: 9:00 AM

Authors: Mr. Christopher Gillie; Clare Bolin; Mark Bryant; Mr. Isaac Jerome Roberts, IV

Abstract: Before the VAULT Platform, building data analytic pipelines and creating data visualizations was a great effort. An individual use case faced a variety of time intensive challenges including discovering and accessing the correct data, finding the right analytical tools, and hiring technical experts, to name a few. Fortunately for the AF enterprise, the VAULT Platform, hosted in AWS GovCloud up to the secret level, gives users access to over 50 authoritative AF data sources and the ability to extract, transform, and load their own data within a secure, cloud-based environment. The VAULT Platform equips airmen, space professionals, and civilians to execute an analytic use case through its lifecycle with industry leading tools and resources. Data munging and analysis tasks are made easy with Zeppelin, Databricks, and Trifacta, which provide robust and scalable solutions at your fingertips. Combining the curated data sets and visualization tools already within the VAULT, tools that include Tableau, Plotly Dash, and RShiny, users are empowered to solve problems using machine learning, create visualizations, and make solutions accessible to Senior Leaders and across the enterprise. With the help of the VAULT Platform, you and your teams are empowered to bring your data analysis into the 21st century.

Classification: UNCLASSIFIED
Working Group: FS01 Analytic Capability Development

59689 - Air Force Analytic Cloud Environment and Collaboration

Start Date: 6/16/2022	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Bryan Fagan

Abstract: In July 2020, the Air Force Analytic Community began the transition from desktop enabled applications to cloud analytics. Since the start of the transition the tools provided to the Air Force Analytic Community include five different software tools, two educational platforms, and one assessment tool. All of these tools combine to ensure operations research analysts have the right tool for their analytics with the appropriate training. During this presentation, you can learn about the different tools adopted by the Air Force Analytic Community, some sample projects completed from the community, and the way these tools come together to increase collaboration for the Department of the Air Force.

Classification: UNCLASSIFIED
Working Group: FS01 Analytic Capability Development

60553 - Understanding Quantitative Dimensions of Behavior – Why it Matters in Data Analytics

Start Date: 6/16/2022	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Dr. Kenneth W. Lewis
Abstract: In 2022 and beyond, Data Analytics & Big Data continue to be the new poster-boy buzzwords that add excitement and sparkle to the otherwise drab topics of statistics, operations research, quantitative methods, data analysis and management science. Sometimes our young or inexperienced analysts will use the wrong measurement or dimension of the behavior they are studying. They might mistakenly think they are studying the frequency of that behavior, when in fact they should actually be studying the magnitude, longevity or cost of that behavior. Understanding exactly what type of dimension of behavior the analyst is studying provides clarity and validity to the research study process. It determines the type of analysis that the research project requires. If you see the recorded data point of (7), what does it mean? Kenneth Lewis, who has taught operations research, quantitative methods and educational research methods for over 36 years, will connect some of the dots of what to measure, how to analyze and how to interpret the results. Keywords: Data Analytics, Dimensions of Behavior, Research Methods, Computer Technology, Research Action Verbs Classification: UNCLASSIFIED Working Group: FS01 Analytic Capability Development

59831 - Accelerating Government Decision Making with Data Literacy

Start Date: 6/16/2022	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Gabrielle Cappadona		
Abstract: Data Science has fundamentally changed how government agencies make decisions, build solutions, and plan for the future. Yet as government agencies look to extract value from data at scale, the lack of data literacy and culture remain the biggest impediment towards operationalizing data at scale. This talk will dive into the value of data literacy within government agencies, and how it's the pillar of building sustainable data cultures. We'll discuss the skills that make up the data literacy spectrum, and how they are transferrable across domains, and how they can be leveraged by government agencies across the board. Finally, we'll cap it off on best practices for beginning an upskilling journey in data science, and how DataCamp can enable individuals of all skill levels and ambitions to accelerate and measure their learning progress, and start applying what they learn quickly. 3 takeaways for the audience: - An understanding of how data literacy is the basis of building sustainable data cultures - How data skills can enable government agencies to be more reactive and proactive when providing value to citizens - How DataCamp can enable individuals of any skill level and ambition to accelerate their learning progress Classification: UNCLASSIFIED Working Group: FS01 Analytic Capability Development		

60102 - Application Design Supporting the Army's Continuum of Analysis

Start Date: 6/16/2022	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Myles Durkin; COL Justin W. Brown; Brian Wade; Mr. Mark Young		
Abstract: The Army Continuum of Analysis (ACA) supports Army Senior Leaders' decisions around modernization efforts spanning across time from the current force to the deep futures. The ACA provides a framework to elicit decision needs and focuses the Army Analytic Community around those needs. The Center for Army Analysis (CAA) and The Research and Analysis Center (TRAC), working with the broader Army Analytic Community, established the ACA to establish the framework, identify gaps in analytic support to major decisions, and provide awareness and synchronization of analytic studies. The synchronization is primarily facilitated by a series of applications using R (Flexdashboard and Shiny) to display the ongoing and planned study efforts. The application facilitates data entry and storage, visualizes the results for Synchronization of the Army Analytic Agenda Committee (SAAC) meetings, and provides a mechanism for literature review at the start of a new effort. This talk provides an overview of the ACA framework, highlights the value and challenges of prototyping, and discusses the teams' application design methodology and lessons learned. Classification: UNCLASSIFIED Working Group: FS01 Analytic Capability Development		

60461 - Army Vantage- Update from the Product Office

Start Date: 6/16/2022	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: John H Woodcock, Jr		
Abstract: *placeholder--will update when presenter is finalized*. Currently engaging with PEO-EIS, Vantage Product Office to provide a brief on the latest capability developments for Army Vantage Data Analytics platform. More to follow soon. Classification: UNCLASSIFIED Working Group: FS01 Analytic Capability Development		

60262 - Analysis + Trust + Communication + Experience = Awesome Analytics!

Start Date: 6/16/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Mr. Walt DeGrange		
Abstract: How does an Analytics Professional learn the skills required to convince people to use their analytics? The math is important, but APs try to persuade people, not computers. This presentation introduces the human-to-human aspects of analytics that are seldom covered, such as building swift trust, communicating small atomized bits of statistics, and how to gain experience quickly. We use several examples, such as an award-winning kidney donation model, sports analytics, and a U.S. Navy supply ship scheduling model, to demonstrate these techniques. Classification: UNCLASSIFIED Working Group: FS01 Analytic Capability Development		

60031 - Analytic Capability Development Focus Session Hotwash

Start Date: 6/16/2022	Start Time: 2:00 PM	End Time: 3:00 PM
Authors: Christopher Santos; Chad Kimmel		

Abstract: This is a 60-minute session hotwash for the 90th MORSS Analytic Capability Development (ACD) Focus Session. All persons interested in professional development, training opportunities, and hardware/software availability for the analyst are welcome to attend. Feedback on the conduct and content of the week's focus session presentations are welcome. We will also begin a roster of those willing to keep abreast of future ACD developments in the future, or who would like to participate in advancing ACD within the broader MORS community.

Classification: UNCLASSIFIED
Working Group: FS01 Analytic Capability Development

Special Session

60312 - Resilience Training for Critical Infrastructure: A TTX for Climate-Driven Surprise

Start Date: 6/13/2022	Start Time: 1:00 PM	End Time: 4:00 PM

Authors: Prof. David L. Alderson; Daniel A Eisenberg; Dr Thomas P Seager

Abstract: This year at the Military Operations Research Society (MORS) 90th Annual Symposium, Working Group 3 (Infrastructure Analysis, Protection, & Recovery) would like to showcase multidisciplinary work contributing to the analysis, protection, and recovery of critical infrastructure (CI) systems in US and Allied nations in the presence of climate-driven threats. Alongside more frequent and disruptive natural disasters across the world seems to be a recurring sense of surprise; despite increased warnings on the part of climate scientists and policy-makers, system managers are too often caught unprepared by extreme weather events that stress CI systems beyond their capacity and threaten mission failure.

Our starting point is simple: even in information-rich contexts (1) we will continue to experience things that we have not seen before (i.e., the future is not going to be like the past), (2) surprise will happen, and (3) we need to invest to be better prepared for surprising events. At the heart of the matter is: how to be better prepared for things that have not happened before? Table Top Exercise (TTX) events serve as one potentially important type of preparatory activity for developing resilience.

This workshop builds on recent work to develop theory and methods for training and education that help participants understand, study, and learn from surprise events [1]. Participants will be asked to play the role of key decision-makers for the operation of a “realistic, yet fictitious” CI system that is challenged by climate-driven extreme events. Participants will learn first-hand about the processes that create adaptive capacity and the ways these processes can break down to understand the ways CI systems become surprised, what the consequences of these surprises might be, and how surprise events can manifest in uncertain future climates.

The ultimate goal of this TTX is for participants to experience surprise and thereby improve their expertise on the resilience of CI systems.

[1] Alderson DL, Darken RP, Eisenberg DE, Seager TP, 2022 "Surprise is inevitable: How do we train and prepare to make our critical infrastructure more resilient?," International Journal of Disaster Risk Reduction, 72: 102800, 1 April 2022

Schedule: Monday 13 June 2023
Room Size: 20-30 people.

Time allotment: 1/2 day (3 hours)

Please bring your laptop to this session.

Classification: UNCLASSIFIED
Working Group: Special Session

60588 - Rist Prize Competition

Start Date: 6/13/2022	Start Time: 1:00 PM	End Time: 4:00 PM
Authors: David Azari, Ph.D.; Mr. Jed Richards		

Abstract: The Rist Competition is a classified session open to participants who sent in their clearances. We ask that participants please remain quiet during the judging. The three finalists are:

1. "TEMPEST: A custom tool to quickly analyze kill chains" By: Andy Farnsler & Ted Roofner
(1300 - 1400 ET)

1. "ReARMM Analysis" By: MAJ Christine Krueger, CPT Marty Harris, LTC Spencer Timmons, LTC Christy Licklider, MAJ(R) Harvey Smith, Dr. Joshua Jones, MAJ Michael Lee, Dallas Kuchel, and Craig Ferguson
(1400 - 1500 ET)

3. "Optionally Manned Fighting Vehicle (OMFV) Phase II Analysis" By MAJ Seth Church, MAJ Seth Church, MAJ Bethany Dumas, Dr. Joshua Sexauer, Mr. Hector Aguirre, Mr. Evan Bradshaw, Mr. David Castillo, Mr. Matteo D'Andrea, Mr. James Greene, Mr. Arthur Longoria, Dr. Heather Pfeiffer, and Mr. Lloyd Waggoner
(1500 - 1600 ET)

Classification: SECRET NOFORN
Working Group: Special Session

61406 - First Timer Orientation

Start Date: 6/13/2022	Start Time: 1:30 PM	End Time: 2:30 PM
Authors: Ms. Sarah E Stewart		

Abstract: Join members of the 90th Leadership Team to learn how to get the most out of the MORS Symposium. Review the Schedule of events, and strategies for planning which Working Groups and presentations to attend, learn more about the Special Sessions, and how to use the MORS App to create your own personal schedule of events. The team will be available to answer all your questions and assist you to make your MORS Symposium experience worthwhile and fun!

Classification: UNCLASSIFIED
Working Group: Special Session

61052 - 90th MORS Symposium Plenary

Start Date: 6/14/2022	Start Time: 8:30 AM	End Time: 12:00 PM
Authors: Ms. Jennifer Ferat		

Abstract: Join us for the 90th Symposium opening session starting at 0830 with a Keynote address, President remarks along with the announcement of this year's Prize and Award Winners. Following the keynote address will be the MORS sponsor panel.

Panelists include:
Dr. Steven Stoddard, Army Sponsor
Mr. Douglas Hoffman, Marine Corps Sponsor
Ms. Mindy Montgomery, Navy Sponsor
Ms. Virginia "Robbin" Beall, Navy Sponsor
Mr. Wayne Schatz, Air Force Sponsor
Mr. John Garskta, OSD Sponsor
Dr. John Dargan, DHS Sponsor
Moderator: Dr. Les Servi, MORS President-Elect

Classification: UNCLASSIFIED
Working Group: Special Session

61406 - First Timer Orientation

Start Date: 6/14/2022	Start Time: 12:00 PM	End Time: 1:00 PM
Authors: Ms. Sarah E Stewart		
Abstract: Join members of the 90th Leadership Team to learn how to get the most out of the MORS Symposium. Review the Schedule of events, and strategies for planning which Working Groups and presentations to attend, learn more about the Special Sessions, and how to use the MORS App to create your own personal schedule of events. The team will be available to answer all your questions and assist you to make your MORS Symposium experience worthwhile and fun! Classification: UNCLASSIFIED Working Group: Special Session		

61402 - Cyber Warfare Analytic Challenges

Start Date: 6/14/2022	Start Time: 1:30 PM	End Time: 2:30 PM
Authors: Dr David S Alberts		
Abstract: Coming Soon. Classification: UNCLASSIFIED Working Group: Special Session		

61358 - Academia Junior/Senior Analyst Panel

Start Date: 6/14/2022	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Dr. Richard F. Deckro, FS; Dr. Gregory S. Parnell, FS		
Abstract: This session offers an opportunity for junior and midlevel analysts to learn about what it is like to work in academia. The senior faculty members will give overviews of their experiences and describe what it is like to practice OR in an academic setting. The senior faculty members will also define the background an analyst needs to be effective in academia. The Q&A portion of the session gives the junior analysts the opportunity to ask questions specific to their situation		

Classification: UNCLASSIFIED Working Group: Special Session

61350 - Air Force Junior/Senior Analyst Panel

Start Date: 6/14/2022	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Chan Swallow		
Abstract: This session provides junior analysts the opportunity to meet with senior analysts in a small group setting to receive general career and analytic advice from one or more senior analysts in the Air Force. Typical topics include a description of what it is like to work in their organization, amount of education needed for advancement, the best way to become a well-rounded analyst, the relationship of goals to career paths, lessons learned by the senior analyst along their career path culminating in their current position, etc. The Q&A portion of the session gives the junior analysts the opportunity to ask questions specific to their situation. Classification: UNCLASSIFIED Working Group: Special Session		

60159 - Army Junior Analyst Session: Framing and Presenting Analysis to Army Senior Leaders

Start Date: 6/14/2022	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Mr. Martin Dubbs; Bradley W. Pippin		
Abstract: The U.S. Army requires analysts and staffs who can effective frame and present information to senior leaders. Successfully framing and presenting information requires the application of a systematic process of preparation, rehearsal, and critical thinking. The information presented must be objective and relevant to the decision under consideration. Presenters must be sufficiently prepared and confident to employ active listening and dynamically adjust to senior leader feedback. Dr. Steve Stoddard and Mr. Brad Pippin will present their process that they refined over many years as analysts and senior leaders. Classification: UNCLASSIFIED Working Group: Special Session		

61356 - Federally-Funded Research and Development Center (FFRDC) Junior/Senior Analyst Panel

Start Date: 6/14/2022	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Dr. John Andrew Stine; Dr. Stephen Henry		
Abstract: This session offers an opportunity for junior and midlevel analysts to learn about what it is like to work in a Federally-Funded Research and Development Center. The senior analysts will give overviews of their experiences and describe what it is like to practice OR in their organization. The senior analysts will also define the background an analyst needs to be effective in an FFRDC. The Q&A portion of the session gives the junior analysts the opportunity to ask questions specific to their situation. Classification: UNCLASSIFIED Working Group: Special Session		

61354 - Homeland Security Junior/Senior Analyst Panel

Start Date: 6/14/2022	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Dr. John Dargan		

Abstract: This session provides junior analysts the opportunity to meet with senior analysts in a small group setting to receive general career and analytic advice from one or more senior analysts in the Department of Homeland Security. Typical topics include a description of what it is like to work in their organization, amount of education needed for advancement, the best way to become a well-rounded analyst, the relationship of goals to career paths, lessons learned by the senior analyst along their career path culminating in their current position, etc. The Q&A portion of the session gives the junior analysts the opportunity to ask questions specific to their situation. Classification: UNCLASSIFIED Working Group: Special Session

61357 - Industry Junior/Senior Analyst Panel

Start Date: 6/14/2022	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Mr Trip Barber; Dr. Daniel Thomas Maxwell		
Abstract: This session offers an opportunity for junior and midlevel analysts to learn about what it is like to work in industry. The senior analysts will give overviews of their experiences and describe what it is like to practice OR in their organization. The senior analysts will also define the background an analyst needs to be effective in industry. The Q&A portion of the session gives the junior analysts the opportunity to ask questions specific to their situation. Classification: UNCLASSIFIED Working Group: Special Session		

61353 - Marine Corps Junior/Senior Analyst Panel

Start Date: 6/14/2022	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Mr. Douglas Klett Hoffman		
Abstract: This session provides junior analysts the opportunity to meet with senior analysts in a small group setting to receive general career and analytic advice from one or more senior analysts in the Marine Corps. Typical topics include a description of what it is like to work in their organization, amount of education needed for advancement, the best way to become a well-rounded analyst, the relationship of goals to career paths, lessons learned by the senior analyst along their career path culminating in their current position, etc. The Q&A portion of the session gives the junior analysts the opportunity to ask questions specific to their situation. Classification: UNCLASSIFIED Working Group: Special Session		

61351 - Navy Junior/Senior Analyst Panel

Start Date: 6/14/2022	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Ms. Virginia R. Beall		
Abstract: This session provides junior analysts the opportunity to meet with senior analysts in a small group setting to receive general career and analytic advice from one or more senior analysts in the Navy. Typical topics include a description of what it is like to work in their organization, amount of education needed for advancement, the best way to become a well-rounded analyst, the relationship of goals to career paths, lessons learned by the senior analyst along their career path culminating in their current position, etc. The Q&A portion of the session gives the junior analysts the opportunity to ask questions specific to their situation.		

Classification: UNCLASSIFIED
Working Group: Special Session

61355 - OSD/Joint Staff Junior/Senior Analyst Panel

Start Date: 6/14/2022	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Mr. John J Garstka		
Abstract: This session offers an opportunity for junior and midlevel analysts to learn about what it is like to work in OSD and the Joint Staff. The senior analysts will give overviews of their experiences and describe what it is like to practice OR in their organization. The senior analysts will also define the background an analyst needs to be effective in a joint organization along with the ensuing benefits. The Q&A portion of the session gives the junior analysts the opportunity to ask questions specific to their situation. Classification: UNCLASSIFIED Working Group: Special Session		

60161 - Army Special Session: The Army Continuum of Analysis: A Primer

Start Date: 6/15/2022	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Mr. Martin Dubbs; James Amato; Ms. Pamela I. Blechinger; Mr. Patrick J. O'Neill; Sally Sleeper		
Abstract: The purpose of Army Continuum of Analysis (ACA) is to synchronize efforts across the Army Analytic Community. Improved coordination between analysis activities will better support Army senior leader (ASL) decisions by incorporating a greater body of analysis and recommendations to address near, mid, and deep future questions. Improved analytic synchronization will provide support that is more responsive to ASLs as they lead the Total Army to meet the challenges of today and tomorrow. The ACA provides a mechanism to engage ASLs periodically to ensure they address the most important questions to deliver this Total Army. This presentation will provide an overview of how the ACA functions and how it is evolving using examples of its application to ongoing analysis. Classification: UNCLASSIFIED Working Group: Special Session		

62469 - Barchi Honorable Mention: Operationalizing Agile for Military Planners

Start Date: 6/15/2022	Start Time: 3:30 PM	End Time: 4:00 PM
Authors: Ian Wolfe		
Abstract: Agile as a concept was developed in 2001 as software developers rebelled against the constraints of traditional waterfall planning processes. The rapid pace and decreasing cost of innovation rapidly made the software market more complex, and traditional methods of software planning were no longer able to produce good and timely results. Military planning is at a similar point, where planners face complex and rapidly evolving challenges in the form of Irregular and Asymmetric Warfare. Despite this environment, the primary planning tool described by Joint Publication 5-0 – Joint Planning is linear and oriented around backward planning. This presentation examines why linear planning has been so successful historically, as well as why it is no longer up to the task with the aid of the Cynefin Framework developed by David Snowden. Finally, the author proposes an Agile Planning Framework that can be applied to operational problems in the field along a spectrum of complexity.		

Classification: UNCLASSIFIED
Working Group: Special Session

59722 - Building Trust– Effective Strategies for a Positive Work Environment

Start Date: 6/15/2022	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Ms. Renee G. Carlucci, FS; Ms. Brittlea S. Brown; Maggie Dozier; Ms. Sarah E Stewart		
Abstract: 90th MORS Symposium Special Session -Building Trust– Effective Strategies for a Positive Work Environment, Women In MORS Community of Practice Have you ever worked in a low trust environment? Trust is the foundation for building strong teams, creating a positive work culture, and producing results. With the growth of hybrid and remote work arrangements, more teams can fall prey to the damage caused by a lack of trust. Mistrust can increase job stress and diminish motivation which can hinder productivity. The Women In MORS Community of Practice invites you to a Special Session for their June COP Meeting featuring a presentation on effective team- and trust-building strategies as well as some fun and practical exercises. In addition, we will be interviewing our quarterly Trailblazing Women in OR. Join us to learn and network with the Women In MORS Community of Practice members. Classification: UNCLASSIFIED Working Group: Special Session		

59672 - Data Science and Artificial Intelligence CoP Meeting

Start Date: 6/15/2022	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Dr. Nathaniel D. Bastian; Mr. David D. Saranchak		
Abstract: Annual meeting for the MORS Data Science and Artificial Intelligence Community of Practice with the objective to connect data science and artificial intelligence practitioners, researchers, academics and leaders across the national and homeland security community with a common goal of sharing best practices and leveraging the unique tools, techniques and technologies of the field. Classification: UNCLASSIFIED Working Group: Special Session		

60023 - Ethics Special Session

Start Date: 6/15/2022	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Mr. Terrance J. McKearney, FS		
Abstract: Ethical behavior is critical in the practice of OR; OR practitioners need to be seen as honest, forthright, and dedicated to the highest principles of honesty. This workshop, hosted by the MORS Ethics Committee, will review the MORS Code of ethics and as well as review the current thought in professional ethics for analysts and the ethical issues often faced by practicing analysts A popular session in past MORSS, the Ethics Special Session will allow junior and senior analysts from both industry and government to explore ethical issues and discuss the role of ethics in their efforts to provide forthright and honest assessment. Because attaining these ideals is a matter of constant practice and self-awareness, the Special Session will feature not only a presentation on current ethics regulations and concepts, but a workshop/seminar, where participants will be challenged to respond to a series of situations where ethical issues in the conduct of their work as analysts will be		

challenged. As in past sessions, this will result in a lively dialogue on the ethical challenges analysts face.

Classification: UNCLASSIFIED
Working Group: Special Session

59224 - Heritage Special Session - The History of Operations Research in the United States Marine Corps

Start Date: 6/15/2022	Start Time: 3:30 PM	End Time: 5:00 PM

Authors: Mr. John Moskowitz

Abstract: In honor of this year's MORS Symposium being convened at Marine Corps Base Quantico, and in celebration of the historic 90th event, the Heritage Committee Special Session will focus on the history of Operations Research in the United States Marine Corps.

Over the past many decades, military and civilian analysts working for the Marine Corps have made invaluable contributions to the field of Operations Research, which have been recognized by the Society in the form of prizes and awards and even fellowships. Through data mining, optimization, statistical analysis, modeling and simulation, and other computational techniques, Marine Corps analysts have provided meaningful, impactful analyses that have served to secure and strengthen the nation while also helping to protect its interests. While climates and crises may have changed over the years, analytical rigor has remained resolute.

A moderated panel will feature individuals who have made significant contributions to Operations Research throughout their careers with the Marine Corps, with each offering a unique perspective. In addition to questions posed by the moderator, the audience will have the opportunity to actively engage with the panel members.

We hope you will join us for this insightful and informative event.

Classification: UNCLASSIFIED
Working Group: Special Session

60429 - Marine Corps Force Design Affordability Analysis

Start Date: 6/15/2022	Start Time: 3:30 PM	End Time: 5:00 PM

Authors: Elena Heit

Abstract: The Marine Corps' concept for Force Design 2030 calls for major changes across the service both structurally and programmatically. These changes created significant shifts in programmed resources and re-prioritized future funding in an already fiscally-constrained environment. The Marine Corps' Programs and Resources (P&R), Program Analysis and Evaluation Division (PA&E) has developed a repeatable process to assess affordability of USMC programs with respect to the USMC topline, Force Design, and relevant portfolios within the current and potential future budgetary environments. Through this process, P&R created a framework for assessing current and future programs that drive or constrain FD implementation. This assessment included a 15 year look beyond the current base year of the Program Objective Memorandum (POM) cycle, and included Force Design, the Aviation Plan (AVPLAN), the Ground Combat Tactical Vehicle (GCTV) Plan, and the Network Modernization (NETMOD) Plan. P&R developed a Tableau-based tool to facilitate capital planning and strategic risk analysis. It is envisioned that P&R's FD affordability study will provide a

centerpiece for the detailed costing of all of the Commandant of the Marine Corp's Force Design transformation initiatives for the Supporting Establishment and Organizational Commands.

Classification: UNCLASSIFIED
Working Group: Special Session

60236 - Undersea Warfare (USW) Community of Practice

Start Date: 6/15/2022	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Dr. Michael W. Kopp		
Abstract: The Undersea Warfare Community of Practice will hold a general analysts' meeting of present and prospective COP members. During this session, COP leadership will review COP operations for the last year, invite discussion on COP vision and near term objectives and solicit input from membership for future meetings, operations and projects. Classification: UNCLASSIFIED Working Group: Special Session		

60909 - Barchi Winner Presentation

Start Date: 6/16/2022	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: David Azari, Ph.D.		
Abstract: LTC Paynter, Jonathan L. Operations Research Center, MIT Army Officer Manpower Readiness: Measuring the Price of Professional Development Guidance Military leaders must ensure that the organization has the right types of personnel to meet its needs for hundreds of thousands of personnel with various ranks and specialties. Additionally, the lack of lateral entry for mid-grade and senior-grade leaders means that ensuring that a future pool of personnel has the requisite skills requires guidance and monitoring of individual skill development during a service member's career. The career path guidance can lead to system bottlenecks that create a surplus of personnel waiting for certain positions and a shortage of personnel available for other positions, hurting the organization's overall readiness. This paper presents a method for understanding the readiness price caused by career path professional development guidance. We model personnel readiness, constrained by career path policy, with a linear programming formulation that determines the optimal volume of people on each career path to minimize organizational readiness shortfalls. We extend this formulation with two methods to select the best additional career paths to improve readiness. We leverage data on the assignment histories of thousands of active-duty U.S. Army officers as a use-case, and provide three main insights for Army personnel leaders. Classification: UNCLASSIFIED Working Group: Special Session		

60022 - Becoming a MORS Author

Start Date: 6/16/2022	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Mr. Terrance J. McKearney, FS		
Abstract: Promoting the professionalism and advancement of operations analysis in the support of national security through publishing is a primary mission of MORS. The Society offers several		

publishing platforms for analysts to share their work: the journal Military Operations Research (MOR) is a peer reviewed academic periodical that provides authors the opportunity to publish their work in a highly regarded, formal forum. The Phalanx is the Society's quarterly magazine that shares information about Society activities, publishes thoughts and opinions from the community's leasers, and allows practicing analysts the opportunity to share their current work with colleagues. Finally, MORS publishes a range of books and monographs on analytic techniques and procedures. During this session, members of the Society's Publications Committee, the MORS staff, and the editors of MOR and Phalanx will discuss opportunities for publication in each of these venues and the steps aspiring authors should take in getting their work in print.

Classification: UNCLASSIFIED
Working Group: Special Session

59941 - Center for Army Analysis (CAA) Analyst Professional Development Guide

Start Date: 6/16/2022	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Ms. Sarah E Stewart		
Abstract: Within CAA's analytic workforce, analysts have different job requirements, career interests and goals, and varying backgrounds and skill levels; therefore, they require different professional development to progress their careers. CAA has developed a guide for analyst professional development no matter their background, skills, or career goals. The CAA Analyst Professional Development Guide provides a model for CAA civilian analysts to use as a reference document as they develop their annual appraisal objectives and plan their career progression. The authors will present the CAA Analyst Professional Development Guide for other analytic organizations and outside analysts to adapt for their own use and will seek feedback on the guide for future CAA improvements. Classification: UNCLASSIFIED Working Group: Special Session		

60361 - Human Behavior and Performance Community of Practice

Start Date: 6/16/2022	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Dr. Susan K. Aros		
Abstract: Come join the Human Behavior and Performance (HB&P) Community of Practice (CoP) kick-off session. The HB&P CoP will cover a broad spectrum of research topics such as human machine interface, performance of our forces on the battlefield, and the behaviors of our allies and adversaries. Effective modeling of HB&P requires an interdisciplinary approach and may include specialists in disciplines such as cognitive science and physiology, psychology, sociology, operations research, and efficient experimentation design and analysis. The goal of the HB&P CoP is to provide a place for researchers in this area to connect and a forum to share our research. In this session we will provide more information and invite your input as we get this CoP rolling. Classification: UNCLASSIFIED Working Group: Special Session		

60104 - Integrated Deterrence Working Special Session

Start Date: 6/16/2022	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Mr. David D. Saranchak		
Abstract: Throughout 2021, the United States Secretary of Defense, Lloyd J. Austin III, gave several speeches that offered insights into how the international security community could overcome significant modern-day threats to democracy. He named the unifying principles "Integrated Deterrence" and stated that this policy would be a vital component to the National Defense Strategy (NDS). While the NDS remains unpublished as of late February 2022, SECDEF Austin has said that evidence of this strategy can be observed in the response to the Russian invasion of Ukraine. This will be a working session that complements a portion of the Symposium Sponsor's Panel discussion on published components of the NDS and observable evidence of this strategy in action. The intended output from this session are products to support further development of this Operations Research community, to include: - Complete a literature review of how each of the 5 Eyes Partners supports this strategy with the applicable scientific and operations research methods for quantitative measures of evaluation, both in war gaming competition and in conflict. - Establishing commonalities and differences in these implementations. - Develop an initial common framework that includes theory, application and limits to its application. - Publish findings in an appropriate MORS publication. - Ascertain the feasibility of a permanent MORS working group around the doctrine and, if relevant, a timeline of proposed actions. - Feasibility of a MORS Special Meeting on the topic and, if relevant, a timeline of proposed actions. Classification: UNCLASSIFIED Working Group: Special Session		

60659 - U.S. Coast Guard Data, Analytics, and Integration

Start Date: 6/16/2022	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Mr. John R. Cobb, IV; CAPTAIN Brian Erickson; CAPTAIN Michael Lachowicz		
Abstract: Senior data, analytics, and performance leaders within the U.S. Coast Guard (USCG) will discuss the current and future state of analysis within the organization. Agenda topics include acquisitions in support of data readiness, improving enterprise-level analyses and impact, championing organizational change, and the expanding USCG analyst community. Additional topics include challenges facing USCG analytics and data. Classification: UNCLASSIFIED Working Group: Special Session		

Tutorial

59607 - Antifragility and Future Conflict: A Tutorial

Start Date: 6/13/2022	Start Time: 8:30 AM	End Time: 10:30 AM
Authors: William Buppert		

Abstract: Operations research needs to acquaint itself with the limits of modeling and the pitfalls of insufficient and misguided asymmetrical evidentiary bars. Antifragility offers not only an explanatory framework of black swan events but creates opportunities for organizations to build themselves from the ground up to be adaptable and resilient in the face of crisis and conflict.

This tutorial will introduce the novice to the concepts of antifragility and how the model may create new ways of looking at future conflict, achieve adaptive frameworks, improve conflict forecasting and better explain ways to build military organizations that respond to violence and capability degradation in a way that parallels the stressor strength improvement in complex systems.

This brief will discuss how the adoption of antifragility models to template conflict dynamics and build resilient learning organizations that improve with stress optimizes the western ability to survive peer and near-peer conflicts in the future. Problem structuring methods (PSM), morphological analysis and other operations research methodologies will be used to tackle the wicked problem sets in antifragility.

Classification: UNCLASSIFIED
Working Group: Tutorial

60100 - Data Science in the Cloud: Accelerating the Machine Learning Lifecycle through Amazon SageMaker

Start Date: 6/13/2022	Start Time: 8:30 AM	End Time: 2:00 PM
Authors: Michael Liu; Mr. Shaun Doheney		
Abstract: Today, organizations have access to an ever-increasing amount of data. To leverage this growing collection of data, projects require machine learning (ML) capabilities to scale and deliver insights to the workforce. In this tutorial, attendees will gain hands-on experience in the end-to-end lifecycle for building and deploying machine learning models on various forms of data such as text and imagery. The tutorial will leverage Amazon SageMaker, a fully managed end-to-end machine learning service that enables data scientists, developers, and machine learning experts to quickly build, train, and host machine learning models at scale. Attendees will go through hands-on exercises that will take them through setting up an ML environment, preparing data for machine learning, performing model training via distributed training and automated hyperparameter optimization, and deploying models trained for inference. Attendees walk away from the tutorial with the tools needed to train ML models, giving them the capability to deploy production capable models. Cloud enthusiasts are welcome to join to gain a better understanding of the cloud and the opportunities to perform machine learning and analytics at scale. Classification: UNCLASSIFIED Working Group: Tutorial		

60908 - Intro to Data Science for Digital Forensics

Start Date: 6/13/2022	Start Time: 8:30 AM	End Time: 5:00 PM
Authors: Dr. Shannon Gallagher		
Abstract: Data are ubiquitous and critical in decision making processes in the field of digital forensics. In this tutorial, we will cover some of the core concepts of data science including exploratory data analysis and hypothesis testing. Additionally, we will step through a lab focusing on the application of mis-, di-s, and mal-information (MDM). This session will consist of active engagement from		

participants in addition to hands-on coding modules with Jupyter notebooks. This tutorial is for introductory learners and those who need to be able to understand core data science concepts to make decisions.

Participants are encouraged to bring a laptop to be able to access and work with relevant labs.

Classification: UNCLASSIFIED
Working Group: Tutorial

60480 - Managing Exponential Decision Spaces (MEDS)

Start Date: 6/13/2022	Start Time: 8:30 AM	End Time: 9:30 AM

Authors: Dr Moises Sudit; Dr. Rajan Batta; John Becker; Dr. Katie McConky; Demetrios Papazaharias; Mr. Prashant Sankaran; Jose Walteros

Abstract: Decision-making in the battlefield is based on a huge amount of information that needs to be fused to create not only current situational awareness, but also project the impact to blue forces as well as the potential changes in behavior of red forces. One way to accomplish a set of courses-of-action that will maximize success and satisfy mission objectives is to run a simulation to understand the different potential outcomes and generate probabilities of success based on our actions. The difficulty of such an approach in the middle of a mission is that you need to run enough simulation runs on an environment that is constantly changing and to attain acceptable confident intervals will be impractical or lack of timeliness. It is important to note that simulations are critical to generate enough heterogeneous scenarios and datasets for training, however there is the need of an alternative to be able to decide best course of action when time of the essence. Our tutorial termed Managing Exponential Decision Spaces (MEDS) will assist commanders and decision makers through a variety of analysis and modeling techniques that automate the evaluation of options to take at any given state while presenting the best alternatives in a clear and concise manner for final approval.

Classification: UNCLASSIFIED
Working Group: Tutorial

60153 - Modeling with Streamed Sensor Data – "What to do when your data is a curve."

Start Date: 6/13/2022	Start Time: 8:30 AM	End Time: 9:30 AM

Authors: Dr. Thomas A. Donnelly

Abstract: Sensors that record sequences of measurements are now embedded in many systems. There is information in the shapes of the sensor stream that is highly predictive of the likelihood of a system failure or performance. These data are often being used inefficiently due to lack of knowledge and tools for how to properly leverage it. In this presentation we will show how to fit splines to data streams and extract features called functional principal component scores. Then, we use these features as inputs into machine learning models like neural networks. Answering a wide variety of questions becomes a two-step process of functional feature extraction followed by modeling using those features as inputs. Additionally, it will be shown how when combined with Design of Experiments, one can then model the principal component scores to predict the shapes of data streams as functions of the factors in the design.

Classification: UNCLASSIFIED
Working Group: Tutorial

59814 - Next-Level Poisson Modeling for Military Applications

Start Date: 6/13/2022	Start Time: 8:30 AM	End Time: 12:00 PM
Authors: Dr. Thomas Reed Willemain; Dr. Nelson Seth Hartunian; Brock Osborn		
Abstract: Demand forecasting, inventory management and maintenance operations all have a history of using the Poisson model for event counts and the related exponential model for component lifetimes. We will review these first-level models, then present their second-level elaborations: the Negative Binomial model for counts and the Weibull model for lifetimes. Finally, we will introduce a little-known third-level model for counts: the doubly-stochastic Poisson process, also called a Cox process. Estimation of the Cox process is difficult, but the stochastic expectation-maximization algorithm provides a way forward. We will present a basic overview of the stochastic EM algorithm then illustrate how the Cox process can be applied in spares forecasting and automated tipping and cueing. Classification: UNCLASSIFIED Working Group: Tutorial		

60299 - Tableau for the Analyst

Start Date: 6/13/2022	Start Time: 8:30 AM	End Time: 12:00 PM
Authors: MAJ Brian Harris		
Abstract: Tableau is one of the most popular analytics software tools across DoD and the private sector. This tutorial is intended to be a hands-on workshop where participants can learn the basics of using Tableau Desktop, Tableau Prep, and Tableau Server. The tutorial will include content around building products frequently used in the military analytic community as well as cover some additional topics such as advanced geospatial analysis, R/Python integration and advanced analytics. The tutorial will also highlight various DoD and government use cases and community resources. Note: While having Tableau Desktop and Prep installed to allow you to follow along is not required, it is recommended. A trial license will provided during the class if needed. Classification: UNCLASSIFIED Working Group: Tutorial		

60152 - Exploratory Data Analysis & Root Cause Analysis - "What can you do when you don't have a designed experiment?"

Start Date: 6/13/2022	Start Time: 9:30 AM	End Time: 10:30 AM
Authors: Dr. Thomas A. Donnelly		
Abstract: This tutorial demonstrates how to explore data and do root cause analysis for any data set. Analysis is often straightforward when data come from a designed experiment. But when they don't, and the data are messy, and potential predictors are highly correlated, there are still robust approaches to finding what are the dominant factors. This tutorial explores both graphical and statistical tools for getting to the root cause of a process. Methods demonstrated include: Dynamically linking graphs and filtering responses to find correlations. Using easy to understand data mining methods like decision trees. Finding the best design of experiment subset of data within an historical haphazardly collected data set. Using Penalized Regression methods (e.g. LASSO) to do variable selection among correlated factors and reduce the dimensionality of the process space.		

Classification: UNCLASSIFIED Working Group: Tutorial

60562 - How to Validate Your Models and Simulations

Start Date: 6/13/2022	Start Time: 9:30 AM	End Time: 12:00 PM
Authors: Dr. Averill Martin Law		
Abstract: All models and simulations are surrogates for physical experimentation with the system of interest, which is usually impossible, disruptive, or not cost-effective. Thus, if a model is not reasonably “valid,” then any conclusions drawn from the model results might, very well, be erroneous. In this tutorial we present a comprehensive set of techniques for building valid and credible simulation models. Ideas to be discussed include the importance of a definitive problem formulation, discussions with subject-matter experts, interacting with the decision-maker on a regular basis, development of a written "assumptions document" (not the same as a requirements document or a conceptual model), structured walk-through of the assumptions document, use of sensitivity analysis to determine important model factors, comparison of model and system output data for an existing system (if any) using numerical statistics and graphical plots, and comparison of model output data with the comparable output data from another model that is thought to be “valid.” Each idea will be illustrated by one or more real-world examples. We will also discuss the considerable difficulty in using formal statistical techniques (i.e., confidence intervals and hypothesis tests) to validate simulation models. Classification: UNCLASSIFIED Working Group: Tutorial		

60147 - Machine Learning – Using Robust Data Mining Methods

Start Date: 6/13/2022	Start Time: 10:30 AM	End Time: 12:00 PM
Authors: Dr. Thomas A. Donnelly		
Abstract: Through case studies, you'll learn to build better and more robust models with advanced predictive modeling techniques. Featured methods will include many types of regression, neural networks, and decision trees. Part 1 will focus primarily on splitting your data into training, validation (tuning) and test subsets to prevent over fitting. Part 2 will focus on different data mining approaches. You will also see how to use graphical and statistical comparison techniques to help choose the best predictive model. Featured case studies include building a dozen surrogate models of a computer simulation of a helicopter flying surveillance and identifying the best predicting model, as well analyzing the 1998 KDD Cup Cyber Attack Data set with over 40 possible causes of 20 types of attack and building a robust ensemble predictor model. This tutorial is for analysts, scientists, engineers and researchers interested in learning how predictive modeling can help them use the data they have today to better predict tomorrow. Classification: UNCLASSIFIED Working Group: Tutorial		

60585 - How to Leverage Text, Image, and Social Interaction Data for OSINT Analysis: A Hands-On Tutorial

Start Date: 6/13/2022	Start Time: 12:00 PM	End Time: 5:00 PM
Authors: Dr. Onur Savas; Regina Kay;a Catipon; Dr. Lisa Scott Holt; Adam Lind		

Abstract: Open-source intelligence (OSINT) is the collection and analysis of publicly available (PAI) information, such as online activity on social media. A recent example of OSINT analysis include the real-time tracking of Russian military equipment at the Ukrainian border through Twitter and Telegram posts. While the array of data that can be collected from the digital information environment (such as text, image, and social interactions) is powerful, it can also be overwhelming. AI/ML approaches like NLP, computer vision, and network graph models can help operators meet the challenges of large-scale data collection and analysis.
In our tutorial, we will use case studies to walk through example OSINT methodologies such as PAI collection and geo-spatial analysis. We will then demonstrate how AI/ML analytics like topic modeling, sentiment analysis, image classification, social interaction graphs, and bot behavioral analytics can help to improve workflow efficiency. Participants will walk away with an understanding of how to gain better insight by applying AI/ML analytics to PAI. Note: OSINT collection and analysis will be demonstrated on SCRAAWL.

Classification: UNCLASSIFIED
Working Group: Tutorial

60660 - Art of Successful Analysis

Start Date: 6/13/2022	Start Time: 1:00 PM	End Time: 2:00 PM
Authors: Mr. Arthur H. Barber, III, FS		
Abstract: This presentation provides specific recommendations for analytic project leaders on how to organize, execute, and deliver briefings on analytic projects done for senior national security leaders in ways that lead to successful outcomes supporting well-informed decisions by those leaders. It is based on lessons learned across 25 years of leading analytic projects in the Pentagon and 7 years of doing this in private industry. It identifies five steps in the end-to-end process of delivering useful analysis to decision-makers, from focusing the key question through podium style in delivering the end-of-project briefing to a senior audience, and it describes the order and methods by which these steps should be done. Classification: UNCLASSIFIED Working Group: Tutorial		

60148 - Custom DOE – Making Your Experimental Design Fit the Problem

Start Date: 6/13/2022	Start Time: 1:00 PM	End Time: 2:00 PM
Authors: Dr. Thomas A. Donnelly		
Abstract: This tutorial will present solutions to real-world Design of Experiment (DOE) problems. Nearly all of the solutions listed below cannot be achieved using classic textbook DOE. If textbook designs are your only resource experimenters will often change their problem to fit the available designs. It is highly recommended that experimenters instead make their design fit their real-world problem. This tutorial will show how to treat separately and in-combination, factors of the following types: continuous/quantitative, categorical/qualitative, discrete numeric, mixture, covariate, blocking, and hard-to-change. It will demonstrate how to constrain design regions and disallow certain factor level combinations. It will show how to augment or add onto existing experiments. By using both augmentation and constraints it will show how to repair a broken design. It will show how to design for special knowledge of the model. Algorithmic custom DOE is the most efficient way to develop accurate and useful models of real-world processes.		

Classification: UNCLASSIFIED Working Group: Tutorial

59643 - A Gentle Introduction to Battlefield AI and Autonomy for Non-Technical Beginners

Start Date: 6/13/2022	Start Time: 2:00 PM	End Time: 5:00 PM
Authors: Mr. Jerry L. Schlabach		
Abstract: Modern Artificial Intelligence (AI) and Machine Learning (ML) are disruptive technologies that have recently blossomed under the market leadership of the U.S. commercial sector. The U.S. Government, its military competitors, and the global defense industry are racing to militarize these newly refreshed technologies, which ironically owe much of their contemporary existence to U.S. Defense research from previous decades. Future autonomous systems will certainly leverage and weaponize AI/ML technologies, which in turn will likely revolutionize warfare. In response to substantial positive feedback from a set of tutorials, presentations, and special sessions in 2019 through 2021, this tutorial consolidates those presentations to provide a solid conceptual overview for non-technical beginners. This extended session will: - Define and characterize the various levels of military autonomous systems with respect to AI/ML capabilities, human direction, and human trust. - Dispel and re-characterize many common misperceptions about AI/ML and battlefield autonomy, to include the likely technical, moral, and operational limits to weaponization. - Introduce, at a very high level, the AI and ML fields, with focused example applications. - Explain the extraordinary dependency of modern Deep-Learning ML upon the acquisition and conditioning of large amounts of training data (or synthetic models). - Frame the likely military utility of integrating AI/ML into military systems at the various levels of the cognitive domain (Bloom's Taxonomy). Identify which cognitive tasks are likely to remain with humans, and which are candidates for machine reasoning. - Highlight and discuss select OR analytic implications from battlefield AI/ML integration with respect to traditional paradigms such as Commander's Intent and decision-making. - Outline select AI/ML issues related to the future of warfare. Jerry Schlabach is an Engineering Fellow in the Operations Research Department at Raytheon Missile Systems in Tucson, who also co-chairs the newest MORS Working Group (#35), "AI and Autonomous Systems." He has a Master's degree in Computer Science (AI) from the University of Illinois at Urbana-Champaign, as well as a Bachelor's degree in Physics from the United States Military Academy at West Point. In addition to a 22-year Army career in Military Intelligence, he has over 20 years' experience at integrating AI into C4ISR prototypes. Jerry will be asking the other WG-35 co-chairs to co-present, with color commentary, this special session to provide a broader perspective for understanding the impact of AI/ML on future battlefields. Classification: UNCLASSIFIED Working Group: Tutorial		

59377 - A Little Knowledge is a Dangerous Thing

Start Date: 6/13/2022	Start Time: 2:00 PM	End Time: 5:00 PM
Authors: Mr. Kenneth A. Amster		
Abstract: This tutorial is based upon a set of class lectures given in the Naval Postgraduate School's Distance Learning Systems Analysis Curriculum. Its focus is on analysts at the beginning of their		

career. It consists of four parts. The first can best be described as Analysis 101 and it provides an overview of how to approach an analysis task; defining the problem, selecting the best tool, and working with the sponsor to ensure that they get what they need. The Second part is a case study where the audience is expected to ask the hard questions, about assumptions, methodology, and conclusions. The third part is another case study where the focus will be on how to present data and results effectively. The last part is a presentation of providing a program office data on probably the most important elements necessary for decision making: effectiveness, risk, cost and schedule.

Classification: UNCLASSIFIED
Working Group: Tutorial

60309 - How to Depict and Assess Rksk Correctly: the Pandemic Case

Start Date: 6/13/2022	Start Time: 2:00 PM	End Time: 3:00 PM
Authors: Dr. Douglas A. Samuelson		

Abstract: We discuss how to assess various methods of depicting and responding to threats: risk is best expressed as neither a sum nor a product, but rather as a sum of products -- or, in more general form, a multiple Stieltjes integral. This seemingly somewhat daunting depiction greatly clarifies the problem and simplifies readily, as SIPMath ™ provides a quick and easy way to compute probabilities and expected values of consequences. Chancification ™ software, the newest breakthrough from probabilitymanagement.org, then makes it easy to display histograms of risk and locate tipping point values. Deterrent and mitigation effects are then best depicted as the difference between computed risk with and without the proposed measure. We then show how usual metrics of statistical variation can be wildly misleading when assessing risks involving rare, high-consequence events, often leading to grossly inaccurate estimates of risk. Again, proper depiction of risk avoids the pitfalls. Illustrative examples are drawn from modeling scenarios of spread and mitigation of epidemics, including how to estimate whether facilities are likely to be overwhelmed. We note that the same methods and software can be easily adapted to cybersecurity scenarios. We present and discuss how to apply SIPMath and Chancification to develop these kinds of metrics.

Classification: UNCLASSIFIED
Working Group: Tutorial

60149 - Modern Screening Design of Experiments - How to Get More Information from Fewer Trials

Start Date: 6/13/2022	Start Time: 2:00 PM	End Time: 3:00 PM
Authors: Dr. Thomas A. Donnelly		

Abstract: This tutorial is meant to expose testers to the most effective Design of Experiments (DOE) screening methods introduced in the last decade. Attendees will learn about recently published methods for not only efficiently screening factors but for using the data to more rapidly develop second-order predictive models. Definitive Screening Designs (DSDs) will be shown to not only detect main effects and curvature in each factor, but in many cases also two-factor interactions.
DSDs when first published in 2011 could support only continuous factors. Over the last decade methods have been developed to support 2-level categorical factors and blocking. Furthermore, a new way to take advantage of the inherent fold-over structure of row pairs allows for robust modeling of first-order and second-order effects when less than half the factors are active. When the number of significant factors is small, a Definitive Screening design can collapse into a 'one-shot' design capable of supporting a response-surface model with which accurate predictions can be made about the characterized process.

A case study will be shown in which a 10-factor process is optimized in just 24 trials. Checkpoint trials at predicted optimal conditions show the process yield increased by more than 20%. In cases where more than a few factors are significant and the design can't collapse into a one-shot design, the existing trials can economically be augmented to support a response-surface model in the important factors. Graphical comparisons between these alternative methods and traditional designs will show the new ones to yield more information in often fewer trials.

Classification: UNCLASSIFIED
Working Group: Tutorial

60560 - Design of Experiments for Stochastic Simulation Modeling

Start Date: 6/13/2022	Start Time: 3:00 PM	End Time: 5:00 PM

Authors: Dr. Averill Martin Law

Abstract: Simulation models often have many input factors, and determining which ones have a significant impact on performance measures (responses) of interest can be a difficult task. The common approach of changing one factor at a time is very often incorrect, because for many models factors interact to impact on the responses. In this two-hour tutorial we present an introduction to design of experiments specifically for stochastic simulation modeling, whose major goals are determining important factors and predicting model responses for factor-level combinations that were not actually simulated due to execution-time or setup-time constraints, or because predictions are needed in real time. Traditional experimental designs such as two-level factorial, two-level fractional factorial, and central composite do not work well because responses are often nonmonotonic functions of the factor levels and because three-factor (or even higher) interactions may be present.

We then discuss Latin hypercube designs that are often more appropriate for the complex response surfaces seen in simulation models. This is followed by a presentation of metamodels (surrogate models) based on regression, neural networks, and Gaussain process models (Kriging).

Classification: UNCLASSIFIED
Working Group: Tutorial

60150 - Efficient Modeling & Simulation Using Design of Experiments Methods

Start Date: 6/13/2022	Start Time: 3:00 PM	End Time: 4:00 PM

Authors: Dr. Thomas A. Donnelly

Abstract: This presentation will show how Design of Experiments (DOE) methods can be used to extract the most useful information from the smallest number of computer simulation runs. By sequentially running blocks of simulations, computer experimenters can conduct the overall fewest trials necessary to do sensitivity analysis of the factors being studied without over-utilizing high performance computing resources. The greatest benefit occurs when fast-running (seconds) surrogate model can be developed for long-running (hours, days or weeks) simulations.
The fast surrogate model enables testers and analysts to interactively query the modeled process to find optimal operating conditions or the frontiers of the acceptable operating window. These conditions of high interest can then be run using the full simulation to both validate the surrogate model as well as increase the accuracy of prediction. Design solutions demonstrated will include the application of traditional DOE methods to discrete event and agent-based simulations, and modern

space-filling designs to more complex physics-based simulations such as Computational Fluid Dynamics (CFD).
When to use, and how to choose among traditional linear regression approximation methods and spatial regression interpolation methods will be discussed. The effective practice of using checkpoint simulations for determining the accuracy of surrogate model predictions will be demonstrated.

Classification: UNCLASSIFIED
Working Group: Tutorial

60498 - Human Factors in Data Visualization

Start Date: 6/13/2022	Start Time: 3:00 PM	End Time: 5:00 PM
Authors: Dr. Paul M. Thompson		
Abstract: This tutorial treats some of the Human Factors aspects of visual cognition that are important in designing effective data visualizations in defense planning and analysis. We review some of the characteristics of human visual processing, illustrate how to leverage them to design effective data displays, and show examples that fail to account for these factors. We draw material from several of fields of study, including Cognitive Psychology, Visual Analytics, Scientific Visualization, Exploratory Data Analysis, and Statistics. Classification: UNCLASSIFIED Working Group: Tutorial		

60044 - Strategic Analytics for National Defense and International Security

Start Date: 6/14/2022	Start Time: 3:30 PM	End Time: 4:30 PM
Authors: Dr. Greg H. Parlier, COL, USA (Ret)		
Abstract: This tutorial orients on the future of our Military Operations Research profession: “Where do we need to be going?”; “What should we be doing?”; How can we address, in imaginative and creative ways, the many persisting problems and seemingly intractable national and global security challenges that confront us? Strategic Analytics, the alignment of optimization methods, predictive models, and descriptive techniques with the “ends-ways-means” strategy paradigm, is presented. To fully capitalize on advances in information technologies and rapidly growing Big Data opportunities, the complementary power of operations research, data sciences, and management innovation will be essential. Functional components and enabling disciplines are described: decision support capabilities, engineering systems, dynamic strategic planning, and “engines for innovation” to encourage and guide transformational endeavors. Three recent applications of Strategic Analytics to enterprise system challenges are described and explored: defense resource planning, global logistics supply chains for materiel readiness, and recruiting for the All Volunteer Force. We must integrate our intellectual capacities, considerable strategic planning acumen, diverse analytical capabilities, and bring them all to bear on formidable national and international security challenges of our time. Our Nation and partners across the globe will surely benefit from such a commitment on our part. Classification: UNCLASSIFIED Working Group: Tutorial		

WG01 Strategic Operations National Security Analysis

59174 - Forward Posture and Deterrence of Hostile Measures Below Armed Conflict

Start Date: 6/14/2022	Start Time: 1:30 PM	End Time: 2:30 PM
Authors: Dr. Stephen Watts		

Abstract: Academics and practitioners have long debated whether the forward presence of conventional military forces exerts any observable influence on competitors' use of hostile measures below the threshold of armed conflict. Some believe that the successful establishment of deterrence at the nuclear and conventional levels pushes competition down to the sub-conventional level. The Office of Policy Planning, for instance, worried that U.S. posture enhancements in Europe in the 1980s might cause the Soviets to increase support for insurgencies in other regions. Others believe that forward-positioned forces can deter both conflict and lesser forms of malign activity. For example, some at the State Department believed a drawdown of U.S. forces in Italy to support the war in Vietnam would embolden the Soviets and various Arab regimes in the Mediterranean region to undertake aggressive measures below the level of direct armed conflict. But there is no consensus about which effect might predominate – or if there is in fact no general relationship.

In this paper, we use regression analyses to analyze the relationship between the forward presence of U.S. military forces and competitors' use of hostile measures below the level of armed conflict. Using data derived from a large number of existing social-science datasets, as well as datasets that RAND has developed from both military sources and through synthesis of other open-source datasets, we examine the relationship between U.S. forces both in and nearby U.S. partners and allies and a range of adversary activities – arms transfers, economic coercion, proxy support, military intimidation, and the limited use of force – in the post–World War II period. To account for common challenges to causal inference, we use two-stage models in which we first predict the likelihood of U.S. troop deployments based on predictors common in the literature and then use propensity-weighting methods to reduce anticipated selection bias.

Findings suggest that U.S. military forward presence does condition competition dynamics, but it does so in subtle and complex patterns conditioned by factors such as U.S. forces' proximity to competitors and the persistence or predictability of the U.S. forces' presence and activities. The deterrent impact of U.S. forward posture on hostile measures below the threshold of armed conflict will seldom be enough by itself to justify the costs and risks of substantial overseas presence. It is, however, one important factor in a broader competition strategy. The findings have implications for emerging concepts of integrated deterrence as well as earlier concepts such as dynamic force employment.

Classification: UNCLASSIFIED
Working Group: WG01 Strategic Operations National Security Analysis

59832 - Game Theory Framework to Evaluate Nuclear Deterrence

Start Date: 6/14/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Mr. Michael Cevallos cevallos; Dr. Mark A. Gallagher, FS		

Abstract: This research game theory framework to evaluate the resilience of Nuclear Deterrence options between two players. We use lexigraphical linear goal programing to value four priorities of political, military, economic, and civilian casualties. The value order may be varied. We demonstrate our approach with six player choices of no action, demonstration, counterforce, tactical military, economic, or countervalue strike. We use game theory to construct and analyze the resulting payoff matrix. We conclude that credible deterrence requires having at least equivalent offensive damage capabilities.

Classification: UNCLASSIFIED
Working Group: WG01 Strategic Operations National Security Analysis

59218 - It's Your Move: Introducing a Framework for Measuring Relative Costs in the Precision Missile Versus Air Base Peacetime Competition

Start Date: 6/15/2022	Start Time: 9:00 AM	End Time: 10:00 AM

Authors: Mr. Jacob Heim

Abstract: Contemporary U.S. defense strategy has a renewed focus on assessing peacetime, long-term military competitions to identify U.S. military advantages relative to those of other great powers. Policymakers, strategists, and analysts need tools to help them diagnose U.S. advantages and disadvantages relative to competitors. This brief introduces a framework for estimating the cost to each side of maintaining a peacetime military operational competition and uses that framework in an analysis of the cost to the DoD and PLA of maintaining the ongoing precision missile versus air base competition.

The growth in Chinese precision missile capabilities over the past twenty years threatens the air bases used by U.S. forces to project power in the event of a conflict. A natural question for policymakers is whether it is possible to reverse this eroding U.S. position in a cost-effective manner. This briefing demonstrates a way to answer this question using a framework that combines modeling and simulation, intelligence assessments, and cost estimation techniques.

Classification: SECRET NOFORN
Working Group: WG01 Strategic Operations National Security Analysis

59756 - Deterrence Communications: Theory and Practice

Start Date: 6/15/2022	Start Time: 10:30 AM	End Time: 11:30 AM

Authors: Mr Oliver Toby Barton

Abstract: Alongside 'credibility' and 'capability', 'communications' form the third key pillar of UK deterrence policy. Deterrence communications (DetComms) are a crucial instrument of policy and strategy, not just an adjunct. Strong resolve and sufficient punitive capability could prove inconsequential, or possibly even counter-productive, if the adversary fails to understand:

i. the specific action from which we wish them to refrain;
ii. our willingness and ability to exact costs and/or deny benefits should they fail to comply; and
iii. how they would be better off acquiescing to our wishes than persisting.

This presentation sets out the characteristics of an 'ideal' DetComms strategy, the challenges involved in achieving this ideal, and the practical steps one can take to address these challenges. The presentation is based upon over ten years' worth of research and exercising conducted by the Defence Science and Technology Laboratory (the research branch of the UK Ministry of Defence).

DetComms include all national means of communication that could have a bearing on how an audience perceives our credibility and intent, including our thresholds, red-lines, resolve, and preparedness to respond. These means of communication include, inter alia: declaratory policy; public diplomacy; defence engagement; and military 'presence, posture and purpose'. Deeds are as important as words. '[A]ctions will speak louder than words over time' since they form audiences' empirical evidence of our reputation and resolve.

The success of any deterrence strategy can never be guaranteed. However, achieving our objectives can be made more likely, and the implications of failure made potentially less damaging, by ensuring that our DetComms fulfil a range of criteria:

i. Integrated;
ii. Tailored;
iii. Systematic;
iv. Comprehensible;
v. Compelling;
vi. Co-ordinated;
vii. Evaluated;
viii. Adjustible.

In practice, finely balancing all the competing factors outlined above is likely to be extremely challenging. Like any other area of strategy, fog and friction will likely frustrate the conduct of DetComms. Some of the risks and challenges that practitioners may confront and that they need to be prepared to manage include, inter alia:

i. Imperfect knowledge;
ii. Time pressure;
iii. Biases and stress;
iv. Competing needs of third parties and domestic audiences;
v. Controllability of the strategic narrative;
vi. Assessing effectiveness;
vii. Need to respond to others' messages; and
viii. Asymmetry of stakes, capability and risk appetite.

Past practice and academic literature suggest a number of ways of mitigating these risks and challenges.

i. Conducting systematic analysis;
ii. Placing an emphasis on general deterrence communications;
iii. Combining threats and assurances;
iv. Cultivating mutual understanding; and
v. Managing expectations.

Classification: UNCLASSIFIED
Working Group: WG01 Strategic Operations National Security Analysis

59807 - USAFE-AFAFRICA A9A Support to Operation Allies Refuge/Welcome

Start Date: 6/15/2022	Start Time: 1:30 PM	End Time: 2:30 PM
Authors: Owen Joyce		
Abstract: During Operation Allies Refuge, United States Air Forces in Europe (USAFE) Analyses, Assessments, and Lessons Learned Division (A9A) provided analytic support to assist in the Non-Combatant Evacuation Operations (NEO). USAFE A9A provided support at the CCMD, MAJCOM, Wing, and Squadron level. A9A answered stakeholders questions such as "What is the overall traveler status		

at Ramstein Air Base?", "How do I keep track of the travelers that have arrived?", and "How do I properly capture lessons learned for future use?". Additionally, A9A members augment the 86 Airlift Wing in providing support to the travelers who were housed in "tent city" during their time at Ramstein AB. A9A was able to respond quickly to the need for analytic support, and showed the value of the Operations Research Community in fast moving Operations.

Classification: UNCLASSIFIED
Working Group: WG01 Strategic Operations National Security Analysis

60316 - Chasing the virus origin to prepare for the future

Start Date: 6/16/2022	Start Time: 9:00 AM	End Time: 10:00 AM

Authors: Dr. Eva K. Lee

Abstract: Motivation and Goals: SARS-CoV-2 has unleashed the pandemic of the century, inflicting over 949,000 deaths in the United States, and 6 million worldwide since it was reported in December 2019. Tracing its origin is challenging yet of paramount importance. It allows the reconstruction of the causal chain, provides deeper insight into the viral evolutionary pathways, and enables prediction and mitigation for future spillovers. This work began at the start of the COVID-19 in January 2020. We aimed to build a prospective system model to (a) understand the beginning spill of a mysterious SARS-like disease that seems to be spreading in China, and (b) uncover the virus' origin and disease start time.

Methods and Design: Our system incorporates a chance-risk module and overlays it with integrated simulation and optimization engines. The system model (a) captures the potential origins including natural spillover, accidental leakage, or genetic engineering, and their transmission pathways; (b) utilizes known biological and pathological behavior of prior viruses; and (c) incorporates the interplay of multiple hosts. It returns a list of pathways and timelines of virus origin each associated with an occurrence probability score. The model handles uncertainties, e.g., estimations from other viruses for infection timelines for animal-to-human, animal-to-animal, human-to-animal.

We validate our model output by new known knowledge as events unfolded. This adds confidence to the respective origin pathways. We connect the virus-origin model to our biological-behavior-logistic model to predict mortalities and cases under various interventions. Reported events allow for feedback and refinement.

Results: Millions of virus-origin pathways with stochastic uncertainties are returned. Natural animal spillover is the most likely origin with a chance occurrence of 87% and a takeoff starts around October/November 2019. The most likely pathway is through wildlife trafficking, black markets, and wet market natural spillover to a host of animals and then to humans. Accidental escape of infected lab animal pathway has a probability of 41.3% with an earlier start time of September 2019. The lab accident of infected humans is more convoluted with only a 9.5% chance. It requires numerous events to align and work together, which places it at an earlier start of July/August 2019.

Our model predicts prospectively the pandemic events rather accurately. Specifically, (a) our pathways pinpoint accurately that ~25% of early reported cases were linked to animal-human transmission; (b) our human-to-animal-to-human timeline reflected well the actual mink events in Denmark; (c) the spatial information of Wuhan excess deaths coincides with our analyses. It did not

rule out entirely the lab possibilities; and (d) Multiple lineages of SARS-CoV-2 viruses early on support lab events, potentially pointing to simultaneous human-human and human-animal-human infection.

Classification: UNCLASSIFIED
Working Group: WG01 Strategic Operations National Security Analysis

60158 - An Integrated Offensive/Defensive Hypersonics Deterrence Framework

Start Date: 6/16/2022	Start Time: 10:30 AM	End Time: 11:30 AM

Authors: Mr. Joseph E Uzdzinski; Mark T Birney; Simona Dean

Abstract: There is a national need for an integrated multi-layered hypersonics and advanced weapons system technology framework and deterrence and defense strategy and supporting analysis.
-Linking defensive actions with offense (e.g., cases where defensive launch may look threatening to a 3rd party)
-Linking conventional actions to offensive deterrence (e.g., what if China sinks a US carrier?; what if the US struck China home soil?)
-Schemes for signalling, where appropriate, US intent

The purpose of this paper is:
-To develop insight into offensive-defensive integration Lockheed Martin is leveraging the knowledge and experience gained within both the hypersonic offensive strike and defensive missions to develop a broader strategy using both offensive and defensive capabilities
-To develop a combination of ISR, C2, and communications capabilities along with both offensive strike and defensive effectors to counter the Regional and Strategic threats
-To offer thought leadership to help shape path forward for the integration of offensive and defensive hypersonic capabilities with external customers
-To provide a framework for guiding technology investments for an integrated hypersonics systems architecture

Classification: UNCLASSIFIED
Working Group: WG01 Strategic Operations National Security Analysis

60420 - The 4GIM (Four Generations of Innovation Model)

Start Date: 6/16/2022	Start Time: 1:30 PM	End Time: 2:30 PM

Authors: Richard M. Buchter

Abstract: The Four Generations of Innovation Model (4GIM) is based on consolidating existing and emerging Innovation Theory models. But unlike current Innovation Theory models, it separates extraordinary from status quo innovation. Doing so allows for the discussion of extraordinary innovation approaches that are frequently hidden under such labels as "emerging technology", "future technologies", and "Third Horizon Innovation" that may both pose a threat, and improvement, to existing status quo efforts. Presentation will discuss the four major areas of innovation: status quo, Radical innovation (familiar to the status quo), Revolutionary Innovation (not familiar to the status quo), and Lateral Innovation (repurposed technology from a different status quo effort), and the location of existing Innovation theory within it. The transition boundary between Status Quo Innovation and Extraordinary Innovation will then be briefly explored. The discussion will conclude with a review of the "Disruptive Dozen"- methods employed in above the line extraordinary innovation: Loonshots, Serendipity, Maneuvering, Prizes, Convergence, Experimental, Creative

Desperation, Basic Research, Buchter's Razor, Skunkworks, Supersizing, and Moonshots (Iron Man to JFK), as well as their potential for disrupting the status quo.

Classification: UNCLASSIFIED
Working Group: WG01 Strategic Operations National Security Analysis

60280 - Systems Thinking for National Defense and International Security

Start Date: 6/16/2022	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Mr. Carl J. Unis

Abstract: The systems thinking tutorial orients on the future of our Military Operations Research profession: “Where do we need to be going?”; “What should we be doing?”; “How should we be thinking differently about these challenges?”; How can we address new and innovative ideas that need to be vocalized to address interconnected, interdisciplinary, multi-dimensional systems architecture challenges and the countless strategic enterprise systems challenges that currently plague our DoD systems? With the correct framework, these complicated challenges can be addressed and pursued.

The German philosopher Hegel noted, “We learn from history that we don’t learn from history.” The revolving door of re-learning processes with every catastrophic event, that often cascades out-of-control, frequently results in systems with significant financial or operational damage. In the systems engineering world, interconnected complexity relates to the multitudes of complex systems and subsystems, both internally and externally, often termed as ecosystems of ecosystems. For example, a ground-based satellite communications system must be connected to a power grid and may have a backup generator to maintain operational capability during an outage. An unintended consequence of the COVID-19 pandemic is that it has forced organizations and enterprises to reconsider their business models, operational models, re-examine their supply chain’s resilience to shock, and strengthen their supply chain foundations. Unfortunately, this resiliency was not checked or re-examined in many instances, bottlenecking and stove piping many organizations’ ability to provide critical services and distribute supplies as needed. This will be a continual evolutionary process and needs to be addressed as such.

We need to utilize systems thinking to visualize the current interconnected ecosystems landscape and the evolving complexities and risks. To enhance enterprise supply chain resilience, we must reimagine how to address the challenges in our current and future environmental settings. In DoD systems, we must consider the unique requirements of the enterprise subsystems such as infrastructure, systems, IT, and environment, in their entirety, to prepare and plan for the impact of policy interventions in sustainability, cyber security, supply chain and the need for enterprise growth.

Three recent applications of Systems Thinking to enterprise system challenges are described and explored: defense resource planning, global logistics supply chains for materiel readiness, and creating resiliency for the infrastructure that supports our operational missions to the warfighter. We must integrate our intellectual capacities, considerable strategic planning acumen, diverse analytical capabilities, and integrate them into the national and international security challenges of our time. Our Nation and partners across the globe will benefit in many domain spaces from this type of commitment.

Classification: UNCLASSIFIED
Working Group: WG01 Strategic Operations National Security Analysis

WG02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

60330 - Methodology Development for Electromagnetic Pulse (EMP) Performance Data Generation for Use in One Semi-Automated Forces (OneSAF) Simulation

Start Date: 6/14/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Robert Hessian, Jr		
Abstract: In April 2021, the Joint Program Executive Office for Chemical, Biological, Radiological and Nuclear Defense (JPEO CBRND) sought the Combat Capabilities Development Command DEVCOM Analysis Center (DAC) assistance to develop a methodology for generating EMP performance data for use as an input to OneSAF. The 2009 EMP Physical model Knowledge Acquisition Document (PKAD) requires Probability Loss of Functionality as well as Duration of Loss data to support EMP effects on OneSAF scenarios. Currently data related to electronic component/system responses is not readily available. DAC's methodology exploits any combination of subject matter expertise and test data. DACs approach is by class of component or system thereby avoiding the need for system specific vulnerability. This presentation will discuss the key PKAD parameters as well as use of data to support EMP analysis. Classification: UNCLASSIFIED Working Group: WG02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense		

60162 - Simulation-Supported Wargaming at the Campaign Level

Start Date: 6/14/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Mr. Charles D Burdick, CAP		
Abstract: This paper addresses Wargaming at the Campaign Level capable of gaming the Russian Invasion of Ukraine. In his 2015 article, former DepSecDef Bob Work stated in that "…players should be able to observe and live with the consequences of their actions in the face of a thinking and reacting competitor... Actions must have tangible consequences that are determined by the actual performance of weapons and sensors in the real world, backed by a rigorous adjudication process..." The wargaming community has for years sought computer-supported "in stride adjudication." This has met with some success in air and maritime operations. But land operations in both the STORM and JICM models use aggregate brigade-level attrition over hours-long periods with scripted maneuver providing a general outline of the ground battle. For STORM, its associated wargame is played out in the SWIFT model where additional detail is added. But meeting Work's other 2015 dictum is harder, "The best wargames seek to create an environment for applying critical reasoning techniques and diagnosing the characteristics of competition under the "fog" and "friction" of war where incomplete and imperfect knowledge prevails." From 2006 to 2010, JFCOM (J9) Experiments conducted simulation-supported wargaming using the Joint Analysis System (JAS), a minimally aggregated model with all weapon types explicitly represented, countable, and subject to destruction. Each has its own characteristics, kill rates, and consumes munitions when fired. If mounted on a vehicle, fuel is consumed. JAS employs computer agents which respond to orders for movement, conduct combat or avoidance, call for fires, request logistics, etc. And JAS allows substituting humans for selected agents while the simulation is paused. JAS decisions are made on perceptions created by status reports and sensor inputs, with		

• Simulated communications networks link all “thinking” units/players (agents and/or human)
• Internal message flows (orders, requests, status reports, etc.)
• Sensor inputs generating a displayable Common Operational Picture (COP) readable by both humans and agents
JAS was archived in 2011, when JFCOM was disestablished, but could be revived and has some major capabilities of advanced wargaming.
1. JAS records all inputs necessary to rerun a wargame since human inputs use the same meta-data as the computer agents. Thus, JAS can rerun a wargame at high speed with the human inputs executed by computer agents and get the same results as the original wargame. If external changes are made, e.g., weather, enemy forces, etc. the wargame can become a Monte Carlo simulation.
2. JAS allows rapidly reviewing the decisions made and what the outcomes of different decisions might have been
A perception-based wargame, with detailed Land maneuver, C4ISR, and linked to a multi-domain simulation allows the best of both analytical tools (simulation and wargaming) to be combined in a study. Let’s revive it.

Classification: UNCLASSIFIED
Working Group: WG02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

60679 - ‘No Special Privileges’? British Nuclear Forces, Transatlantic Relations, and Arms Control.

Start Date: 6/14/2022	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Mr Oliver Toby Barton

Abstract: On 26 June 2020, in response to repeated calls by the Trump Administration for China to join negotiations for a successor to New START, the Russian Deputy Foreign Minister, Sergei Ryabkov, told the TASS news agency that ‘we insist that the United States’ closest NATO allies possessing nuclear weapons should join these hypothetical talks. They are France and the United Kingdom.’ In so doing, Ryabkov revived a long-standing Russian claim that so-called third-party systems must be included in the arms control process, if negotiations were to result in significant reductions in US and Russian stockpiles. The Russian Government made similar claims after the British Government recently announced an increase in the cap on the size of the British nuclear stockpile.

The UK’s position on the role of British nuclear forces and arms control has remained largely unchanged for 39 years. In 1983, Britain’s top foreign policy priority was the implementation of NATO’s dual track decision. At the same time, as a nuclear power, the UK’s strongest interest was the protection of it strategic deterrent. These goals were increasingly in tension the more that the Soviets found a sympathetic audience amongst European Allies for their claim that the exclusion of British and French nuclear forces was the main obstacle to reaching an INF agreement.

Having effectively blunted domestic opposition to Cruise by winning the 1983 General Election, the Thatcher Government encouraged the Allies to show continued resolve. However, the Germans, facing much stiffer opposition, wanted to avoid NATO being blamed for the failure of the negotiations and the need to deploy new systems. Consequently, the Germans called for the British and French to be more forthcoming about when and how their nuclear forces would be included in arms control. Although they claimed ‘no special privilege’, the British fiercely resisted such calls, fearing a slippery slope towards greater concessions.

Finding themselves increasingly isolated on an issue that they believed threatened their most vital national interest, the British eventually conceded that in the unlikely event that negotiations gave rise to 'substantial reductions' in US and Soviet arsenals, 'Britain would want to review its position'. Why, when the dual track decision had reached its critical stage and European public support hung in the balance, were the British not prepared to be more accommodating? In short, the Thatcher Government had reached a tipping point where protecting the viability of the British strategic deterrent trumped the imperative to implement the dual track decision.

With recent calls to broaden participation in future arms control negotiations, this episode highlights the central role that British and French nuclear forces have often played in arms control, and the tensions that debates about their status have caused within NATO.

Classification: UNCLASSIFIED
Working Group: WG02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

59587 - Requirements for the Implementation of COVID-19 Control Measures Given Prevailing Rates of Vaccine Compliance

Start Date: 6/15/2022	Start Time: 8:30 AM	End Time: 9:00 AM

Authors: Mr Robert Cubeta

Abstract: In this presentation, we describe our analytical approach to determining the requirements and opportunities for using various measures to control outbreaks of COVID-19, assuming the primary objective is to reduce the average number of infections caused by a contagious individual in any given outbreak (R) to below one. We establish relationships between a set of parameters describing characteristics of both disease and response measures, from which we are able to determine the circumstances in which outbreak control measures could be effective. In particular, we explore how the requirements for various control measures, such as isolation and quarantine, can vary given different rates of vaccine compliance in a population.
We begin by developing a profile of mean individual COVID-19 transmission over time that accounts for both pre-symptomatic and asymptomatic transmission. We then use that profile to determine the point in time, relative to both exposure and mean symptom onset, when an individual would, on average, transmit COVID-19 to one other person. Next, we assess the requirements for implementing control measures such that they would, collectively and on average, stop transmission at or before that point in time. We consider a layered approach, beginning with vaccination and adding isolation, triggered by either symptom onset or as a result of diagnostic testing, and finally quarantine.
Our work shows that COVID-19 outbreaks cannot be controlled solely through isolation of symptomatic individuals, given the high transmissibility of COVID-19 combined with asymptomatic and pre-symptomatic transmission. Vaccines can overcome this challenge if they are sufficiently effective, and if compliance rates are sufficiently high. Yet if vaccine compliance rates remain low in certain regions, or if the effectiveness of vaccines is compromised by the emergence of variants, transmission of COVID-19 may continue or even increase. Should that be the case, our assessment shows that—assuming prompt isolation of symptomatic individuals continues—implementation of quarantine and/or population-wide diagnostic testing can cause an outbreak to wane. While more burdensome than vaccination and isolation, these measures can be effective if limited to quarantine of readily identifiable household contacts, or screening tests administered weekly. Screening in particular may avoid the disruption that comes from quarantine and other forms of restriction of movement.

Classification: UNCLASSIFIED
Working Group: WG02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

60073 - Homeland Security Biological Detection and High-Quality Technology Readiness Assessments

Start Date: 6/15/2022	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Mr. John Mendez Ortiz, Jr

Abstract: Countering Weapons of Mass Destruction (CWMD) was established within the Department of Homeland Security (DHS) to protect against the dangers posed by hostile state and non-state actors who seek to acquire and use nuclear, chemical, radiological or biological materials in the form of weapons of mass destruction to harm Americans or U.S. interests. CWMD is pursuing efforts to update the BioWatch program that was established in response to the 2001 anthrax attacks and designed to provide early indication of an aerosolized biological weapon attack. Biological Detection for the 21st century (BD-21) is the latest acquisition in a series of efforts to upgrade BioWatch. However, critical technologies needed to provide early detection have inherent limitations. DHS has proposed the use of a new and novel capability through artificial intelligence / machine learning technology that, if successfully developed, could be an improvement over the existing system. The Government Accountability Office (GAO) was asked to evaluate BD-21 technology readiness and made several recommendations aimed at improving technology readiness assessments across the agency and the BD-21 program.

GAO is an independent, nonpartisan agency serving the Congress by helping to improve performance and ensure accountability in the federal government. GAO has developed a Technology Readiness Assessment Guide (GAO-20-48G) to provide a better understanding of technology maturity and a framework for conducting high-quality TRAs. GAO's TRA guide establishes a methodology for evaluating critical technologies, such as those being pursued by CWMD, based on best practices that can be used across the federal government to determine a project's readiness to move past key decision points that typically coincide with major commitments of resources.

Classification: UNCLASSIFIED
Working Group: WG02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

60186 - Using Simulation to Forecast the Impact of Events on Aircraft Availability

Start Date: 6/15/2022	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Dr. Greg H. Gehret

Abstract: At the onset of the Coronavirus pandemic, the previous Chief of Staff of the Air Force (CSAF) inquired about the potential impact of COVID-19 on AF readiness. We utilized several OR tools to create inputs, and then used simulation to estimate a cause-based, 6-month forecast of Aircraft Availability (AA) on 13 major AF fleets. Because the underlying inputs to the simulation were cause-based time elements, the simulation can be used to forecast AA for any time-based disruptions, including funding, manpower, and Chemical, Biological, Radiological, Nuclear, and high yield Explosives (CBRNE). Our presentation will discuss why we used simulation, how we established cause-based inputs, and possible use of the simulation for other "What If" scenarios, including CBRNE.

Classification: UNCLASSIFIED
Working Group: WG02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

59740 - Radiation Mapping Overview

Start Date: 6/15/2022	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Dr. Andy O Li; Wesley Huang; Richard Kroeger; Nathan Paradis; Ivan Ulloa-Gracia

Abstract: There are a variety of possible situations where hazardous levels of radioactivity may be released in the environment either by accident, a terrorist attack, or foreign adversaries. The general problem of detecting and maneuvering through an unknown radiation environment is essential in support of risk quantification, mitigation, and battlefield operations. It is important to minimize exposure to the teams responsible for detection and characterization of the radioactivity, but also for other personnel that may be required to operate in a contaminated area.
The task of quickly characterizing radiation in an area can be accomplished in several ways. A practical and straight forward approach is the use of coarse-collimated detectors. Vehicle mounted detectors provide real-time direction and dose data to assist in navigation through a contaminated area and quickly develop a site contamination survey. With support from the Defense Threat Reduction Agency, the Naval Information Warfare Center Pacific has developed radiation mapping using vehicle-mounted radiation detection systems. Radiation mapping is designed to provide real-time situational awareness in a high-risk environment where radiation exposures are potentially lethal. In this work, the mapping algorithm and its current implementation are described in general terms. Furthermore, results from recent test events are presented.

Classification: UNCLASSIFIED // FOUO
Working Group: WG02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

60020 - Dynamics of residual chemical agent vapor levels in cargo aircraft interiors that have been purged in flight using smoke removal techniques.

Start Date: 6/15/2022	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Jerry Jensen

Abstract: Past studies have shown that combat aircraft environmental control systems (ECS) flow air at relatively high rates. These data suggest that aircraft could, in theory, purge their interiors of toxic vapors by flying in clean air and letting the ECS airflow replace the contaminated air with clean air. In fact, emergency flight procedures are established for all aircraft for using this concept to remove interior smoke. DTRA and the Air Force performed a set of tests using C-130 aircraft to test this concept. We found that the procedures work but at low levels, residual vapor dynamics become more complex. The paper covers research to date and methodologies to model presence of low level desorption of vapors that have been sorbed onto and into interior surfaces and voids. This paper discusses the properties of the purge procedures and how they interact with the desorption process using a mathematical model formulated to determine purge procedures necessary to reduce the vapor levels to safe levels. These results apply to any occupied volume involved with clean air purging such as combat vehicles and collective protection systems.

Classification: UNCLASSIFIED // FOUO
Working Group: WG02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

60086 - Mild Effects Estimates for Percutaneous Liquid Exposures to Nerve Agents for Use in Evaluating Protective Equipment

Start Date: 6/15/2022	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Mr. Douglas R. Sommerville		
Abstract: Updated human proxy mild effect dose–response-probability (DR-P) curves were derived for percutaneous (PC) liquid exposures to several nerve agents. In the absence of any observable mild clinical signs, acetylcholinesterase (AChE) inhibition was chosen as the proxy because it is the first known health-based effect. The dose–response (DR) curves are needed for modeling and requirements purposes, which were not addressed in previously derived values for laboratory safety. A new statistical method, tolerance interval derived dose–response curves (TIDRC), was used to convert minipig intravenous (IV) AChE inhibition dose–response severity (DR-S) curves (fitted via a four-parameter logistic (4PL) equation) into DR-P curves for specific AChE inhibition levels. The resulting minipig IV DR-P curves were converted to a human basis via an updated allometric model fit of existing mammalian nerve agent IV lethality data. Ratios of minipig PC and IV median effective doses (ED50 values) (either sub-lethal or lethal) were calculated and then used to derive human PC ED50 values for 20, 50, and 80% AChE inhibition levels. To complete the DR-P curves, the previously derived probit slope for human VX PC liquid AChE inhibition was assumed to be appropriate for all nerve agent exposures. Classification: UNCLASSIFIED // FOUO Working Group: WG02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense		

60013 - Chemical Wide Area Decontamination

Start Date: 6/15/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Dr Neil Alan Hawbaker		
Abstract: Release of a chemical warfare agent, either accidental or deliberate, is a deadly, tragic, and chaotic event. Contamination of a key points of infrastructure, including airports and seaports, can hinder life-saving response by medical and military personnel and can slow evacuation efforts. This program aims to develop a rapid, cost effective way of decontaminating large scale infrastructure and minimize the risk for vehicles and personnel which must traverse through a contaminated area. Use of traditional decontaminants is not feasible for wide area applications due to the cost, preparation, storage, and efficacy limitations associated with scale up. This work explored the use of reactive formulations based on widely available commodity chemicals for direct remediation and the use of chemically used agricultural and construction polymers for encapsulation of the contaminant. A large variety of reactive chemicals were screened for their ability to remove CWAs from concrete and asphalt surfaces. The best performers were then downselected based on logistics considerations, including price, environmental impact, health and safety, scalability, and material compatibility. Of these chemicals, peroxysulfate oxidants provided the best profile of efficacy and logistics over other chlorinated oxidants and caustic bases. Design of Experiment was used to provide a final recommended formulation which can be prepared in the field and used only bulk chemicals and existing equipment. This formulation provides distinct advantages in both efficacy and logistics over existing technologies. Barrier polymers for encapsulation have been studied and evaluated by testing the reduction in the contact (dermal) hazard and vapor (inhalation) hazard. Polymers such as bitumen sealcoats, acrylic soil stabilizers and methyl cellulose stockpile sealant proved to be moderately effective at		

encapsulation of contaminated concrete and asphalt. Both encapsulation and direct remediation are being further explored as options for chemical wide area decontamination. This technology aims to fit an unfilled need and enable first responders, victims and military personnel to more safely operate in a contaminated environment.

Classification: UNCLASSIFIED
Working Group: WG02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

59838 - Estimation of ISO 5725 Intermediate Precision Standard Deviation (IPSD) for multiple process/equipment configurations using design of experiments dispersion "DOE".

Start Date: 6/15/2022	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Mr John Powell Davies, Jr

Abstract: The Decontamination Sciences Branch (DSB) at the U.S. Army Combat Capabilities Development Command Chemical Biological Center (DEVCOM CBC) studies the physical and chemical mechanisms that are relevant to chemical warfare agents (CWAs) for the purposes of developing decontamination technologies. The test methodologies developed by the DSB in support of this research usually involve many possible process/equipment configurations. Finding the optimal configuration that minimizes the intermediate precision standard deviation (IPSD) by performing a formal ISO 5725 precision study with live CWA for each and every possible configuration is usually not feasible. Therefore, the DSB has made use of design of experiments dispersion DOE which dramatically reduces the number of CWA samples required and allows for lower performing configurations to be screened out so that only the most promising configurations move on to the more lengthy formal ISO 5725 precision study. Approved for public release: distribution unlimited

Classification: UNCLASSIFIED
Working Group: WG02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

60475 - Toward Pandemic Risk Assessment Using a Custom Smart Phone Application for Location Tracking

Start Date: 6/16/2022	Start Time: 8:30 AM	End Time: 9:00 AM

Authors: Jerry Jensen; Dr Brian Phillips; Mr Bill Greer

Abstract: Pandemic COVID-19 variants may infect US military personnel during periods of heightened operational need. The environment that these military personnel inhabit affects the risk of viral transmissibility and, eventually, military readiness.
In order to understand the risk to people during operations, the Defense Threat Reduction Agency and United States Air Force Research Laboratory sponsored a study to understand how fixed site mission activities might impact the risk of person-to-person COVID-19 transmissibility. This effort led to the creation of a custom smart phone application that tracked the location of military members during exercises. These locations would then be used to generate a contact matrix that details how long each person was in contact with another.
This discussion highlights the approach to designing, building, and deploying a low-cost smart phone application to gather the location data for military personnel, store that data, and inspect its accuracy. The discussion will focus on technology, requirements, and the challenges of building an inexpensive quick-turn location tracking application using low-cost COTS phones and minimal cloud

data collection services. It will also give a look-ahead for the analytical approach as well as targeted exercise events.
The views and opinions presented herein are those of the author(s) and do not necessarily represent the views of DoD or its components.

Classification: UNCLASSIFIED // FOUO
Working Group: WG02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

60529 - Evaluation of Long-Term Health Effects from Acute Exposure to Toxic Chemicals

Start Date: 6/16/2022	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Ms. Theresa Pennington		

Abstract: Since 2016, the Chemical Security Analysis Center of the Department of Homeland Security Science and Technology Directorate and the Army Public Health Center (APHC) have partnered to develop guidelines for acute exposure to chemicals of concern resulting in chronic effects. The Acute Exposure/Chronic Effect (AECE) project utilizes a toxic syndrome (i.e., toxidrome) based approach where the likelihood of long-term health outcomes are evaluated as a function of the acute exposure level (mild, moderate, severe, life-threatening). Six toxidromes (Cholinergics, Blood, Opioid, Irritant/Corrosive – Upper Pulmonary, Irritant/Corrosive – Lower Pulmonary, and Vesicants) have been completed and three toxidromes are planned for FY22-23 (Convulsant, Hemolytics, Metabolic). Collecting data based on a toxidrome rather than a single chemical addresses the issue of sparse data, as findings made for a toxidrome can be leveraged for any chemical in that toxidrome. The supporting assumption for this generalization is that chemicals in the same toxidrome elicit similar acute effects, and that long-term health effects can be estimated based on the extent of the injury demonstrated by acute effects. This project utilizes Subject Matter Experts (SMEs) and peer reviewed journal articles to identify the acute exposure symptoms, which are categorized by health effect severity. SMEs then identify potential long-term symptoms which are separately categorized by health effect. Then the probability of a long-term health effect based on each level of acute exposure can be elucidated by the SMEs and combined into a single probability for each acute exposure level. These effect probabilities are combined with acute effect dose-response estimates to yield long-term health effect curves for each chemical in the toxidrome. APHC will utilize these calculations to expand on the military exposure guidelines (MEGs). Currently, MEGs only consider the acute effects of acute exposures despite documented evidence that acute exposures can lead to long-term effects. Such evidence includes incidences with military relevance, such as exposure to mustard agents during World War I and sarin attacks in Syria from 2012 until present day. Better knowledge of how an acute exposure can lead to long-term effects allows for better military planning, as long-term effects could manifest during the course of a deployment in ways that would impact operational readiness. The CSAC will apply these values to modeling potential harm to civilian populations to inform the Homeland Security Enterprise (HSE).

Classification: UNCLASSIFIED
Working Group: WG02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

59648 - DOD CWMD Annual Assessment

Start Date: 6/16/2022	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Daniel Rauscher; Michael Tinker; Roberto Salas		

Abstract: The USSOCOM J10 Countering Weapons of Mass Destruction (CWMD) Directorate assesses the DOD Functional Campaign Plan for CWMD (FCP-CWMD) and develops an Annual CWMD Assessment memo, signed by CDRUSSOCOM. This memo to the Secretary of Defense summarizes the assessment findings and proposes recommendations to improve CWMD campaign effectiveness. Once endorsed by the SecDef, these recommendations are tasked across the Department for implementation.
USSOCOM J10 conducts the Annual CWMD Assessment through a robust analysis of the FCP-CWMD; the 2021 Chairman's Annual Joint Assessment responses; Service, National Guard Bureau, and Combatant Command Assessments. The Assessment also includes interagency responses to a USSOCOM-developed CWMD questionnaire identifying areas of mutual collaboration and support. The team uses these data sources to assess the overall effectiveness of the Department's CWMD campaign and identify the Military Strategic Risk and Military Risk in accordance with CJCSM 3105.01A Joint Risk Analysis Methodology.
Building on the successes of the 2021 Annual Assessment, USSOCOM J10 continues to refine the methodology to make actionable recommendations to improve execution of CWMD across the Department of Defense.

Classification: SECRET NOFORN
Working Group: WG02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

59902 - What is Left After the Dust has Cleared?—Final Human Toxicity Estimates for the Classical Agents in the Wake of the ECBC Low-Level Toxicology Program and Related Efforts (1998-2008)

Start Date: 6/16/2022	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Mr. Douglas R. Sommerville

Abstract: When the US Army Field Manual (FM) 3-11.9 (2005) was published, human chemical warfare (CW) agent toxicity estimates were still being re-evaluated because of the on-going Edgewood Chemical Biological Center (ECBC) Low-Level Toxicology Program (1998 to 2008). The FM suffered from not having the data subsequent to about 2003 available. A technical manual (TM) was published in 2017 which included updated toxicity material (other related subject material). However, the TM does not explicitly state the parameters required for defining the dose-response curve (DRC) for toxicity estimates (ex. median effective dose, probit slope and toxic load exponent (TLE) (for inhalation (IH) exposures)). Instead, the TM presents time—concentration profiles for the various agents. Thus, this TM is not user-friendly for operators of transport and dispersion models and related applications.
In response to the TM update, several ECBC authors decided to include in a book chapter on CW agent toxicology (Hulet et al., 2019) their recommendations for updates of FM 3-11.9 (2005)'s human CW agent IH/ocular (OC) toxicity estimates, the agents addressed being GA, GB, GD, GF, VX, mustard, phosgene, and chlorine. The chapter included the proper DRC parameter values for mild and severe effects and lethality—all based on the total state of knowledge upon the conclusion of the Low-Level Program. The estimates are for both the healthy human subpopulation (SP) and the general population. FM 3-11.9 only had addressed the healthy SP. In addition, the talk will present updated DRC parameter values for World War I era CW agents not originally addressed by Hulet et al.: arsine, cyanogen chloride and hydrogen cyanide.
This talk will review the toxicity estimates of Hulet et al. (2019), as well as the general history of and basic philosophy behind the development of these estimates from the data generated by the Low-Level Program and other sources. The Department of Defense (DoD) had started the Low-Level

Program in response to the recommendations of Reutter-Wade (1994)(as cited by Bakshi (1997)). The pre-1994 toxicity estimates were a product of an offensive CW mindset (from when the US had an offensive CW agent program), with an emphasis on short exposure durations and the need to incapacitate the most resistant individual as quickly as possible. With the new defensive CW mindset, Reutter-Wade had recommended updating the human toxicity estimates since the emphasis had changed. DoD needed estimates appropriate for defending the average to most sensitive individual, which involved exposure to lower agent concentrations over longer durations. Such estimates were the final product of the Low-Level Program.

Classification: UNCLASSIFIED
Working Group: WG02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

60032 - Statistical Analysis of Survivability & Fratricide of Strategic Systems

Start Date: 6/16/2022	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Dr. David Bacon; Mr Bill Greer		

Abstract: For several decades DoD conducted various studies to better understand the impact of dust and debris created from a nuclear blast on the survivability of blue systems subjected to red attacks and on the fratricide potential of blue attacks on red systems. Over the years, the methodologies employed grew more sophisticated as each analysis brought new insights and, along with our growing understanding of the potential hazards posed to mission critical systems, drove more sophisticated modeling. Due to the limited amount of computing power available at the time, however, the end result was a point analysis where conservative upon conservative assumptions were overlaid. With the end of the cold war, this topic went dormant.
Today, the US is recapitalizing its strategic systems and the starting point has been the same conservative single point analysis. This in spite of the fact that we know that the impacts of geology and meteorology, while variable in nature, are bound and a significant database exists that can be used to understand the impact of this variability statistically. Over the past 4 years, just such a statistical analysis has been done for the impact of dust, pebbles, water, and ice particulates on ICBM survivability on launch and the fratricide impacts on re-entry. This analysis is a potential game-changing methodology as it enables the determination of the potential hazard or threat to the system to a given level of confidence leading to the ability to trade off performance for survivability with pre-knowledge of the fraction of time and/or space that is significantly impacted.

Classification: UNCLASSIFIED // NOFORN
Working Group: WG02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

60018 - Method Precision Study for Evaluation of Candidate Replacement Chemicals in Activated Carbon Filter Lot Acceptance Testing

Start Date: 6/16/2022	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Matthew Browe		

Abstract: Quality control is typically assessed with activated carbon filters using lot acceptance testing on both the filter level and tube level to assess performance of the filter as a whole and the isolated performance of the constitutive activated carbon itself, respectively. The present study outlines a scenario in which the reference gas for this acceptance testing, gas A, is in short supply and requires evaluation for a candidate gas, gas B, as a feasible alternative. Testing utilizes a metal-incorporated

activated carbon in two filter forms, filter A and filter B, and in tube form. Method precision and bias are evaluated for both methods with the activated carbon in tube and filter form, in line with International Organization for Standardization documents ISO 5725-1, ISO 5725-2, and ISO 5725-6. The method will determine if lot acceptance based on pass/fail rates from gas B can be expected to suitably mimic lot acceptance efforts based on gas A breakthrough times.

Classification: UNCLASSIFIED
Working Group: WG02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

WG03 Infrastructure Analyses, Protection and Recovery

60598 - Methodology for Assessing Regional Infrastructure Resilience

Start Date: 6/14/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: William DeLong; William McNamara		
Abstract: The Cybersecurity and Infrastructure Security Agency (CISA) has conducted thousands of critical infrastructure assessments nationwide, including examinations of the resilience of interconnected infrastructure systems that span entire regions. Since 2009, CISA has conducted more than 120 of these regional assessments through its Regional Resiliency Assessment Program (RRAP). The RRAP is a voluntary program that uses a structured assessment approach to conceptualize projects, collect data, analyze information, and present options for improving regional infrastructure resilience. CISA has learned valuable lessons from conducting this slate of RRAP projects, including what is required for successful regional infrastructure assessments, typical challenges, and strategies for engagement across a range of public and private stakeholders. The Methodology for Assessing Regional Resilience was developed to distill these lessons and articulate a generalizable, repeatable methodology for conducting regional infrastructure assessments. It introduces foundational concepts of resilience and then walks through the multi-step methodology, from identifying relevant infrastructure problems and designing assessments, to collecting data, conducting analysis, documenting results, and promoting action. The document is geared to any organization with a stake in the resilience and security of critical infrastructure operations, including state, local, tribal, and territorial governments, regional public-private partnerships, private sector entities, federal government agencies, and researchers. The application of this methodology is intended to bolster capabilities of organizations, communities, and regions to analyze, understand, and improve the resilience of critical infrastructure systems nationwide Classification: UNCLASSIFIED Working Group: WG03 Infrastructure Analyses, Protection and Recovery		

60662 - Assessing the Perception and Comprehension of Adversarial Cyber Activity in Operational Technology Environments Using Bayesian Networks

Start Date: 6/14/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Dr. Lee T Maccarone; Dr. Dennis M. Buede; Mr. Scott T. Bowman; Mr. MacLeod C. Bracken; Dr. Gabriel A. Weaver; Mr. Charles D Burdick, CAP; Mr. Brian K. Castle		
Abstract: Critical infrastructure and other operational technology (OT) environments face increasing cybersecurity risks from adversarial behavior. The Cybersecurity for the Operational Technology Environment (CyOTE) program seeks to enable asset owners and operators (AOOs) to secure their OT		

environments. The cornerstones of the CyOTE methodology are the perception of observable cyber-events and the comprehension of these observables in broad context including people, processes, and technologies. This cycle of perception and comprehension enables business decisions on whether the observables suggest malicious cyber activity or a benign reliability failure. By applying the cycle of perception and comprehension to anomalous observables in the OT environment, AOOs can better identify adversary behavior and reduce the likelihood of impact.

This research defines a risk-based approach to enhance comprehension of observables. The approach leverages the MITRE ATT&CK® for Industrial Control Systems (ICS) framework as a common lexicon for describing potential adversary behavior in the OT environment. MITRE ATT&CK® for ICS is a taxonomy of adversary actions that categorizes techniques into groups of tactics based upon their intended malicious purpose within the victim's environment. The risk approach draws connections between the MITRE ATT&CK® for ICS techniques and their observables to enable improved attack comprehension.

A Bayesian network was developed to quantify the risk associated with combinations of observables and artifacts. Observables are reported in open-source reporting whereas artifacts are potentially observable events that were not reported, but likely occurred based upon digital forensic expertise. Stages of an attack are specified as nodes in the network. Each attack stage includes tactics that an attacker might employ during that stage. The tactics are mapped to techniques that are in turn mapped to the observables and artifacts that they might generate. The likelihood of perceiving and comprehending the malicious behavior is calculated as each piece of new evidence is introduced through discovery of more observables.

This approach is demonstrated using multiple historical case studies of cyber-attacks affecting OT systems. As the adversary utilizes techniques and generates observables, the Bayesian network is used to calculate the likelihood of perception and comprehension of the on-going behavior. Opportunities for improved perception and comprehension are identified through sensitivity analysis of each observable and artifact of the attack.

Classification: UNCLASSIFIED
Working Group: WG03 Infrastructure Analyses, Protection and Recovery

60314 - Network Shaping for Critical Infrastructure Exploitation and Protection

Start Date: 6/14/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Prof. David L. Alderson; W. Matthew Carlyle, PhD; Daniel A Eisenberg		

Abstract: Traditional network interdiction problems focus on finding the target package that yields the worst-case performance for network operations given a level of attack. However, in many cases it may be desirable to disrupt a network such that its performance falls below a given performance threshold while retaining other properties, such as the ability to quickly restore performance. This is important in traditional joint operations, where the military may conduct shaping operations by interdicting a network to enable tactical success, then conduct stabilization operations that require restoration of the network. This broader view of network shaping is important for exposing operationally relevant states that are not normally identified by the traditional interdiction and restoration methods of network flow problems. However, unlike attacker-defender problems that can be solved efficiently using appropriate algorithms, understanding the state space for network shaping activities is computationally intensive and often difficult to use in practice. In this presentation, we

review recent progress in formulating and solving these problems and present promising directions for future advances.

Classification: UNCLASSIFIED
Working Group: WG03 Infrastructure Analyses, Protection and Recovery

60295 - Systems Thinking for Infrastructure Analyses, Protection and Recovery

Start Date: 6/15/2022	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Mr. Carl J. Unis

Abstract: The systems thinking tutorial orients on the future of our Military Operations Research profession: “Where do we need to be going?”; “What should we be doing?”; “How should we be thinking differently about these challenges?”; How can we address new and innovative ideas that need to be vocalized to address interconnected, interdisciplinary, multi-dimensional systems architecture challenges and the countless strategic enterprise systems challenges that currently plague our DoD systems? With the correct framework, these complicated challenges can be addressed and pursued.

The German philosopher Hegel noted “We learn from history that we don’t learn from history.” The revolving door of re-learning processes with every catastrophic event, that often cascade out-of-control, frequently results in systems with significant financial or operational damage. In the systems engineering world, interconnected complexity relates to the multitudes of complex systems and subsystems, both internally and externally, often termed as ecosystems of ecosystems. For example, a ground-based satellite communications system must be connected to a power grid and may have a backup generator to maintain operational capability during an outage.

An unintended consequence of the COVID-19 pandemic is that it has forced organizations and enterprises to reconsider their business models, operational models, re-examine their supply chain’s resilience to shock and strengthen their supply chain foundations. Unfortunately, this resiliency was not checked or re-examined in many instances, bottlenecking and stove piping many organizations’ ability to provide critical services and distribute supplies as needed. This will be a continual evolutionary process and needs to be addressed as such.
We need to utilize systems thinking to visualize the current interconnected ecosystems landscape and the evolving complexities and risks. To enhance enterprise supply chain resilience, we must reimagine how to address the challenges in our current and future environmental settings. In DoD systems, we must consider the unique requirements of the enterprise subsystems such as infrastructure, systems, IT, and environment, in their entirety, to prepare and plan for the impact of policy interventions in sustainability, cyber security, supply chain and the need for enterprise growth.
Three recent applications of Systems Thinking to enterprise system challenges are described and explored: defense resource planning, global logistics supply chains for materiel readiness, and creating resiliency for the infrastructure that supports our operational missions to the warfighter. We must integrate our intellectual capacities, considerable strategic planning challenges, diverse analytical capabilities, and integrate them into national and international security challenges of our time. Our Nation and partners across the globe will benefit in many domain spaces from this type of commitment.

Classification: UNCLASSIFIED
Working Group: WG03 Infrastructure Analyses, Protection and Recovery

59693 - Understanding Risk in Complex Engineered Systems

Start Date: 6/15/2022	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Willie Brown; Dr. Jonathan Alt; Dr. John Richards; George Edward Gallarno; Titus Rice		
Abstract: Complex socio-technical systems incorporate engineered and technical systems as well as human operators to provide required capabilities in a number of settings, often interacting with the environment. Decision makers require an understanding of the current state of these systems, and the interaction between sub-systems, in order to best allocate resources to maintain a high operational condition and prevent future system degradations. This research 1) developed a novel methodology to assist decision makers in understanding the likelihood that an engineered system would be degraded given the state of its components and 2) employed design-of-experiments methods with consequence models to develop estimates of the consequences of a sub-system outage on the system's mission. The combination of likelihood of degradation and consequence of outage facilitates an understanding of the relative risk of each component of the system. Risk-based prioritization of components, constrained by resources, is enabled through the development of a mathematical optimization program. This presentation includes proof-of-concept results for two case study watersheds. Classification: UNCLASSIFIED Working Group: WG03 Infrastructure Analyses, Protection and Recovery		

60029 - CINCI: Climate Impacts to National Critical Infrastructure

Start Date: 6/15/2022	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Dr. Chuck Randall Smallwood; Dr. Thushara Gunda; Nicole Jackson; Dr. Stephanie Kuzio; Dr. Thomas Lowry; Kevin L. Stamber; Dr. Jonathan Zimmerman; Richard Garrett		
Abstract: To ensure America's security and prosperity we must address our nation's critical infrastructure and environmental challenges through transformative science and technology solutions. Climate change has been consistently referred to as a "threat multiplier" meaning that its impact exacerbates existing vulnerabilities within economic, environmental, and military states and provides fertile ground for amplifying existing national security risks related to extremism and terrorism. Additionally, climate change is seen as an anthropogenic threat to America's environment and potentially exposes new security risks to society (e.g., through the proliferation of diseases impacting readiness) and critical infrastructure. As a leader in quantitative systems-oriented risk assessments, Sandia National Laboratories (SNL) has invested research and development for measuring and modeling rapidly changing climate impacts to critical installations, including assessment of multiple feedbacks and uncertainty quantification for infrastructure performance. This discussion provides an overview of the tools and approaches developed at SNL that are used to devise adaptation strategies and predict the effects of intervention strategies on various man-made and natural environments. Leveraging interdisciplinary expertise in engineering, biodefense, and analytical detection will be required to ensure the resilience and security of the nation's critical infrastructure to natural and anthropogenic climate-related threats. Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525. SAND2022-2366 A		

Classification: UNCLASSIFIED
Working Group: WG03 Infrastructure Analyses, Protection and Recovery

60216 - Community and Infrastructure Adaptation to Climate Change (CIACC)

Start Date: 6/15/2022	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Joshua D. Bergerson; John K. Hutchison

Abstract: Critical infrastructure systems throughout the U.S. are increasingly at risk due to systemic underinvestment and intensifying natural hazards driven by anthropogenic climate change. Disruptions of critical infrastructure systems, such as drinking water and electric power systems, threaten the safety and well-being of people and communities, cause significant financial damage, and may inflict socioeconomic damages that span years or decades. Research on climate change, impacts on infrastructure, and infrastructure adaptation is constantly evolving and researchers are publishing at a blistering pace. This makes it nearly impossible for individuals – or even teams – across government, academia, and industry to review scientific and engineering advancements and to use them to inform their climate adaptation decision-making. Decision-makers require actionable, understandable guidance on location-specific climate conditions projected at future time periods, the potential impacts of these future conditions on infrastructure systems, and remedial climate change adaptation strategies to enhance the resilience of these systems and reduce risk associated with their future disruptions.

To address this need, a team of researchers at Argonne National Laboratory is developing the Community and Infrastructure Adaptation to Climate Change (CIACC) tool which leverages several artificial intelligence methodologies, including natural language processing, topic modeling, and machine learning, to read millions of articles – offering a solution to the challenge decision-makers face in wrapping their arms around research on climate change and infrastructure impacts. A fundamental component of CIACC's development is the creation of a dynamic critical infrastructure and climate change corpus of research documents. As a first step towards establishing such a data pipeline, the project team is using the Allen Institute's Semantic Scholar Open Research Corpus. Trained machine learning models in CIACC serve as lenses for identifying documents discussing specific topics. CIACC is currently equipped with three lenses to identify individual or combinations of climate change hazards (comprised of 9 extreme events and 9 climate trends), 16 critical infrastructure sectors, and 55 national critical functions. These lenses enable users to identify subsets of the corpus of interest and boils it down to summary data and synthesized trends. The tool offers decision-makers cutting-edge and actionable information on climate hazards, threats to critical infrastructure, and climate adaptation best practices – helping them better safeguard systems and communities. In this discussion, we present 1.) an analysis of weak to strong supervised learning that minimizes human-in-the-loop feedback, 2.) an overview of CIACC architecture, and 3.) a discussion of challenges and opportunities surrounding effective visualization and communication of aggregated NLP results to empower decision makers.

Classification: UNCLASSIFIED
Working Group: WG03 Infrastructure Analyses, Protection and Recovery

59879 - Climate Surprise and Military Response: A Case Study of Marine Corps Base Camp Lejeune and Hurricane Florence

Start Date: 6/15/2022	Start Time: 11:30 AM	End Time: 12:00 PM

Authors: Emily Pesicka

Abstract: Climate Surprise and Military Response: A Case Study of Marine Corps Base Camp Lejeune and Hurricane Florence
Emily A. Pesicka

On September 14, 2018, a large and slow-moving Category-1 Hurricane named Florence was on track to make landfall and impact multiple East Coast states and military installations, including Marine Corps Base Camp Lejeune (MCBCL) home of the expeditionary forces. Hurricane Florence's forecasted impacts were nothing new for MCBCL as numerous past storms did not cause major impacts to installation critical infrastructure or military readiness. However, Hurricane Florence severely impacted operational capacities, military readiness, and critical infrastructure at MCBCL and the installation systems remain fragmented to this day. Why was Hurricane Florence unlike previous events and what indicators help us identify and manage such disasters? This work presents a case study on the emergency response and operational decisions surrounding Hurricane Florence and past storms to determine what decisions helped reduce or exacerbate impacts at MCBCL. We develop a timeline showing how decisions were made and apply a framework based on the history of military surprise attacks to determine if infrastructure and readiness at MCBCL was resourced to handle normal operations (day-to-day), past storms (situational surprises), and never-before-experienced disasters (fundamental surprises). We find decisions at the installation and across the Department of Defense were based on hindsight – i.e., expectations on the resilience of operational, infrastructure, and readiness needs based on normal operations and past storms. We also find indicators that Hurricane Florence should be understood as a fundamental surprise – i.e., an event that does not match past experience such that successful response requires adaptive capacity to resource new and unforeseen needs. Our analysis suggests that the impacts associated with Hurricane Florence were not extreme due to a lack of effort, but rather a lack of adaptive capacity to produce innovative solutions to fundamental surprises. Overall, we argue military systems will continue to experience things that they have not been exposed to in the past, which requires services to develop new capabilities to sense, anticipate, adapt to, and learn from fundamental surprises.

Classification: UNCLASSIFIED
Working Group: WG03 Infrastructure Analyses, Protection and Recovery

59890 - Data Fusion Informed Cellular Coverage Mapping for the Virgin Islands

Start Date: 6/15/2022	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Jacob Wigal

Abstract: In 2017, the U.S. Virgin Islands (USVI) were struck by two Category 5 hurricanes within two weeks of each other, placing enormous stress on the cell phone infrastructure in the territory. Over 60% of cell towers were taken offline and the uncertainty of where one could receive cell service disrupted the communication among disaster recovery crews and caused increased roadway congestion as people drove around looking for signal. After such disasters, quickly understanding which infrastructure components failed and determining how to provide communications to emergency responders and impacted communities is critical. Even though individual providers may know their own coverage areas and can provide this information to emergency responders, understanding who will lose service in an outage is complicated because each provider uses different combinations of cell towers, has different rules, does not share information with competitors, may have outdated and legacy systems, and may not coordinate with local governments and first responders until emergencies are oncoming. Instead, combining model-based estimates of cell phone coverage maps with real-time data for actual cell reception can provide a composite picture across

providers and communities for outage predictions and improved coordination of first responders. In this work, I present an effort coordinated with local stakeholders in the USVI to combine on-the-ground cell coverage data with a cell coverage model for the territory and validate model results. This initial data fusion approach helped identify which critical facilities across the territory would lose cell phone reception in the event of a tower outage. Together, the fusion of geospatial data, on-the-ground data, and modeling techniques provides a new capacity for the territory to estimate what facilities and communities will lose cell phone reception when antennae or towers fail. These maps will be used to prioritize hazard mitigation efforts and guide future recovery and response in the USVI.

Classification: UNCLASSIFIED
Working Group: WG03 Infrastructure Analyses, Protection and Recovery

59967 - Occupancy and Space Allocation Studies (OSAS)

Start Date: 6/15/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Mr. Micheal Vincent Pannell		

Abstract: The Center for Army Analysis conducts occupancy and space allocation assessments of Department of Defense infrastructure such as the Pentagon and other key facilities. Office space and other required spaces are often allocated based on ad hoc requests and other historical practices. Many organizations find they need to periodically reassess overall occupancy and space allocation in light of organizational changes, new mission requirements, or changes to the workplace made possible by new or emerging technology. With numerous competing demands at play, finding the ideal mix of collocated functions and tiers of leadership is a complex problem large organizations must solve. This briefing addresses the process of establishing metrics for determining occupancy and space allocation through the analysis of organizational structures, relationships, and core missions that are critical to support the predominate nature of the work performed.

Classification: UNCLASSIFIED
Working Group: WG03 Infrastructure Analyses, Protection and Recovery

59541 - Planning a Cloud Migration Effort: Cost Estimating Considerations

Start Date: 6/15/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Mr. Kyle Connor Ferris		

Abstract: The utilization of cloud computing services allows for real-time data distribution and storage within customizable web-based infrastructures, designed according to the operational needs of a customer. The benefits of cloud solutions include minimal investments in physical hardware and IT infrastructure, customized server scaling to meet operational demands, and the convenience of consolidating data and applications under a standard online architecture.

With the growing prevalence of customizable cloud solutions, the challenge of developing a defensible cost estimate for the migration of legacy data to cloud environments becomes increasingly complex. Organizations must now consider a variety of cost factors: including the adoption of “Cloud First” vs. “Cloud Smart” migration strategies, the viability of Multi-Cloud vs. Hybrid Cloud deployment models to diversify workloads, and the incorporation of edge computing architectures for reduced network latency.

The purpose of this presentation is to demystify the fundamentals of cloud computing, and establish important cost estimating considerations when working to define the purpose and scope of a cloud

migration effort. Understanding these fundamental requirements and considerations in relation to associated capability gaps can enhance organizational agility, leading to the development of effective cloud migration strategies that satisfy operational objectives.

Classification: UNCLASSIFIED
Working Group: WG03 Infrastructure Analyses, Protection and Recovery

59687 - The Importance of Inland waterway Systems to the Global Maritime Transportation System

Start Date: 6/16/2022	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: Dr. John R. Hummel, FS		

Abstract: The global economy is dependent upon an efficient maritime transportation system (MTS). The COVID-19 pandemic has demonstrated the significant impacts that can results from disruptions in the MTS. While most people know about the major U.S. ports where global shipments are off-loaded, many do not realize that many of the shipments still need to move by water to get to their final destinations. In a similar fashion, many products originate from inland locations before they get loaded onto ocean going freighters.
This presentation will first give an overview of the major inland waterway systems that are coupled to the global MTS. The potential disruptions to the inland waterway systems will be discussed along with the impacts they may have from an economic and national security perspective.

Classification: UNCLASSIFIED
Working Group: WG03 Infrastructure Analyses, Protection and Recovery

59398 - Economic Analysis Approach to Critical Infrastructure Resilience

Start Date: 6/16/2022	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Jeffrey Lineberry		

Abstract: Critical infrastructure resiliency is an imperative global concern. The consideration of critical infrastructure interdependencies complicates the identification of resilience optimality. Many nations are faced with budgeting constraints and the need to optimally determine infrastructure resilience investment. The ability to identify critical infrastructure essential node vulnerability is paramount to decision makers. Determining overall economic impacts associated with critical infrastructure disruptions is a desirable approach. Utilized real data consisting of Sweden's rail network, power supply network, and associated economic commodity data is implemented in a tri-level model approach utilized to pinpoint vulnerability considering critical infrastructure interdependencies. This Defender-Attack-Defender model representative of vulnerability reductions, network disruptions, and recoverability enhancements is utilized to determine vital interdependent nodes associated with the rail and power supply networks. The analysis from this model gives insight into associated economic impacts, thus providing the framework necessary to link economic sectors to critical infrastructure interdependencies in order to determine optimal resilience investment. This model results in an overall ability to guide resilience investment based on overall economic sector considerations.

Classification: UNCLASSIFIED
Working Group: WG03 Infrastructure Analyses, Protection and Recovery

59769 - Rapid exact restoration of federated market state after systemic failure

Start Date: 6/16/2022	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Dr David Rushing Dewhurst		

Abstract: Continual efficient operation of US financial markets is critical to DoD operations and the wellbeing of society. Natural disasters or adversarial actions such as cyberattack could cause outages in financial market operations. Recovering from an outage to a consistent view of market state that is sufficiently rich to enable resumption of trading is nontrivial because trading activity in modern financial markets is distributed across multiple trading venues which, in turn, are distributed across multiple physically distinct data centers. Past outages, such as the 2013 “Flash Freeze” trading halt in NASDAQ-listed securities, lasted for multiple hours and exposed the lack of a system-wide algorithm for resilient restart of trading.
We introduce algorithms for automatically restoring a consistent view of market state across all trading venues in a federated financial network and for detecting possible signals of future outages. We model a federated financial system as a discrete factor graph and use exact inference algorithms to infer a minimal market state for all trading venues at which outages have occurred. The factor graph includes constraints that denote desired market microstructure conditions. In our framework, successful termination of inference procedures constitutes a constructive proof that the microstructure constraints are satisfied. Parameters of the factor graph are learned from event-level data in the market of interest and are continuously updated on streaming data for maximal relevance. We demonstrate the effectiveness of these algorithms in case studies using both high-frequency equities data and financial market models. Our algorithms successfully restore market state within milliseconds of unexpected outage in one or more trading venues. Finally, we discuss a methodology for online detection of predictable inconsistency of information generated by one or more trading venues. Predictable information inconsistency could be an indicator of technical issues with a trading venue.

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Classification: UNCLASSIFIED
Working Group: WG03 Infrastructure Analyses, Protection and Recovery

60181 - Assessment of Water Distribution Infrastructure Criticality through Network and Hydraulic Assessment

Start Date: 6/16/2022	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Noah Garfinkle; Lt Col Justin Delorit; Mr. Michael Peter Duczynski

Abstract: Every critical mission on DoD installations depends upon the resilience of water supply, whether for serving human needs, powering industrial processes, cooling essential equipment, or providing fire suppression capacity. Planning and investing to improve resilience against a broad and uncertain catalogue of threats and hazards will require the adoption of existing and new quantitative techniques for assessing the relative prioritization of installation water infrastructure across a range of scenarios. This presentation will discuss development of graph-theoretic and hydraulic-modeling based approaches for assessing the resilience of water distribution systems and predicting the consequences of failure of elements of the network. The presentation will highlight work under development by the Air Force Institute of Technology and the Army Engineer Research and Development Center, funded by the Department of Defense Energy Security Technology Certification Program.
Over the course of the session, presenters will discuss the conceptualization of water distribution systems utilizing asset models, graph theory, and computer simulations. Building upon this layered assessment methodology, presenters will utilize a fictional water distribution network (for operational security reasons) to engage with the audience in discussion of how the network might be assessed for

likelihood and consequence of failure. Particular attention will be paid to discussion of the data requirements for each methodology, as well as how the different approaches compare and contrast based upon application to real water distribution systems and to their role in the resilience of Department of Defense installations. The desired end state of this presentation is to engage the audience in discussion of how the resilience of water distribution systems can be assessed using both current and emerging techniques, as well as the role of the research and development and academic communities in supporting installations with water resilience.

Classification: UNCLASSIFIED
Working Group: WG03 Infrastructure Analyses, Protection and Recovery

59980 - Efficient Vulnerability Assessment of Large-scale Dynamic Transportation Networks

Start Date: 6/16/2022	Start Time: 11:30 AM	End Time: 12:00 PM

Authors: Venkateswaran Shekar; Dr. Lance Fiondella

Abstract: This talk presents an approach to assess the vulnerability of each link/time pair contained within a dynamic transportation network. Unlike vulnerability assessment methods based on static traffic assignment, which only indicate link disruptions that would most negatively impact network travel time, dynamic vulnerability assessment provides insight into both when and where a disruption would be most detrimental. To enhance the efficiency of dynamic transportation network vulnerability assessment, a subnetwork approach is proposed, based on the intuition that the negative impacts are most heavily concentrated about the area immediately surrounding the disruption. Our experiments study the tradeoff between subnetwork size and rank correlation of each link/time pair determined from simulation of the entire network as well as the time savings enabled by the subnetwork approach compared to full network simulation. A simple heuristic to effectively balance the tradeoff between correlation and computational speed up is subsequently identified. The experiments are performed in the context of two case studies from the literature, including an enhanced version of the Sioux Falls network [1] and SUMO Traffic Scenario [2] for the city of Luxembourg. Our results indicate that, as the size of the network increases, the savings enabled by the subnetwork approach increases because the primary impact of a disruption was indeed experienced in the portion of the network immediately surrounding it. The subnetwork approach is then employed to identify a deployment of a limited number of guidance mechanisms such as variable message signs within the subnetwork. The results indicate that the effects of the disruption cannot be mitigated entirely, but that a substantial reduction can be achieved with a well-placed set of mechanisms to reroute traffic. The subnetwork approach therefore offers a computationally efficient approach to both identify and mitigate the impact of disruptions within a dynamic transportation network.

References
[1] A Chakirov and P J Fourie. Enriched Sioux falls scenario with dynamic and disaggregate demand. Arbeitsberichte Verkehrs-und Raumplanung, 978, 2014.
[2] L Codeca, R Frank, S Faye, and T Engel. Luxembourg sumo traffic (LuST) scenario: Traffic demand evaluation. IEEE Intelligent Transportation Systems Magazine, 9(2):52{63, 2017.

Classification: UNCLASSIFIED
Working Group: WG03 Infrastructure Analyses, Protection and Recovery

60235 - Modeling Impacts to Interdependent Lifeline Infrastructures from Catastrophic Events

Start Date: 6/16/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Steve Folga		
Abstract: A lifeline infrastructure enables the continuous operation of critical government and business functions and is essential to human health and safety or economic security. The U.S. is experiencing an increase in the frequency and severity of catastrophic events and in 2021, there were 20 weather/climate disaster events with losses exceeding $1 billion each to affect the United States. In the aftermath of a catastrophic event, chaos and confusion can exacerbate a situation that already has the potential to cause significant damage to U.S. critical infrastructure. Emergency planning is crucial to effective disaster response and recovery. Clear Path is the U.S. Department of Energy Office of Cybersecurity, Energy Security, and Emergency Response's (CESER's) annual all-hazards energy security and resilience exercise series. The series examines the energy sector's response and restoration roles, responsibilities, and plans and procedures following a major incident, stressing interdependencies between multiple lifeline infrastructure sectors. Each year, Clear Path presents response officials from a diverse array of challenging exercise scenarios, allowing them to build upon and validate improvements made in response to lessons learned from previous exercises and real-world incidents. In fall 2020, Clear Path VIII brought together over 200 energy and lifeline sector partners in a virtual environment to simulate the energy and lifeline sectors' response roles, responsibilities, plans, and procedures. The 2020 scenario was a 7.0 magnitude earthquake along Utah's Wasatch Fault Zone that severely affected critical infrastructure and public safety across Utah. Modeling and simulation were used to determine the potential impacts of the earthquake on lifeline infrastructures, stressing the interdependencies among multiple lifeline infrastructure sectors within the state of Utah. Interdependencies modeling and integration allowed anticipation of cascading failures among lifeline infrastructure systems and the evaluation of propagating effects within each infrastructure system. This paper presents the application of a framework to integrate multiple lifeline infrastructure models, to anticipate regional and local cascading failures, and design resilient energy systems. The results highlight the complex interdependencies while identifying opportunities and strategies to enhance infrastructure resilience. Classification: UNCLASSIFIED Working Group: WG03 Infrastructure Analyses, Protection and Recovery		

60313 - Learning from Surprise: Training and Education for Resilient Critical Infrastructure

Start Date: 6/16/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Prof. David L. Alderson; Daniel A Eisenberg; Dr Thomas P Seager		
Abstract: While current practices for infrastructure currently follow principles of reliability and risk, these are—by necessity—based on knowledge of past events. They are not suited to adapt infrastructure to dramatic change and/or future surprises. In this presentation, we describe efforts to develop novel training exercises that complement current approaches by drawing upon a theory of resilience that emphasizes adaptive response to surprise. We argue that experience with surprise in 'realistic, yet fictitious' infrastructure systems simulations can improve the capacity of infrastructure managers to sense, anticipate, adapt to, and learn from surprise in virtual crises gaming scenarios when trainees successfully integrate their experiences from simpler to more complex stages of expertise. We		

describe our experience to date conducting this training in classroom and operational settings and its ability to increase expertise among infrastructure managers confronted with surprise.

Classification: UNCLASSIFIED
Working Group: WG03 Infrastructure Analyses, Protection and Recovery

WG04 Homeland Security, Homeland Defense and Civil Support

60558 - UNDERSTANDING QUANTITATIVE DIMENSIONS OF BEHAVIOR – WHY IT MATTERS IN DATA ANALYTICS

Start Date: 6/15/2022	Start Time: 8:30 AM	End Time: 9:00 AM

Authors: Dr. Kenneth W. Lewis

Abstract: In 2022 and beyond, Data Analytics & Big Data continue to be the new poster-boy buzzwords that add excitement and sparkle to the otherwise drab topics of statistics, operations research, quantitative methods, data analysis and management science. Sometimes our young or inexperienced analysts will use the wrong measurement or dimension of the behavior they are studying. They might mistakenly think they are studying the frequency of that behavior, when in fact they should actually be studying the magnitude, longevity or cost of that behavior. Understanding exactly what type of dimension of behavior the analyst is studying provides clarity and validity to the research study process. It determines the type of analysis that the research project requires. If you see the recorded data point of (7), what does it mean? Kenneth Lewis, who has taught operations research, quantitative methods and educational research methods for over 36 years, will connect some of the dots of what to measure, how to analyze and how to interpret the results.

Keywords: Data Analytics, Dimensions of Behavior, Research Methods, Computer Technology, Research Action Verbs

Classification: UNCLASSIFIED
Working Group: WG04 Homeland Security, Homeland Defense and Civil Support

60050 - Ethical AI: Some Practical Practices

Start Date: 6/15/2022	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Joseph Troy Morgan; Jared Shamwell

Abstract: The U.S. Department of Defense adopted a series of ethical principles for the use of Artificial Intelligence (AI) in 2020. The adoption of AI ethical principles aligns with the DOD AI strategy objective directing the U.S. military lead in AI ethics and the lawful use of AI systems. The department's AI ethical principles encompass five major areas: Responsible, Equitable, Traceable, Reliable, Governable. However, from an AI practitioner perspective, there remains a significant gap between these guiding principles and the practical implications for putting AI/ML tools into production. This discussion will cover some prudent measures that can be realistically implemented short-term. These practices are based upon experiences within a financial institution's robust model risk management processes and best practices from a MLOps perspective.

Classification: UNCLASSIFIED
Working Group: WG04 Homeland Security, Homeland Defense and Civil Support

59844 - Lakehouse: A New Generation of Open Platforms that Unify Data Warehousing and Advanced Analytics

Start Date: 6/15/2022	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Zafer Bilaloglu		
Abstract: In this presentation we will discuss how the data warehouse architecture as we know it today will wither in the coming years and be replaced by a new architectural pattern, the Lakehouse, which will (i) be based on open direct-access data formats, such as Apache Parquet, (ii) have first class support for machine learning and data science, and (iii) offer state-of-the-art performance. Lakehouses can help address several major challenges with data warehouses, including data staleness, reliability, total cost of ownership, data lock-in, and limited use-case support. We discuss how the industry is already moving toward Lakehouses and how this shift may affect work in data management. We'll also demonstrate a key capability on top of Databricks Lakehouse platform, Databricks AutoML, which is the industry's first "glass box" AutoML solution. Databricks AutoML allows machine learning practitioners to quickly generate baseline models and notebooks. Using AutoML, ML experts can accelerate their workflow by fast-forwarding through the usual trial-and-error and focus on customizations using their domain knowledge, and citizen data scientists can quickly achieve usable results with a low-code approach. Classification: UNCLASSIFIED Working Group: WG04 Homeland Security, Homeland Defense and Civil Support		

59678 - Leveraging Data Science to Improve Personnel Turnover Forecasting

Start Date: 6/15/2022	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Dr. Daniel Thomas Maxwell; Mr. John Gugliotti; Mr. Peter Rogers		
Abstract: The work environment for Federal employees of the future will be quite different than before. Between COVID and the turnover in the workforce due to myriad reasons, leaders in the Federal Government will need to adapt their expectations and approach to strategically managing the workforce. This presentation describes how a Department of Treasury organization used data science techniques from the advertising industry and synthesized twenty years of employee and economic data into a dataset that describes the employees' journeys through the organization. A combination of machine learning and good old-fashioned analysis has generated insight into the workforce, including predictive models identify employees that are most likely to resign or retire. This has enabled leaders to adjust hiring and retention policies to improve recruiting effectiveness, workforce stability and productivity. Classification: UNCLASSIFIED Working Group: WG04 Homeland Security, Homeland Defense and Civil Support		

60307 - Introducing Effective Information Environment Organization Strategies (EIEIOS) through GitLab for Non-Programmers: Analyst's Perspective on Reframing Knowledge Management

Start Date: 6/15/2022	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: David Azari, Ph.D.; William Kirschenman		
Abstract: This presentation first introduces the concept of Effective Information Environment Organization Strategies (EIEIOS) - an alternative approach to the widely known knowledge management for analytical organizations. EIEIOS is then applied in summarizing a multi-month effort		

to enable real-time distributed tool creation via GitLab. Standard workflows, platforms, security requirements, and group structures are presented, with the authors providing real examples of successful dispersed development efforts that abide local restrictions. Discussion will address alternative approaches to improving information resiliency, and explore how GitLab can enable and promote innovative, decentralized tool development among non-programmers within National Security analytic organizations.

Classification: UNCLASSIFIED
Working Group: WG04 Homeland Security, Homeland Defense and Civil Support

60184 - Building a Coordinated R&D Ecosystem for the Department Homeland Security

Start Date: 6/15/2022	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Dr. Kelli Esser

Abstract: In March 2019, the Government Accountability Office (GAO) published Report 19-210, "Homeland Security: Research and Development Coordination Has Improved, but Additional Actions Needed to Track and Evaluate Projects". The report provided four recommendations aimed at improving Department of Homeland Security (DHS) abilities to prioritize, resource, measure, and transition research and development (R&D) activities in support of DHS Components and homeland security missions.

DHS' lead organization for R&D, the Science and Technology Directorate (S&T), used the GAO recommendations as an opportunity to look critically at the complexities of coordinating and integrating R&D across a large federated department, to get a better understanding of where improvements could be made in both the near- and long-term. Of the various complexities examined, three were highlighted as priority for improvement:
(1) Governance
(2) Process Alignment
(3) Traceability and Transparency
The importance of these three complexities stems from DHS having one of the lowest R&D budgets in all of federal government, making up only 0.35% of federal R&D. This extremely limited budget, coupled with the responsibilities for carrying out a diverse set of missions to secure the nation's homeland, translate into DHS needing to ensure that all R&D resources are being used in the most efficient and effective manner to maximize impact to the missions. DHS must take a strategic approach to addressing its R&D needs – not just through the allocation of its own limited resources, but also by leveraging the solutions, capabilities, and investments of other federal R&D organizations and private sector.

In February 2020, the "R&D Coordination Initiative" was launched as a department-wide effort, under the leadership of DHS S&T, to enable a more coordinated, integrated DHS R&D ecosystem through improved partnerships, guidance, and strategic resourcing. Over the past 2.5 years, the R&D Coordination Initiative has successfully changed the way DHS leaders and decision-makers come together to share information on where R&D is currently making an impact on homeland security missions, and determine priorities for allocating future limited resources to address emerging threats in light of continuous rapid acceleration in technology-driven capabiilties.

This is a good news story of a "lemons into lemonade" situation, where what started as the need to address GAO concerns about DHS abilities to coordinate R&D resulted into an unprecedented

department-wide commitment to optimizing its use of R&D and partnerships for homeland security missions. But much work remains to be done to ensure long-term sustainment and value for DHS R&D and the R&D Coordination Initiative. Further details on accomplishments, challenges, and path forward will be presented in the full presentation.

Classification: UNCLASSIFIED
Working Group: WG04 Homeland Security, Homeland Defense and Civil Support

59526 - Station Allocation Scheduling Assistant (SALSA)

Start Date: 6/15/2022	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Mr. Matthew S Cosner; Dr. Sandra Beaulieu; Alexander Phan

Abstract: The Naval Air Warfare Center Aircraft Division, Warfare Effectiveness Department (WED) leads studies examining crewed and uncrewed aircraft which inform aircraft design and science and technology investment decisions. A common metric used to evaluate future designs and concepts of operations is persistence: the ability to remain on-station for extended durations in support of a mission. Historically, persistence analysis has been conducted via subject matter expert (SME)-developed spreadsheet flight schedules. These spreadsheets often took a day or more to complete, lacked intuitive visualization, and did not enable comparison across many options nor sensitivity analysis.

In response, a team of analysts initiated the Station Allocation Scheduling Assistant (SALSA) project to develop a MATLAB-based tool to evaluate multi-aircraft persistence as a function of user-defined inputs. The goal was a model that could run persistence analysis cases in minutes vice days, reduce reliance upon SME assumptions, produce deeper and richer metrics, facilitate parametric and sensitivity analysis, and provide intuitive visualizations and playbacks for briefings.

SALSA is specifically designed for analysis of sea-based aviation operating from distributed sea bases. Inputs include air vehicle performance; aircraft maintainability; aviation manpower; the number of aircraft, surface ships or bases; command and control capabilities; and the desired mission and duration. SALSA outputs include flight schedules; percentage time on-station; coverage over time; aircraft and manpower utilization rates; and a playback animation of the mission. In addition, SALSA outputs can be imported into constructive simulation tools to show the impacts of persistence on mission / kill-chain success.

The model has been used to support multiple studies for the Office of the Chief of Naval Operations, Naval Air Systems Command and Naval Sea Systems Command. Key insights include the relationship of station keeping capability to aircraft characteristics such as transit speed, payload and endurance, and the importance of aircraft maintainability and maintenance manpower on sustained flight operations. These insights are helping to shape future crewed and uncrewed aircraft requirements, designs, and concepts of operation.

Issues encountered during model development were maintaining version control, operating across multiple levels of security, the requirement for user familiarity with MATLAB to run the model, and managing a large design trade space. Recently implemented methods to address these issues include the use of an online code repository to facilitate code-sharing and version control across numerous developers, a modular approach to coding to enable transfer of required features and

implementation of new features, the development of a graphical user interface and the employment of a design of experiments approach for sensitivity analysis and trade space exploration.

Classification: UNCLASSIFIED // FOUO
Working Group: WG04 Homeland Security, Homeland Defense and Civil Support

59651 - A Nuclear Security Enterprise Study of High-Reliability Systems, Collaboration, and Data

Start Date: 6/15/2022	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Mr. Terry Michael Josserand

Abstract: It may seem simple and trivial, but defining the difference between data and information is contested and has implications that may affect the security of United States interests and even cost lives. For security, data are raw facts or figures without context, while information is the compilation or articulation of data that forms context. Security depends on clarity in the differences between data and information and controlling them.

Control is necessary to ensure that data and information are not inadvertently released to foreign governments, the public, or those without Need-to-Know. A primary concern in the practice of security is the control of data to avoid the inadvertent conversion to sensitive information. The complexity of this concern is further augmented when institutions are part of tightly coupled networks that informally share data and information. Additionally, those that share data as a function of legislative action—and/or formally integrate data and information system infrastructures—may be a higher security risk. This paper will present a case study that utilizes elements of literature from Knowledge Management and networks to tell a story of an issue in security—specifically, controlling the conversion of data to information.

Classification: UNCLASSIFIED // FOUO
Working Group: WG04 Homeland Security, Homeland Defense and Civil Support

60425 - The Persistent Monitoring of Emerging Technologies

Start Date: 6/16/2022	Start Time: 3:00 PM	End Time: 3:30 PM

Authors: Richard M. Buchter

Abstract: Input to war games typically consists of "futuring" assessments- Deep Dives, Delphi Method (panels of experts), and trend analysis- frequently conducted on an annual to multi-year revisit basis to provide trend analysis and forecasting of the deep future. But do these approaches keep pace with the rapidly evolving tech sector to provide the ability to keep ones hand on the pulse of the rapidly developing tech sector? This presentation discusses a different approach, a missing component in futuring, the actual reporting of where science and technology institutions, along with industry, say they are going and when, on a daily to weekly basis that they will be available, tailored to support war game and program office needs alike. This presentation, discusses the development process of the persistent monitoring of emerging technology concept, first presented to the Army's Mad Scientist blog in 2020 (awarded "2020 Army Mad Scientist of the Year"). This approach uses news feeds, press releases, conference presentations, annual reports, etc., for capturing the direct reporting of today's business and scientific advancements. Data is then reduced to a simple chart, in this case a periodic chart format, to present potential advancements based on a time scale of ones choosing. Such an approach allows developers to develop tailored reporting lends itself to a wide variety of needs. Discussion concludes with some thoughts on how to expand the approaches usefulness into wargaming and PM risk analysis. Such an approach elevates awareness of technical opportunities and

threats to the status quo and can serve as inputs to the 4GIM (4 Generations of Innovation Model) along its Exceptional Innovation axis supporting the Disruptive Dozen to better understand future threats and opportunity vectors.

Classification: UNCLASSIFIED
Working Group: WG04 Homeland Security, Homeland Defense and Civil Support

WG05 Cyber Operations

59742 - Demonetizing Cyber Crime; Tracing Funds through Blockchain Analytics

Start Date: 6/15/2022	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: Michael Woudenberg		
Abstract: Crypto currencies are exploding across the financial markets, and with that, illicit actors who are using crypto to extract revenue from cyber attacks such as ransomware, crypto hacking, and other cybercrimes. State and non-state actors are also using crypto as a method to bypass sanctions and anti-proliferation laws, obfuscate money laundering, and anonymize cyber criminals. Join us as we explore blockchain analytics, crypto tracing, criminal attribution and the public and private partnerships required to demonetize cyber crime. Classification: UNCLASSIFIED Working Group: WG05 Cyber Operations		

60224 - Threat Analysis Using Machine Learning for 5G and Beyond

Start Date: 6/15/2022	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Mr Ambrose Kam		
Abstract: Fifth Generation (5G) in the cell phone/wireless industry is one of the key emerging technologies coming to the civilian sector; it will also have substantial impacts for military applications in the Joint All-Domain Operations (JADO) environment. While 5G operates at a different frequency spectrum than existing networks, it also differs from the previous generations (4G or 3G) in terms of the architecture as well. Given the dynamic nature of cyber threats in the JADO environment, cyber resiliency is a topic of particular interest. Recent articles and white papers have discussed cyber vulnerabilities at various layers of the 5G architecture. However, there has not been a comprehensive modeling effort at the system or system-of-system level. Such an effort allows us a more thorough view of the 5G architecture (from the chipset layer all the way to the application layer). Additionally, it provides us an opportunity to improve our cyber defensive posture so that our systems can withstand cyber attacks while mission objectives are being completed. With our simulation capability, subject matter experts (SMEs) can provide recommendations and make affordable system trades to enhance mission assurance. Our approach to this 5G research is to leverage system architecture modeling tools and operations analysis techniques via machine learning. With modeling & simulation, we can perform advanced trade studies and sensitivity analysis on potential cyber solutions relative to existing and emerging threats. Classification: UNCLASSIFIED Working Group: WG05 Cyber Operations		

60194 - MDA Cyber Table Top Exercises (CTTX)

Start Date: 6/15/2022	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Dr. Richard C. Goodwin
Abstract: Cyberspace is becoming an increasingly contested domain and the United States and our adversaries are increasing their operations in this domain. The recent elevation of U.S. Cyber Command to combatant command status is indicative of the emphasis that the Department of Defense is placing on cyberspace. The Secretary of Defense is dedicating his personal attention to the status of the military's cyber defense. The Missile Defense Agency (MDA) has significantly increased its engineering efforts to remain mission effective in a cyber-contested operational domain. This process starts with understanding an adversary's attack strategy. Studies to Understand Cybersecurity Requirements and Characterize Cybersecurity Attack Surface will be conducted as part of the systems engineering process and will be repeated as necessary prior to each cyber developmental test event. Programs should begin the initial analysis early and perform iterative reviews throughout their acquisition lifecycle to address cyber requirements and risks, and to inform cyber T&E planning. These reviews contribute to the development and refinement of test objectives and require engagement and collaboration with systems engineers, security engineers, network defenders, developers, system administrators, and operators. Cybersecurity requirements will be informed by engineering analysis of the validated operational cyber threat. Cyber requirements and attack surfaces can be addressed in and further characterized by Cyber Table Top exercises (CTTX). This presentation, drawing from current DoD Cyber-security and Cyber-resiliency, show how MDA proposes to characterize a cyber-contested operational environment to identify cyber-related operational risks for program offices and warfighters. Classification: UNCLASSIFIED // FOUO Working Group: WG05 Cyber Operations

60279 - A Systematic Framework for Simulating Cyber Conflict

Start Date: 6/15/2022	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Mr Merle S Robinson		
Abstract: Problem Statement: Common approaches to simulating cyber conflict tend to be highly technical or very abstract making their use highly suspect compared to kinetic and other domains. They also tend not to provide decision makers with the ability to understand the cost and likely impact of their decisions. Approach: This approach provides a lens to examine cyber initiatives by organizations by looking at typical vectors of action, elements/resources used to build capabilities, and the critical elements that can enhance or reduce a group's ability to develop a variety of capabilities. Techniques: Building a framework/menu of various "Course of Action" approaches that encompass historically observed attack/defense/observation methodologies. Evaluates models for benchmarking development projects and assessing potential impacts. Challenges: The proposed model is focused on the operational level impacts of organizational efforts. Expert support is required to translate the model into options tailored to specific environments Results: This could provide a useful outline of documented vectors of organizational Cyber conflict enabling productive discussion between expert and non-expert participants in Cyber conflict simulations. In specific simulations,it allows consideration of resource limitations, trade-offs in		

decision-making and challenges of dynamic action between attackers/defenders potentially at lower classification levels.

Conclusions: This provides a basic menu of approaches to organizational courses of action in Cyber conflict.

Biography: A retired federal IT Defense Business System Manager, Lean Six Sigma Black Belt with complementing experience in budget, finance, logistics, and process improvement. Corporate officer for the non-profit National Security Decision-Making Game running PMESII-PT simulations at academic, federal, and hobby events.

Classification: UNCLASSIFIED
Working Group: WG05 Cyber Operations

59639 - An Analysis of C/C++ Datasets for Machine Learning-Assisted Software Vulnerability Detection

Start Date: 6/15/2022	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Daniel Grahn		

Abstract: As machine learning-assisted vulnerability detection research matures, it is critical to understand the datasets being used by existing papers. In this paper, we explore 7 C/C++ datasets and evaluate their suitability for machine learning-assisted vulnerability detection. We also present a new dataset, named Wild C, containing over 10.3 million individual open-source C/C++ files -- a sufficiently large sample to be reasonably considered representative of typical C/C++ code. To facilitate comparison, we tokenize all of the datasets and perform the analysis at this level.
We make three primary contributions. First, while all the datasets differ from our Wild C dataset, some do so to a greater degree. This includes divergence in file lengths and token usage frequency. Additionally, none of the datasets contain the entirety of the C/C++ vocabulary. These missing tokens account for up to 11% of all token usage. Second, we find all the datasets contain duplication with some containing a significant amount. In the Juliet dataset, we describe augmentations of test cases making the dataset susceptible to data leakage. This augmentation occurs with such frequency that a random 80/20 split has roughly 58% overlap of the test with the training data. Finally, we collect and process a large dataset of C code, named Wild C. This dataset is designed to serve as a representative sample of all C/C++ code and is the basis for our analyses.

Classification: UNCLASSIFIED
Working Group: WG05 Cyber Operations

60340 - Applying artificial intelligence to energy monitoring data for cyber-attack detection

Start Date: 6/15/2022	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Dr. Bonnie Worth Johnson		

Abstract: Advances in artificial intelligence (AI) offer a promising solution for detecting cyber-attacks on naval facilities ashore and at sea. This project is studying the application of advanced analytics and AI methods to energy usage data to identify possible cyber-attacks. This project is exploring the use of networks of energy monitoring sensors to collect energy usage data, and AI methods to analyze the data to detect cyber-attack on naval shore facilities and ship platforms. This capability would effectively provide energy self-awareness, as a form of metacognition—enabling intelligent systems to self-diagnose to detect unusual activities—in this case, unusual energy usage that might indicate a

nefarious cyber intrusion. The concept involves the development of “patterns of life” (normal energy usage) over time and the detection of variances or anomalies in these patterns that indicate possible cyber-attacks. This presentation will describe the project approach and progress to date.

Classification: UNCLASSIFIED // FOUO
Working Group: WG05 Cyber Operations

59176 - Characterizing the Joint Distribution of Cyber Data and Generating Synthetic Training Examples

Start Date: 6/15/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Capt Marc Winczer Chale; Dr. Nathaniel D. Bastian		
Abstract: Attacks against enterprise cyber networks cost billions of dollars in economic losses each year. Intrusion detections systems (IDS) are a ubiquitous tool to audit cyber traffic for malicious activity. Modern IDS are adopting artificial intelligence (AI) to trigger threat alerts, preventing excessive loss. However, AI techniques such as machine learning require very large training sets. The lack of high-quality cyber training data has proven a major limitation in the advancement of IDS technology. This research uses generative methods to characterize the joint distribution of cyber data and to generate realistic synthetic data to aid in training IDS classifiers. Markov Chain Monte-Carlo, generative adversarial networks, and variational autoencoders are compared experimentally as methods for modeling the joint distribution of cyber data and for generating synthetic training data. Classification: UNCLASSIFIED Working Group: WG05 Cyber Operations		

61111 - Information Warfare and Pandemics: the Linked Threats

Start Date: 6/15/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Dr. Eva K. Lee; Dr. Douglas A. Samuelson		
Abstract: In modern, interconnected society, epidemics spread more through group interactions than via the individual major carrier on whom traditional models focus. Also, countering the epidemic entails spreading information in a fashion similar to physical spread of infection: we are in a race between two dissemination processes. Clearly, then, an adversary seeking to harm a large, modern nation could disrupt and confound information dissemination to amplify the effects of an organic infection, regardless of that infection’s origin. If this is not already happening, surely the COVID-19 pandemic has provided potential adversaries with a wealth of information about how to make it happen in the future. Major reassessments and restructuring of national processes and resources are indicated. Classification: UNCLASSIFIED Working Group: WG05 Cyber Operations		

60310 - UPDATE: How to Measure Cybersecurity Risk

Start Date: 6/15/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Dr. Douglas A. Samuelson		
Abstract: Recapping and expanding on earlier work by Sam Savage, Shaun Doheney, Douglas W. Hubbard, and the present author, we will reexamine the fundamental question of how to depict risk when we do not have an agreed definition of what cybersecurity is. Risk can be understood only in a context of what threats we might contemplate. Assessing vulnerability to such threats requires		

challenge testing. Simulation and experimental design techniques can derive considerable information value from a modest number of such tests, but some testing remains necessary.

Classification: UNCLASSIFIED
Working Group: WG05 Cyber Operations

59178 - Meta-learning for Robust Intrusion Detection

Start Date: 6/16/2022	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Capt Marc Winczer Chale; Dr. Nathaniel D. Bastian		
Abstract: Ongoing research suggests that adversaries can fool intrusion detection systems (IDS) by intentionally perturbing packets of cyber data. By studying the nature of normal, malicious, and perturbed cyber traffic, we identify a meta-learning approach for robust IDS. A multi-level stack ensemble includes a low level ensemble classifiers tuned for (a) unperturbed cyber traffic and (b) perturbed cyber traffic. A high level ensemble learns when to trust the decision from either respective low level classifier. This ensemble design does not require perturbed examples to be explicitly labeled. We seek to demonstrate improved accuracy in each traffic type. Classification: UNCLASSIFIED Working Group: WG05 Cyber Operations		

60670 - Process Innovation and Exploration of Army Enterprise IT as a Service Approaches

Start Date: 6/16/2022	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: MAJ Jaison Desai, PhD; Mark Southwell; MAJ Anthony Abeyta; MAJ Ezra McCalment; LTC James Sanders, Jr.		
Abstract: This presentation discusses the ongoing exploration of new approaches for Army Enterprise Information Technology and how those efforts are driving innovation in organizational processes and techniques. Through the consideration of “as-a-Service” models and unique integration of vendor-provided capabilities, the authors needed to address previously unexplored technical challenges, in addition to procedural paradigms. Here, we discuss several of these solution spaces and how they inform potential approaches to improved collaboration and synchronization as the government explores integration of innovative technologies that disrupt the status quo. First, we highlight the challenges with defining an IT baseline and the benefits of collaborative innovation. Next, we discuss the unique process innovation of the Joint Security Operating Environment (JSOE) to better leverage threat-informed and data-centric security approaches. Finally, we highlight the potential for new organizational paradigms to generate much-needed reforms in legacy policies in order to achieve transformative IT modernization. Classification: UNCLASSIFIED Working Group: WG05 Cyber Operations		

60335 - Tactical network optimization using algorithmic slice creation and dynamic resource allocation

Start Date: 6/16/2022	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Mr. Anthony Castanares		
Abstract: Modern-day and future-force battlefield networks have requirements to be scalable in response to Soldier demand or changing battlefield conditions, and to be resilient to attacks or oversaturation. Currently available tactical radios have limited technical capabilities to deliver such		

scalability or adjustable levels of resiliency when deployed in operational environments, resulting in flat networks that provide "one-size-fits-all" quality of service (QoS) and non-segmented topologies. To address this problem, we propose the use of software defined network (SDN) slices with an algorithmic network optimization methodology to facilitate slice creation and resource allocation. This approach relies upon a methodology that builds an initial collection of network slices for the tactical battlespace with considerations for the type of traffic that each slice will service (UDP, TCP, voice, video, sensor data), the mission of that slice (C2, Intel, Fires, Maneuvers & Recon, Airborne, Logistics), and the unique QoS demands of the traffic at that point in time (no hostilities, eminent hostilities, battle engagement, sensor collection). Other parameters such as application bandwidth requirements, traffic latency tolerances, and currently available link capacities are also considered in the optimization model. In this work we present the model constraints, parameters and optimization functions that facilitate the creation of network slices based upon mission, traffic, and network conditions. We formulate a constrained optimization problem that minimizes total message delivery latency under the constraint of acceptable slice design and implementation. By relaxing the original problem we can obtain an approximate solution then apply a greedy algorithm to maximize local benefits in each slice to find to an optimized network solution. DAC's research in this area will be validated through experimentation and emulation of virtual network functions (VNF) in a software defined networking environment.

Classification: UNCLASSIFIED
Working Group: WG05 Cyber Operations

60603 - The Logistics of Data in the FutureG Fitness Landscape

Start Date: 6/16/2022	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Mr. Thomas Tenorio; Mr. Thom Hawkins; Mr. Carl J. Unis

Abstract: AI is a persistent ubiquitous aspect of cyber evolution that will significantly impact data flow across the operational environment of planetary scale Command and Control that must consider threat modeling and cyber-attack surface analysis at the requirements stage. The emergence of 6G capability by 2028 will represent a transformational scale shift in connectivity from 1GB conveyance to 1TB conveyance. Logistics makes or breaks armies. The orchestration of all-domain cohorts of men, agents, and machines where massive amounts of data will be required to feed AI-In-the-loop elements to complement policy advances regarding HITL, HOTL, and HOOTL (Human [In, On, Out Of] The Loop). The evolution of cloud computing will increasingly focus on continuous data flow analysis between producers and consumers across a broad set of observers, orienteers, decision-hypothesis-generators, and action-test-agents probing the all-domain fitness landscape for adversarial overmatch opportunities and defensive posturing. The leveraging of spectrum will raise new issues of interference and stealth to minimize the impact of operations in denied, degraded, intermittent, or limited (DDIL) environments. The cost of data transmission suggests the need for a logistics of data balancing the requirements for synchronized data inventory against the dynamic and integrity limits of "just in time" need for information. To do this we must establish critical analytics to sustain the concept of continuous integration and continuous development where initial requirements and design knowledge artifacts are identified early and enriched throughout the life cycle. The requisite analytics framework will have to consider both modeling and simulation and inference as the basis for advances in automation and in autonomy across the cohort of man-agents-smart_machines.

Classification: UNCLASSIFIED
Working Group: WG05 Cyber Operations

60273 - Vulnerability Prioritization Based on OSINT and Scan Data

Start Date: 6/16/2022	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Prof. Theodore Allen; John McCarty		
Abstract: The race between offense in finding exploits and defense installing patches continues to be highly relevant with the recent incidence of log4j. Many commercial vendors have vulnerability threat intelligence tools which scrape data from open sources including Twitter, the National Vulnerability Database, the Zero Day Database, and the Exploit Database. From modeling exploit probabilities or other measures for relevant vulnerabilities in time windows, threat intelligence can enable both offensive and defensive operations. In our data, a tiny fraction of distinct vulnerabilities and hosts correspond to nearly 100% of the known cases of compromise. In this presentation, we describe the developing vision for our own developing cybersecurity vulnerability maintenance system supported by two completed NSF projects. The elements of this system exist to varying degrees in our own software and in commercial software from vendors such as Kenna Security, Tenable Inc., and Rapid7. Yet, to a great extent the system is not fully perfected anywhere to our knowledge. Key elements of this system include: (a) methods for spotting truly important or "super-critical" vulnerabilities including log4j, (b) methods to estimate what vulnerabilities are on hosts that happened to be unavailable during scans, i.e., "dark" hosts, and (c) an economic model or other approach to create the prioritization. We use real world data to illustrate the practical relevance. Classification: UNCLASSIFIED Working Group: WG05 Cyber Operations		

60308 - UPDATE: The "Kremlin Playbook" and Information Warfare

Start Date: 6/16/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Dr. Douglas A. Samuelson		
Abstract: Political campaigns and economic entities have become increasingly driven by images, memes and social media messaging rather than policy statements. We review the recent CSIS update on Kremlin economic information warfare and some prominent examples from US Presidential campaigns and discuss how confusing and disruptive messaging was used. Statistics, Operations Research, and Machine Learning helped to develop targeting strategies and detect opponents' attempts to disrupt. We note how these methods are also used to disrupt defense and intelligence networks and possibly misdirect lethal force, and draw some lessons learned about how to increase national and international security. Classification: UNCLASSIFIED Working Group: WG05 Cyber Operations		

WG06 Command and Control (C2)

60039 - Characterizing Complexity of Distributed Command and Control

Start Date: 6/14/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Jeffrey Hudack; Daniel DeLaurentis; Professor Ali Khalid Raz		
Abstract: Distributed Command and Control (C2) has become a key foundation for the evolution of military operations, with new technology identified as the key enabler. Distributed C2 promises		

greater resilience and flexibility through allocation of authority and control closer to sensors and effectors. However, it also introduces additional complexity, particularly non-technical aspects of complexity that complicate the design and management of C2 systems. We present a family of "lenses" on C2 complexity—derived from complexity theory and literature—that are intended to provide insight on striking the risk/reward balance in evolving and designing future distributed C2 systems. We find that complexity analysis is generally focused on technical aspects (e.g. computer systems, networks) of systems, with limited consideration for other dimensions of complexity (e.g., organizational, process, data, environment) that should be included when designing and evolving C2 systems.
This presentation compiles nine types of complexity (one as an integrating framework and eight individual) that capture the dimensions of complexity in C2 systems. , examining them across the hierarchic levels of centralized command, distributed control, and decentralized execution. The complexity of centralized command is characterized primarily by the goals, organizational hierarchy, and influence due to command structure. Distributed control relies more heavily on data sharing across systems, process structure, and how systems are arranged to interact. Decentralized execution relies on the perspective of the individuals and the technology implemented on the edge systems. In addition, temporal evolution is a foundational aspect of complexity, capturing the interplay between timescales of change within and amongst the hierarch levels of C2. In each of these contexts, we examine how these complexity types illuminate key drivers of change: scale, disruption, and evolution. Further, the interdependencies among these complexity types are synthesized into recommendations for how these "lenses" on complexity can increase the depth of understanding of C2 systems and shape their evolution.
The findings presented are not a quantitative "complexity calculator", but instead a framework for designers to ask the right questions as they seek to balance risk and reward in distributed C2. We hope that further investigations prompted by this framework will lead to more informed design and implementation decisions.

Classification: UNCLASSIFIED
Working Group: WG06 Command and Control (C2)

59949 - Dreamcatcher: Attacking moving, distributed, defended targets in dynamic, high-threat environments

Start Date: 6/14/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Connor S McLemore; Travis Hartman; Jeffrey Linderoth		
Abstract: We present an optimization model to help the U.S. Navy's Maritime Operations Centers (MOC) and equivalent C2 elements rapidly generate plans involving time to best allow many distributed and moving Blue missile platforms to conduct strikes against many distributed and moving Red ships, submarines, and other platforms in dynamic, high-threat environments. Given Blue and Red Orders of Battle, the approach supports rapid planning towards the assignment of many kinetic and non-kinetic effects to many Red targets, including defended targets, in a manner that balances Blue offensive coverage and defensive posture in accordance with commander's intent while preserving Blue assets and resources. Dreamcatcher allows MOC planners to maintain experienced human control of the ASuW planning processes while reducing the coordination burden and planning time delays by handling the heavy computational aspects, freeing planners to focus on cognitive tasks. The model is focused on days, not hours, and optimizes the employment of a finite number of Blue missile platforms based on the Red order of battle. It takes into consideration multiple objectives (e.g., commander's priority, probability of success, speed of attrition, defensive capabilities,		

preserving valuable weapons, etc.) and Red undersea, surface, air, and space capabilities in order to allow Maritime Operations Center planners to optimally plan schemes of maneuver over location and time for many Navy and Marine Corps platforms while accounting for sensor, weapon, readiness, threat pairings for soft and hard kills and integrated all-domain defense.

Classification: UNCLASSIFIED // FOUO
Working Group: WG06 Command and Control (C2)

60478 - Multi-Domain Multi-Objective Weapon-Target Assignment Problem

Start Date: 6/14/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Dr Moises Sudit; Dustin Naylor; Dr. Hector Ortiz-Pena; Benjamin Ritz; Timothy Shuler		
Abstract: Technology advancements in autonomy and intelligent decision aids are needed to improve the processing and delivery of information products on the emerging Command and Control (C2) of weapons. Furthermore, the evolution of heterogenous types of weapons in a Dynamic Environment requires the enhancement of our warfighters' decision-making effectiveness by providing them a set of decision aids to recommend courses of action (COA) that accounts for emergent behaviors in the environment, including high value target identification and unexpected activities from actors in the Area of Responsibility (AOR). In this paper we decompose the problem into four major components and analyze the computational tractability of one of the components: multi-domain multi-objective assignment of weapons to targets. Classification: UNCLASSIFIED Working Group: WG06 Command and Control (C2)		

59418 - Machine Learning and Operations Research to Minimize the Risk of Detection by Adversarial Assets

Start Date: 6/15/2022	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Dr. Michael Hirsch; Adam Schunk; Dr. Hector Ortiz-Pena; Dr. Brendan Smith		
Abstract: General Neller stressed that the next battle will be one of signatures, meaning that the Marine Corps (and U.S. military in general) should assume that everything they do will be observed by adversarial forces. For friendly assets engaged in expeditionary advanced base operations or intelligence, surveillance, and reconnaissance efforts, the timing of when collected data is communicated will influence if and when these assets are observed. In this research, we consider the problem of when blue-force assets should communicate throughout a mission timeline. We employ two machine learning approaches – one to learn the expected characteristics of collection requirements from a given tasking, and the second to provide stochastic 'probability of being detected' profiles, as a result of communication emission propagation, given expected blue-force routes and anticipated/potential red-force locations. These two machine learning models feed into a mixed-integer nonlinear program, which when solved determines a communication plan for each blue-force asset over the mission timeline, in order to minimize the risk of being detected as a result of communication events, while still achieving mission objectives. AFSIM is utilized to simulate a real-world scenario, and initial results are presented. Classification: UNCLASSIFIED Working Group: WG06 Command and Control (C2)		

60227 - Automated CoA Generation via Semantic Technologies

Start Date: 6/15/2022	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Dr Zachary Allen Welz; James Arruda; Dr Dane F Freeman		
Abstract: Military Planners are often presented with a handful of options, where the combinatorial space of potential Course of Actions (CoAs) can span thousands to trillions of approaches depending on their individual levels of resolution. This Strategic Initiative Research and Development project in progress at Georgia Tech Research Institute investigates the use of semantic technologies (e.g. semantic data, knowledge graphs, inferencing) to explore the automation of CoA generation. This approach focuses on the translation of simple OV1 descriptions and Commander's Intent (i.e. constraints on CoA design) into fully qualified and expressed representations in a knowledge graph. This structured and semantic information facilitates pattern expression and inferencing in the form of creative discovery. These patterns support a process for generating verifiable scenarios within modern simulation frameworks. This capability improves decision traceability and begins to capture a formalized organizational knowledge management process for C2. This early approach leverages the mid-level Common Core Ontologies (CCO), built on the Basic Formal Ontology (BFO) in order to represent all the knowledge that must be captured in order to describe a CoA, entities that participate in the CoA, Commander's Intent, requirements, and assessment criteria. Initial efforts have down-selected to a reasonable amount of information that can be captured, expressed, explored, and simulated to evaluate CoA designs. This process translates high-level guidance into structured information in a knowledge graph, and uses formal logic to transform this knowledge into qualified scenarios that can be executed within a simulation: early development utilizes UPSTAGE, an event-based simulation framework developed at GTRI. A similar approach has been explored by Huang et al. in a more formal attempt to solve mathematical graph models. This presentation will explore the work being done to capture this process, the challenges and capabilities that this work creates, and the future vision in support of a modern digitized C2 CoA planning process. Classification: UNCLASSIFIED Working Group: WG06 Command and Control (C2)		

60602 - The Logistics of Data in the FutureG Fitness Landscape

Start Date: 6/15/2022	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Mr. Thomas Tenorio; Mr. Thom Hawkins; Mr. Carl J. Unis		
Abstract: AI is a persistent ubiquitous aspect of cyber evolution that will significantly impact data flow across the operational environment of planetary scale Command and Control that must consider threat modeling and cyber-attack surface analysis at the requirements stage. The emergence of 6G capability by 2028 will represent a transformational scale shift in connectivity from 1GB conveyance to 1TB conveyance. Logistics makes or breaks armies. The orchestration of all-domain cohorts of men, agents, and machines where massive amounts of data will be required to feed AI-In-the-loop elements to complement policy advances regarding HITL, HOTL, and HOOTL (Human [In, On, Out Of] The Loop). The evolution of cloud computing will increasingly focus on continuous data flow analysis between producers and consumers across a broad set of observers, orienteers, decision-hypothesis-generators, and action-test-agents probing the all-domain fitness landscape for adversarial overmatch opportunities and defensive posturing. The leveraging of spectrum will raise new issues of interference and stealth to minimize the impact of operations in denied, degraded, intermittent, or limited (DDIL) environments. The cost of data transmission suggests the need for a logistics of data balancing the requirements for synchronized data inventory against the dynamic and integrity limits of "just in time" need for information. To do this we must establish critical analytics to sustain the		

concept of continuous integration and continuous development where initial requirements and design knowledge artifacts are identified early and enriched throughout the life cycle. The requisite analytics framework will have to consider both modeling and simulation and inference as the basis for advances in automation and in autonomy across the cohort of man-agents-smart_machines.

Classification: UNCLASSIFIED
Working Group: WG06 Command and Control (C2)

60338 - Tactical network optimization using algorithmic slice creation and dynamic resource allocation

Start Date: 6/15/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Mr. Anthony Castanares		

Abstract: Modern-day and future-force battlefield networks have requirements to be scalable in response to Soldier demand or changing battlefield conditions, and to be resilient to attacks or oversaturation. Currently available tactical radios have limited technical capabilities to deliver such scalability or adjustable levels of resiliency when deployed in operational environments, resulting in flat networks that provide "one-size-fits-all" quality of service (QoS) and non-segmented topologies. To address this problem, we propose the use of software defined network (SDN) slices with an algorithmic network optimization methodology to facilitate slice creation and resource allocation. This approach relies upon a methodology that builds an initial collection of network slices for the tactical battlespace with considerations for the type of traffic that each slice will service (UDP, TCP, voice, video, sensor data), the mission of that slice (C2, Intel, Fires, Maneuvers & Recon, Airborne, Logistics), and the unique QoS demands of the traffic at that point in time (no hostilities, eminent hostilities, battle engagement, sensor collection). Other parameters such as application bandwidth requirements, traffic latency tolerances, and currently available link capacities are also considered in the optimization model. In this work we present the model constraints, parameters and optimization functions that facilitate the creation of network slices based upon mission, traffic, and network conditions. We formulate a constrained optimization problem that minimizes total message delivery latency under the constraint of acceptable slice design and implementation. By relaxing the original problem we can obtain an approximate solution then apply a greedy algorithm to maximize local benefits in each slice to find to an optimized network solution. DAC's research in this area will be validated through experimentation and emulation of virtual network functions (VNF) in a software defined networking environment.

Classification: UNCLASSIFIED
Working Group: WG06 Command and Control (C2)

60465 - Unmanned Systems Gap Analysis

Start Date: 6/15/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Mr. Robert P. Trost; CAPT Kory Fierstine		

Abstract: The United States Naval Forces Southern Command (USNAVSO)/Fourth Fleet (FOURTHFLT), working with the Office of Naval Research (ONR) SCOUT Experimentation Campaign and the Joint Interagency Task Force – South (JIATF-S), are developing and testing unmanned systems (UxS), as well as artificial intelligence (AI)/machine learning (ML) techniques, to solve operational problems in the JIATF-S area of responsibility (AOR). This paper uses past and ongoing efforts by the USNAVSO/FOURTHFLT to identify potential gaps in UxS capability that could lead to future mission failure if conflict with a near peer competitor were to occur today.

Classification: UNCLASSIFIED
Working Group: WG06 Command and Control (C2)

59784 - Networks, Synchronization and Fatigue: Developing Dynamic Battle Rhythms for Operational Headquarters

Start Date: 6/15/2022	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Dr Timothy McLennan-Smith; Takuma Adams; Dr Alexander Kalloniatis

Abstract: Operational headquarters have long been dominated by routine meeting schedules (known as battle rhythms) as the basis for decision making to plan and execute military operations. The dependency on interconnected meetings becomes even more apparent during times of heightened operational tempo where personnel may face day after day of back-to-back meetings. Such crammed scheduling can be both cognitively draining and remove the space in the day for the actual conduct of work (Karl et al 2021), while nonetheless promoting the otherwise important factor of human-to-human interaction. What analytical framework can test how these elements can be balanced? Moreover, how can battle rhythm be generated, tested, and streamlined to the intended user whilst remaining agile to meet dynamic operational requirements? In this work we provide a mathematical model and battle rhythm development framework that addresses these questions. The model is founded on a representation of synchronization dynamics on networks, where agents are effectively phase oscillators interacting with each other through a graph topology and with some strength of coupling; this is the famous Kuramoto (1984) model. Typically, studies with this model have used static graphs. However, meeting schedules are very much examples of dynamical networks facilitating synchronization of multiple decisions, both within the conduct of any individual meeting and across the entire schedule (Sauer et al. 2015). A potential mathematical paradigm for this type of time-dependent interaction is the approach of `blinking networks' (Faggian et al. 2019), which has initially been applied to the meeting schedule problem in the Command and Control (C2) context by (Kalloniatis 2020). This model was further extended by (Adams & Kalloniatis 2021) to incorporate time-dependent fatigue factors with continuous interaction in meetings, while generating a positive synchronizing effect on decision cycles. The framework we present in this work provides the means to produce suitable battle rhythm given operational, staffing, timing, and reporting requirements of Boards, Bureaus, Centers, Cells and Working Groups (B2C2WGs) which make up the battle rhythm. By incorporating such requirements, battle rhythm schedule options are iteratively and rapidly developed using heuristic optimization techniques. These options are then tested through the Kuramoto order parameter for synchronization and fatigue measurements. We are able to evaluate the success, or otherwise, of each battle rhythm option to ensure that coherent decision making is balanced with the capacity for personnel to take the time to develop quality in their inputs to those decisions. The battle rhythm generated by this framework is then streamlined for the user such that it can be directly ingested into the headquarters' Outlook calendar for immediate operational use.

Classification: UNCLASSIFIED
Working Group: WG06 Command and Control (C2)

59898 - Mathematical Modelling unifying Warfighting and Grey Zone dynamics across the Threshold of Conflict

Start Date: 6/16/2022	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Dr Timothy McLennan-Smith; Michael Francis; Dr Alexander Kalloniatis; Mathew Zuparic

Abstract: Conventional mathematical models of warfighting, such as the Lanchester equations, have been used as a tool to help inform decision makers about the appropriateness of force strengths for conflict contingencies. Although such models have increased in sophistication in recent years with the unification of Command and Control (C2) (Ahern et al. 2021), these models represent activities above the conflict threshold where actors actively engage in combat. In this work, we explore the full spectrum of conflict, particularly in the context of grey zone activities which States face today. Key questions for decision-makers are: how should investments between capabilities supporting warfighting be traded-off against those that enable grey-zone influence, or how should military manoeuvre below threshold be conducted to guarantee best prepositioning should conflict be unavoidable? We answer these by proposing a framework unifying dynamical systems models, individually valid above and below the threshold of conflict. To achieve this, we introduce a mathematical conflict threshold function to represent escalating tensions between adversaries across Grey Zone dynamics. In addition, we reinterpret 'patches' from mathematical biology (Jansen 2001) to describe an arbitrary domain where specific grey-zone activities take place. Such domains could be territorial, cyber or economic; they need not be physical, consistent with the Diplomatic-Information-Military-Economic (DIME) means of national power. In a simple use-case, we explicitly model territorial encroachment, force build up and skirmishes over a contested region that may subsequently escalate into full conflict. We present two versions of this scenario with Red and Blue actors both exercising C2 and Combat warfighting functions (McLennan-Smith 2021) but modified using the conflict threshold function. The first version considers Blue and Red competing over this contested region seeking to gain advantages via their respective C2 responses and their agility to respond their adversaries' actions. The second expands on these dynamics and utilises previous work (Zuparic 2021) to describe Blue and Red actors influencing a population in the contested region enabling them to receive territorial and warfighting advantages based on the local population's support for their force. We explore the range of the behaviours of the model through numerical solution and provide face validation of its behaviours.

Classification: CONFIDENTIAL//REL TO FVEY
Working Group: WG06 Command and Control (C2)

WG07 Intelligence, Surveillance, and Reconnaissance

60326 - Development and utilization of the Tactical Intelligence, Surveillance and Reconnaissance (ISR) Performance Suite (TIPS) within the Framework for Capability-based Tactical Analysis Libraries and Simulations (FRACTALS) at the DEVCOM Analysis Center

Start Date: 6/14/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Eric Harclerode		

Abstract: The Combat Capabilities Development Command DEVCOM Analysis Center (DAC) has developed the Tactical ISR Performance Suite (TIPS), a reusable code library that encapsulates the DAC sensor performance models and behavior methodologies. DAC also develops the FRACTALS to allow integration of numerous item-level performance models and methodologies. Together, TIPS and FRACTALS are utilized to conduct item and/or system level analysis via tactical-level vignettes. TIPS in conjunction with FRACTALS offers an agile, extensible simulation environment to meet the requirements of both current and future ISR and sensor related technologies in our fast-paced, ever-changing world. This briefing will discuss recent and future development updates and utilization of TIPS/ FRACTALS including enhanced Radar performance and timeline methodology, space ISR, end-to-end active protection system modeling, and more.

Classification: UNCLASSIFIED
Working Group: WG07 Intelligence, Surveillance, and Reconnaissance

60471 - Component Level Target Location Error (TLE) Methodology

Start Date: 6/14/2022	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Matthew Banta; Kyle Miele; Marguerite Shepler

Abstract: The Combat Capabilities Development Command DEVCOM Analysis Center (DAC) provides Target Location Error (TLE) data in support of force-on-force modeling for the Modeling and Simulation (M&S) community. TLE is a statistic that represents a measure of a sensor's accuracy when providing the perceived location of a detected target. Previously, DAC did not have a capability to represent the specific component level error associated with measuring TLE. Therefore, DAC only provided a single 50% Circular Error Probability (CEP50) value as a function of range. CEP50 is not an ideal metric since sensor TLE is often not circular in nature. Additionally, analysts cannot assess individual components of TLE such as the error associated with self-location; this makes it difficult for the M&S community to effectively model effects such as the loss Global Positioning System (GPS) capability.

To better represent TLE, DAC enhanced some models to estimate the downrange, cross range, and vertical error components for various sensors including: Ground Moving Target Indicator (GMTI) Radar, Synthetic Aperture Radar (SAR), Electro-Optical/Infrared sensors with Laser Range Finders, and Signals Intelligence (SIGINT) systems. The Component Level TLE Methodology was developed by DAC to produce data in support of meeting this data requirement. With higher fidelity TLE representation, the M&S community can more accurately represent sensor TLE and the effects of the variations on TLE error components. This presentation will contain a detailed explanation of the Component Level TLE Modeling Algorithm, and a comparison of CEP50 and the enhanced TLE values.

Classification: UNCLASSIFIED
Working Group: WG07 Intelligence, Surveillance, and Reconnaissance

60470 - Multi-Purpose Universal TLE Calculator

Start Date: 6/14/2022	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Matthew Banta

Abstract: The Combat Capabilities Development Command DEVCOM Analysis Center (DAC) provides Target Location Error (TLE) data in support of force-on-force modeling for the Modeling and Simulation (M&S) community. TLE is a statistic that represents a measure of a sensor's accuracy when providing the perceived location of a detected target. Warfighters use a wide array of tactical sensor that estimate target location during military operations. DAC required a model that could estimate TLE for multiple sensor types based on multiple TLE methodologies. This model would also have to estimate TLE capability for cases in which the exact TLE algorithm that the sensor employs is proprietary or unknown.

DAC developed the Multi-Purpose Universal TLE Calculator that enables a means to calculate TLE for multiple sensor types such as Electro-optical/Infrared (EO/IR) sensors with Laser Range Finders (LRF), photon-counting detectors measuring radiation from calibrated sources, and Signals Intelligence (SIGINT) sensors. For SIGINT sensors, it calculates the TLE when the sensors are using multiple methodologies to find the target such as Time Difference of Arrival (TDOA), Frequency Difference of

Arrival (FDOA), and/or Angle of Arrival (AoA). This calculator is modular and expandable such that it can estimate TLE for most sensor types and combinations of sensors. The inputs for this calculator are a model that estimates each sensor's raw measurement for a scenario, and a list of variables that could affect the TLE along with a model of how they affect the sensor's raw measurements. This presentation will describe the Multi-Purpose Universal TLE Calculator algorithm. It will include a description of how the algorithm works, a full summary of calculations types, and sample results.

Classification: UNCLASSIFIED
Working Group: WG07 Intelligence, Surveillance, and Reconnaissance

59419 - Machine Learning and Operations Research to Minimize the Risk of Detection by Adversarial Assets

Start Date: 6/15/2022	Start Time: 8:30 AM	End Time: 9:00 AM

Authors: Dr. Michael Hirsch; Adam Schunk; Dr. Hector Ortiz-Pena; Dr. Brendan Smith

Abstract: General Neller stressed that the next battle will be one of signatures, meaning that the Marine Corps (and U.S. military in general) should assume that everything they do will be observed by adversarial forces. For friendly assets engaged in expeditionary advanced base operations or intelligence, surveillance, and reconnaissance efforts, the timing of when collected data is communicated will influence if and when these assets are observed. In this research, we consider the problem of when blue-force assets should communicate throughout a mission timeline. We employ two machine learning approaches – one to learn the expected characteristics of collection requirements from a given tasking, and the second to provide stochastic 'probability of being detected' profiles, as a result of communication emission propagation, given expected blue-force routes and anticipated/potential red-force locations. These two machine learning models feed into a mixed-integer nonlinear program, which when solved determines a communication plan for each blue-force asset over the mission timeline, in order to minimize the risk of being detected as a result of communication events, while still achieving mission objectives. AFSIM is utilized to simulate a real-world scenario, and initial results are presented.

Classification: UNCLASSIFIED
Working Group: WG07 Intelligence, Surveillance, and Reconnaissance

60130 - Using Neural Networks to Detect Battle Damage From Satellite Images

Start Date: 6/15/2022	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Charlotte Ellison

Abstract: Battle Damage Assessment in denied regions using satellite imagery is crucial for situational awareness and decision-making but can be labor intensive. Using artificial intelligence, convolutional neural networks in particular, we developed techniques for automatically detecting damage to houses and buildings from satellite images. These methods ingest images taken before and after damage occurrence and produce a mask labeling the damage severity. Given the complexity inherent to the visual appearance of damage, it is necessary to investigate various aspects of the methods on the detection of damage. We explore the advantages and disadvantages of treating damage detection as an instance segmentation versus semantic segmentation task. In addition, we present the effects of various factors such as image resolution, architecture, and inclusion of before-damage image.

Classification: UNCLASSIFIED // FOUO
Working Group: WG07 Intelligence, Surveillance, and Reconnaissance

60068 - Autonomous Spectrum Sensing using Faster Region Based Convolutional Neural Networks

Start Date: 6/15/2022	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Todd Morehouse, Jr.; Charles Montes; Ruolin Zhou		
Abstract: Intelligent radio must contend for spectrum resources in an increasingly complex and dynamic environment. These radio systems continue to become more mobile, sustain higher data rates, and support complex behaviors, such as the ability to learn and adapt in dynamic environments. Therefore, to operate in this field, radios must sense the spectrum and respond accordingly. This spectrum sensing can be used actively, such as avoiding harmful interference, or passively, to detect anomalous and malicious usage of the spectrum. The dynamic nature of the wireless environment makes this a particularly challenging task. Traditional methods detected transmissions by finding parts of the spectrum where the energy exceeded the noise floor, so-called energy-based detection. However, this approach required statistical analysis of the channel, and was not reliable, lacking the ability to handle complex and dynamic scenarios. Convolutional neural networks (CNNs) were found to greatly exceed the ability to detect signals within a channel, without prior statistical information, but could only detect single signals within a band. Our research focuses on extending the ability of CNNs to multi-signal cases. We used faster region-based CNN (FRCNN) to reliably detect multiple signals within a band and characterize them. Region based CNNs allow bounding box detection of objects within an image. In our implementation, the CNN simultaneously predicts the location in frequency domain for each signal within a wide band. In order to achieve this, we modified the baseline FRCNN to process 1-D signals, greatly reducing computation time, a feature that was not previously available. The use of FRCNN allows detection of the center frequencies and bandwidth of all signals within a frequency band, instead of detecting the presence of signals. This information can be used to optimize spectrum usage by allowing multiple signals to share the spectrum. Additionally, it enables the ability to detect signals in any environment, where allocations may not be known or exist, improving the ability of sensing missions. We tested our system over-the-air using software defined radio (SDR). Software defined radio allowed us to model complex transmitter behavior, in a dynamic and cluttered environment, to show the effectiveness of our system. We test with signals at various center frequencies, bandwidths, and behaviors. Classification: UNCLASSIFIED Working Group: WG07 Intelligence, Surveillance, and Reconnaissance		

60466 - Unmanned Systems Gap Analysis

Start Date: 6/15/2022	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Mr. Robert P. Trost; CAPT Kory Fierstine		
Abstract: The United States Naval Forces Southern Command (USNAVSO)/Fourth Fleet (FOURTHFLT), working with the Office of Naval Research (ONR) SCOUT Experimentation Campaign and the Joint Interagency Task Force – South (JIATF-S), are developing and testing unmanned systems (UxS), as well as artificial intelligence (AI)/machine learning (ML) techniques, to solve operational problems in the JIATF-S area of responsibility (AOR). This paper uses past and ongoing efforts by the USNAVSO/FOURTHFLT to identify potential gaps in UxS capability that could lead to future mission failure if conflict with a near peer competitor were to occur today. Classification: UNCLASSIFIED Working Group: WG07 Intelligence, Surveillance, and Reconnaissance		

59796 - Basic Realistic Target Recognition (BaRTR) Models for AFSIM

Start Date: 6/15/2022	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Wesley Jones		
Abstract: Sensor models provide perceived states about other actors, as well as self. Perceptions are created from a sensor's measurements. Some perceptions, e.g., radar detecting an aircraft, can be modeled based on relatively simple properties of the measured signal, e.g., SNR. Other perceptions, e.g., image identification, involve additional auto/aided target recognition (ATR) processing. Modeling those perceptions require more than signal properties, e.g., whether the ATR was trained on the object. Realistic perception models of this ATR character will have errors as they occur in real sensor systems, e.g., stochastic missed detections, false alarms, incorrect IDs, and mislocations. AFSIM boxset includes perception models for some sensors that reflect some of these error modalities. AFRL COMPASE (and others) have built complex models to cover additional sensors, more error modalities, higher fidelity and validation. However, to use these complex models sensor modeling experts must make significant scenario updates, so their application is limited to studies focused on sensors. This talk describes the new Basic Realistic Target Recognition modes (BaRTR) for AFSIM. BaRTR enhances the AFSIM boxset sensor error modalities with realistic perception error modeling with only simple scenario updates for the boxset sensors that resolve targets (i.e., EOIR, SAR and LADAR). The importance of including the ATR error modalities when studying the full kill chain is demonstrated. Classification: UNCLASSIFIED // NOFORN Working Group: WG07 Intelligence, Surveillance, and Reconnaissance		

60339 - Tactical network optimization using algorithmic slice creation and dynamic resource allocation

Start Date: 6/15/2022	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Mr. Anthony Castanares		
Abstract: Modern-day and future-force battlefield networks have requirements to be scalable in response to Soldier demand or changing battlefield conditions, and to be resilient to attacks or oversaturation. Currently available tactical radios have limited technical capabilities to deliver such scalability or adjustable levels of resiliency when deployed in operational environments, resulting in flat networks that provide “one-size-fits-all” quality of service (QoS) and non-segmented topologies. To address this problem, we propose the use of software defined network (SDN) slices with an algorithmic network optimization methodology to facilitate slice creation and resource allocation. This approach relies upon a methodology that builds an initial collection of network slices for the tactical battlespace with considerations for the type of traffic that each slice will service (UDP, TCP, voice, video, sensor data), the mission of that slice (C2, Intel, Fires, Maneuvers & Recon, Airborne, Logistics), and the unique QoS demands of the traffic at that point in time (no hostilities, eminent hostilities, battle engagement, sensor collection). Other parameters such as application bandwidth requirements, traffic latency tolerances, and currently available link capacities are also considered in the optimization model. In this work we present the model constraints, parameters and optimization functions that facilitate the creation of network slices based upon mission, traffic, and network conditions. We formulate a constrained optimization problem that minimizes total message delivery latency under the constraint of acceptable slice design and implementation. By relaxing the original problem we can obtain an approximate solution then apply a greedy algorithm to maximize local benefits in each slice to find to an optimized network solution. DAC’s research in this area will be validated through experimentation and emulation of virtual network functions (VNF) in a software defined networking environment.		

Classification: UNCLASSIFIED
Working Group: WG07 Intelligence, Surveillance, and Reconnaissance

60204 - Creating a Social Media Intelligence Dashboard in 30 Minutes

Start Date: 6/15/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Joshua Gillmore		
Abstract: Social media intelligence is critical for situational awareness, countering disinformation, and engaging in influence operations. Learn how to cleanse your data using Tableau Prep, create an exploratory Tableau dashboard used in intelligence for data exploration, and how you can tackle any piece of data you encounter without getting stuck on the initial step - What do I do with my data? In this session you will learn how to: · Connect to and prepare a social media data file from Twitter using Tableau Prep · Create a series of worksheets that answer the who, what, when, where, and how · Integrate URL actions for automated translation and free-text entity extraction · Assemble a Tableau dashboard to answer more complex questions Classification: UNCLASSIFIED Working Group: WG07 Intelligence, Surveillance, and Reconnaissance		

59774 - Unconventional Multi-Domain ISR Operations - Proliferated Internet-of-Things Cyber-Physical Sensing

Start Date: 6/16/2022	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: Mr Jordan Garcia		
Abstract: The 2019 Air Force's Science & Technology Strategy calls for Global Persistent Awareness. That is, the on-demand gathering, processing, and fusion of multi-spectral sensors. The strategy emphasizes researching applications in the cyber domain for edge computing. This study builds a framework that introduces proliferated Internet-of-Things (IoT) sensing into multi-domain ISR operations. This augments traditional ISR capabilities. The framework is then applied to examine the feasibility of targeting high value ground targets as launch operations progress. An AFSIM simulation is used to model cyber-physical sensing effects enabled through proliferated IoT sensors to detect the movement of mobile launchers. Acoustic, optical, and vibration signals collected by IoT sensors provide intelligence that is used for tipping and cueing of space-based ISR assets. In turn, this provides targeting data. This study provides a demonstration of a multi-domain ISR chain and its effectiveness in locating time-critical targets in denied environments. Classification: SECRET NOFORN Working Group: WG07 Intelligence, Surveillance, and Reconnaissance		

60242 - Ontologies, Interfaces, and Graph Stores, Bringing Object Based Production to Analysts

Start Date: 6/16/2022	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Daniel Gossman; MAJ Benjamin Carroll Boekestein		
Abstract: Legacy approaches to data management and processing do not support the modern analyst attempting to unite data across sources to render a multi-source assessment or their customers who need integrated analyses, often in near real time. Further, attempts to collaborate rather than stovepipe are inherently stymied by legacy data approaches. This presentation will outline the		

difference between tabular and linked data, and why that difference matters to analysts and advanced data analytic methods. Specifically, this presentation will talk about a form of linked data called Object Based Production (OBP).
This presentation will talk about what OBP is, the information architecture and processes that enable it, and how it enables automated and semi-automated processes to associate data across sources with machine readable linkages that enable machine reasoning and the same kind of graph based modeling techniques that enable industry powerhouses like Google and Facebook to target users effectively.
The presentation will use a real world example where legacy processes were used, the problems it caused, the barriers we faced attempting to implement OBP, how we accomplished it, and the gains that were realized once we did.

Classification: SECRET NOFORN
Working Group: WG07 Intelligence, Surveillance, and Reconnaissance

60324 - Range Advantage & Timeline Analysis

Start Date: 6/16/2022	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Mr John Patrick Mazz		
Abstract: During FY20, the Combat Capabilities Development Command DEVCOM Analysis Center conducted a forward-looking infrared (FLIR) range advantage analysis to assess the improvement in range advantage the third Gen FLIR provides, over the current third Gen FLIR, when in competition against a near-peer FLIR. A simple one-on-one, Optionally Manned Fighting Vehicle (OMFV)-to-threat, FLIR target acquisition duel was portrayed in the Fusion Oriented C4ISR Utility Simulation (FOCUS). The OMFV approached a threat armored personnel carrier (APC) or dismounted anti-tank guided missile (ATGM) team at 10 m/s from a starting range of 6 km with no line-of-sight restrictions. All platforms searched a 90° field-of-regard. This range advantage approach can easily be extended to evaluate time advantage. In support of the Vehicle Protection Suite (VPS) Phase II study, the DEVCOM Analysis Center proposes a time-to-return-fire analysis to assess the situational awareness benefit of the cueing sensors associated with the VPS. The methodology components and data needs of the proposed analysis will be discussed. The Framework for Capability-based Tactical Analysis Libraries and Simulations (FRACTALS), the successor to FOCUS, will be used to conduct the proposed analysis. This presentation will outline the range advantage approach and how it will be applied to the VPS Phase II study. Classification: SECRET NOFORN Working Group: WG07 Intelligence, Surveillance, and Reconnaissance		

WG08 Space Acquisition, Testing and Operations

59962 - SPACECOM's mission command framework and transformation of warfighter tasks

Start Date: 6/14/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Joseph Troy Morgan; Michael Teter		
Abstract: The 2020 Department of Defense (DoD) Data Strategy highlighted the departments' shift to becoming a data-centric organization, which USSPACECOM has sought to exemplify. As part of the command's continual improvement, the Data Management Framework was created to capture a planned 3-year approach to implement a data-centric transformation, accelerating data management		

and analysis capabilities enabling advanced warfighter decisions. At the heart of the framework is the identification and transformation of warfighter tasks to free up human capital and achieve digital dominance. SPACECOM has leveraged a mission command framework to help identify and characterize these tasks, differentiating between real-time and non-real time as well as "back end" business processes versus operational tasks. In particular, the process seeks to uncover specific mission threads (warfighter tasks), identify/streamline common and similar missions and authorities while identifying the requirements, in particular C4I needs, to operationalize the transformation. This framework and process will be shared to help build best practices across the DoD and awareness of SPACECOM's mission.

Classification: UNCLASSIFIED // FOUO
Working Group: WG08 Space Acquisition, Testing and Operations

59969 - SPACECOM digital maturity assessment framework

Start Date: 6/14/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Joseph Troy Morgan; LTC Michael Teter		
Abstract: As USSPACECOM continues it's efforts to be an interconnected, innovative, and digitally dominant warfighting command, the Chief Data Office and Data Council have undertaken efforts to fully leverage digital transformation into order to enhance senior leader decisions, ensure digital modernization via technology, and build and leverage dynamic data environments which robustly support the command and our mission partners. As part of that effort, an assessment of USSPACECOM's digital maturity is helping identify gaps and evaluate whether the application of our people's time, and command funding, on specific initiatives are providing the warranted value and improvement as well as inform future allocation of those limited resources. Fully intertwined with USSPACECOM's digital transformation lines of effort and aligned with DoD guidance and industry best practices, this assessment covers foundational elements (data, architecture, culture) as well as making the assessment focused on USSPACECOM's unique mission set. This discuss will uncover the techniques and procedures used as well as welcome discourse across the community facing similar digital transformation assessments. Classification: UNCLASSIFIED // FOUO Working Group: WG08 Space Acquisition, Testing and Operations		

59780 - Advanced Analytic Tools for Space Modeling & Simulation

Start Date: 6/15/2022	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: Shane N Hall, PhD; Lt Col Adam Messer; Capt Jeff Williams; Jon Vigil; Lt Michelle McGee		
Abstract: Modeling and simulation (M&S) tools are used to analyze Space Force (SF) and Air Force (AF) systems and operations. M&S is critical to developing Space capabilities and requirements in three primary ways: 1) designing Space systems; 2) evaluating the performance and effectiveness of systems; and 3) simulating Space operations to perform descriptive, diagnostic, predictive and prescriptive analyses. Here we present a multi-year effort to integrate optimization, experimentation, and post-run analytics with the Synthetic Theater Operations Research Model (STORM), Advanced Framework for Simulation, Integration, and Modeling (AFSIM), and System Effectiveness Analysis Simulation (SEAS) tools using an automated software suite that allows analysts to: 1) rapidly perform complex optimization analyses that identify the decisions that provide the best outcomes for a given objective or set of objectives, 2) manage and automate studies that require thousands of computationally expensive simulation runs saving analysts hours to weeks of study time, 3) exploit		

multi-core parallelization and high performance computing resources, 4) generate and execute robust design of experiments to assess the operational performance and effectiveness of Space systems, and 5) use advanced analytic and machine learning techniques to identify influential decision criteria and visualize the decision trade space across a broad set of goals and objectives. The advanced analytic methods are discussed, and specific simulation scenarios coupled with optimization are presented. Finally, results and insights from the simulation optimization are provided to show the parameter configurations that optimize the study objective(s).

Classification: UNCLASSIFIED
Working Group: WG08 Space Acquisition, Testing and Operations

60200 - IMProving Simulation Development Time via Reuse and Modularity: The Integrated Modeling Portfolio (IMP)

Start Date: 6/15/2022	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Dr. Richard J. Haberlin, Jr		

Abstract: Simulation organizations across the Department of Defense often lament the limited reusability of mission-level models resulting in extended development timelines. The reasons are many, including lack of standardization, different analytic questions, alternate development styles, and limited return on investment for the overhead required to enable reuse. The Space Security and Defense Program (SSDP) Enterprise Division is prototyping an Integrated Modeling Portfolio (IMP) that speeds AFSIM model development and provides consistency by establishing a 'Gold Disk' of Enterprise Division-accepted scenarios and a catalog of ground-truth assumptions, performance parameters, and mission-threads. At each level of classification, a single AFSIM repository is constructed that leverages object-oriented design and a catalog of components to enable "define once - use repeatedly" during development, thereby standardizing development style and organization. The AFSIM library consists of a reusable hierarchical structure of platform parts, platforms, systems, and laydowns combined into scenarios through strict inheritance. From the simplest platform part to aggregated systems of parts, these components can be reused to simplify and accelerate model development. The repository also contains a parallel SysML model that mirrors the hierarchical structure of the repository and captures integrations and relationships between components. The SysML model contains all the information in the AFSIM model and can be used as a communication tool for stakeholders, as a blueprint for simulation development, and as a standard repository for component parameters. SSDP offers a new paradigm of model development that generates defensible models with greater speed and built-in transparency.

Classification: UNCLASSIFIED
Working Group: WG08 Space Acquisition, Testing and Operations

60515 - Modeling & Simulation Innovation in Wargaming Capability Development

Start Date: 6/15/2022	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Mr. Tyson C. Kackley		

Abstract: The Program Manager for the Marine Corps Wargaming and Analysis Center (MCWAC) will employ state-of-the-art Modeling & Simulation, authoritative data sources, and cutting-edge analytics to inform major decisions for Marine Corps Force Design. The MCWAC program has prototype system that can ingest massive amounts of data from multiple sources; distribute data to appropriate simulation elements; manage models to ensure that game objectives are met; and manage post-game outputs, e.g., via dashboards.

Classification: UNCLASSIFIED
Working Group: WG08 Space Acquisition, Testing and Operations

60107 - U.S. Army SATCOM Throughput Requirements Study (STRS)

Start Date: 6/15/2022	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Mr. Christopher Brassel

Abstract: 90th MORSS
The Research and Analysis Center

Principal Author: Mr. Christopher Brassel
Briefer: Mr. Christopher Brassel
Classification of Presentation: CUI
Presentation Distribution Statement: DISTRIBUTION D
Length of Presentation: 25 minutes
Working Group: WG 8 – Space Acquisition, Testing, and Operations

U.S. Army SATCOM Throughput Requirements Study (STRS)
Keywords: Satellite Communications; Wideband; Discrete-Event Simulation, Data Visualization

The U.S. Army requires access to secure and reliable communications to succeed in the future operational environment. The Army's transformation to Multi-Domain Operations (MDO) and investment in associated modernization capabilities rely upon a network that is expeditionary, mobile, hardened, and intuitive. Access and availability of data is central to achieving the battlefield advantage and increasing the speed of operations required for decision dominance. This study estimates satellite communication (SATCOM) throughput requirements for the Army AimPoint Force 2035 (Corps and below) in large scale combat operations to identify drivers, challenges, and implications.
The study team first updated and refined data collected during the Army Wideband SATCOM study performed by TRAC in 2017, prior to the development of MDO and AimPoint Force 2035. To determine the wideband SATCOM throughput demands, the study team coordinated across the community of interest to identify approximately 4.1 million operationally relevant communication demands for battalion to corps sized elements in two separate operational environments. With the demands established, the team used a discrete-event simulation to determine SATCOM throughput requirements and capability gaps. The team then worked to successfully overcome challenges with simulation run-time, data analytics on 500 GB of simulation output, and server load-time to develop an interactive, CAC-enabled dashboard in R Shiny to share analysis with the community of interest. This presentation describes the study scope, methodology, and an overview of the simulation used to generate the Army SATCOM throughput requirements. It also describes the challenges and limitations overcome during the refinement of simulation excursions and the development of the CAC-enabled dashboard.

Classification: UNCLASSIFIED // NOFORN
Working Group: WG08 Space Acquisition, Testing and Operations

61096 - Leveraging Emerging Technologies to Create Innovative Solutions

Start Date: 6/15/2022	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Ms. Lana E. McGlynn, FS; Scott Gallant; Mr. Christopher J McGroarty; Mr. Christopher J. Metevier
Abstract: Being an innovative analyst requires us to employ both existing and emerging technologies in new and creative ways. Often current technological advancements challenge us to look beyond their intended and adapt them for use in Modeling and Simulation (M&S). Our job as M&S practitioners is to be smart in evaluating how to best adopt these advances to the benefit our stakeholders, while considering interoperability with existing tools, data reuse, and standardization. In order to increase your level of awareness, we invite you to learn more and get involved in the Simulation Interoperability Standards Organization (SISO) Exploration of Next Generation Technology Applications to Modeling and Simulation (ENGTAM) Standing Study Group (SSG). The SSG focuses on technology adoption, technology application metrics, interoperability, and technology areas, such as data analytics, Artificial Intelligence, mixed reality, game development technology, and technology forecasting techniques. Members from the US DoD, many North Atlantic Treaty Organization (NATO) nations, industry, and academia, meet online monthly to discuss emerging technologies with the goal of understanding how they can be adopted and adapted to support a diverse body of M&S stakeholders. This presentation will discuss relevant findings from the ENGTAM SSG and how they can be applied in the use of cutting-edge tools, techniques, and best practices. It will also provide an opportunity to discuss these emerging technologies and how they can be employed to address all challenges, anticipated and unanticipated. Classification: UNCLASSIFIED Working Group: WG08 Space Acquisition, Testing and Operations

60930 - Assured Precision Navigation and Timing Study

Start Date: 6/16/2022	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: (Ret.) LTC David Lee Silvernail, Jr; David Kohlhoff; Mr Scott Meyerhoff; Mr. Ryan Pierce; Shelby Rowe; Mr. John G Zierdt, III		
Abstract: Due to the proliferation and expanded reliance on satellite-based Positioning, Navigation & Timing (PNT) and near-peer threat ability to degrade and/or deny these capabilities, it became necessary to analyze technologies to mitigate these effects. The SMDCoE Studies and Analysis Division conducted analysis to identify the mid and long-term feasibility of existing technologies to augment current PNT capabilities to prevent degradation and/or denial in PNT degraded environments. The study team utilized Training, Tactics, and Procedures (TTPs), and employment strategies with vetted vignettes/scenarios while modeling force-on-force simulations, and analysis to gain insights and understanding of PNT-dependent systems and measure the military utility when employing APNT capabilities to establish PNT resiliency. The team modeled a Brigade and Battalion level scenario with a SEAS/GIANT combination to measure the quantitative aspects of the analysis. Classification: SECRET NOFORN Working Group: WG08 Space Acquisition, Testing and Operations		

60931 - Space Kill Chain Time Line Study

Start Date: 6/16/2022	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: (Ret.) LTC David Lee Silvernail, Jr; Mark J Kinchen; Mr. Ryan Pierce; Mr. Robert Hugh Vasse; Mr. John G Zierdt, III
Abstract: Today, only limited information is available to Army Space decision makers as they resource, deploy, and employ critical capabilities such as the Multi-Domain Effects Battalion (MDEB), Multi-Domain Task Force (MDTF), Theater Strike Effects Group (TSEG), and the Tactical Space Layer (TSL) to support Multi-Domain Operations (MDO). The Space and Missile Defense Command Center of Excellence (SMDCCoE) Studies and Analysis Division is conducting an analysis of how space assets will affect the MDTF's kill-chain and its timeline during competition, crisis, and conflict during the Army 2030 and 2040 timeframes. The study will identify space touch points along the kill-chain and include both terrestrial and low earth orbit (LEO) hardware and software. It will use modeling and simulation with a near-peer environment to conduct a military utility analysis and quantify their effects on the MDTF's kill-chain and timeline. Key areas for analysis will be Anti-Access/Area Denial (A2/AD) penetration, friendly and adversary freedom of action in space, support of long-range surface-to-surface precision fires and missile defense using both non-lethal and lethal effects. Results will inform SMDCoE's master schedule, efforts regarding the TSEG, Navigation Warfare (NAVWAR), TSL, JCIDS documentation, and the Joint Concept for Space Operations. Classification: SECRET NOFORN Working Group: WG08 Space Acquisition, Testing and Operations

60933 - Army Navigation Warfare Study

Start Date: 6/16/2022	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: (Ret.) LTC David Lee Silvernail, Jr; David Kohlhoff; Mr. Richard Mulholland; Shelby Rowe; Mr. John G Zierdt, III		
Abstract: Due to the proliferation and expanded reliance on satellite-based Positioning, Navigation & Timing (PNT), the need to assess current/future, offensive/defensive NAVWAR capabilities increased. The SMDCOE Studies and Analysis Division conducted analysis efforts and identified the mid and long-term feasibility of existing Programs of Record (PORs) from Army and Joint and new proposed Army NAVWAR capabilities, Training, Tactics, and Procedures (TTPs), and employment strategies. The Study Team utilized vetted vignettes/scenarios in force-on-force modeling, simulation, and analysis to gain clearer understanding of PNT-dependent systems and measure the military utility of employing NAVWAR capabilities to establish PNT dominance. This analysis provided critical input for the approval of the Capability Development Document for the Army Capability Manager for Space and High Altitude. Classification: SECRET NOFORN Working Group: WG08 Space Acquisition, Testing and Operations		

60934 - Space Capabilities and Capacities Study

Start Date: 6/16/2022	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: (Ret.) LTC David Lee Silvernail, Jr; Ms. Monica Ann Dumont; Dustin Holmes; Mr. Martin Hooyer; Mr. John G Zierdt, III		
Abstract: The Space Capabilities and Capacities Study identified existing space capabilities and capacities supporting theater Unified Land Operations (ULO) and examined the impacts of the Theater Strike Effects Group (TSEG) in a scenario with a peer/near-peer threat. The TSEG is a proposed organization designed and intended to employ space capabilities and support at the theater level in competition, armed conflict, and the return to competition. The Space and Missile Defense		

Center of Excellence (SMDCoE) conducted a literature search to identify existing and proposed space capabilities and capacities supporting theater ULO. Technical Interchange Meetings with appropriate Subject Matter Experts were consulted to develop CONOPs, TTPs, and target sets for TSEG capabilities. These capabilities were modeled in vetted, force-on-force vignette/scenario to quantify how each TSEG capability would perform independently and as an integrated unit. The analysis helped shape the Joint Warfighter Experiment in PACOM.

Classification: SECRET NOFORN
Working Group: WG08 Space Acquisition, Testing and Operations

60935 - Space Demand Study

Start Date: 6/16/2022	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: (Ret.) LTC David Lee Silvernail, Jr; Mr. Orrin Porter Hatch; Mr. Martin Hooyer; Mr. Ryan Pierce; Mr. John G Zierdt, III		
Abstract: The Space and Missile Defense Center of Excellence (SMDCoE) commissioned the creation of a tool to produce quantitative results for a Space Control Electronic Warfare (SCEW) capability that will be fielded by the Army. The Space Demand tool will consider how many threat systems are present on the battlefield and how many SCEW systems would be required to sufficiently negate the threat while also considering other roles such a system may need to provide. The tool will allow the Center for Army Analysis (CAA) to determine future requirements with the analytical underpinnings to support future Army needs. The tool has the ability to quantitatively measure the effectiveness of a user-defined number of systems against a threat force, which will provide force effectiveness for future CAA war-gaming events. The tool will facilitate the normalization of the Space Domain across the Army. Classification: SECRET NOFORN Working Group: WG08 Space Acquisition, Testing and Operations		

60282 - Orbital Harmonics and Resiliency of Hybrid Constellations

Start Date: 6/16/2022	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Christopher Wishon; Lt Col Ryan M McGuire; Dr. Jason Reiter; Rebecca Widrick		
Abstract: Hybrid constellations are naturally more resilient to losses in coverage as gaps in the multiple layers must synchronize in time and location for a complete loss of mission capability over a given region of interest. The resiliency of these architectures is further enhanced as these gaps are less likely to synchronize over the same or similar regions in the future due to the varied altitude, inclination, and other orbital parameters of the layers. Our research has shown that the synchronization between the layers, referred to by the authors as orbital harmonics, can be very sensitive to even small design changes. For example, as little as a 10 kilometer change in altitude between layers can drive the hybrid constellation out of sync. This implies that very careful consideration must be given when designing hybrid constellations. This presentation will demonstrate the sensitivity of a hybrid constellation's orbital harmonics to various design parameters such as altitude, inclination, plane count, sensor design, and satellite count. Classification: SECRET NOFORN Working Group: WG08 Space Acquisition, Testing and Operations		

WG09 Air and Missile Defense

59665 - Examination of Fundamental Kill-Chain Relationships in Multi-Tiered Kill Web Architectures

Start Date: 6/14/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Mr. Joseph Uzdzinsk; Carl Herman; Tod Schuck; Mr. William G Wilhelm		
Abstract: This presentation investigates fundamental kill-web synergistic relationships in multi-tier Integrated Air and Missile Defense (IAMD) architectures. Fundamental governing IAMD relationships are investigated in order to simplify understanding of complex simulation results for specific operational deployments, as well as to illustrate multi-tier defense kill web design strengths and weaknesses. Architectural variations are selected to address a formal operations analysis (OA) - based set of scenarios to provide operational insights into multi-system information sharing and advanced IAMD engagement concepts. Complex system assessment will include examples involving emergent system behavior, resilient system design, planning, engagement coordination and resource management. The supporting simulation testbed includes multiple, medium fidelity simulation components re-engineered to be integrated into multi-tier, layered kill web architectures. Classification: UNCLASSIFIED Working Group: WG09 Air and Missile Defense		

59718 - Missile Defense Saturated Raid Simulation and Analysis

Start Date: 6/14/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Mr. Richard K. Null		
Abstract: Missile Defense Saturated Raid Simulation and Analysis Adversaries are becoming more capable in mounting mass missile attacks on US forces to overwhelm defenses. This presentation will discuss a high-level simulation and analysis capability designed to conduct rapid assessments of raid size and missile defenses. Using a simple discrete event simulation representing a layered Integrated Air and Missile Defense (IAMD) system, contributions of airborne and terrestrial defenses are examined against raid size and raid synchronization. The presentation includes a description of the missile defense simulation and sample parametric analysis. Classification: UNCLASSIFIED Working Group: WG09 Air and Missile Defense		

59720 - Ballistic Missile Discrimination Simulation and Analysis

Start Date: 6/14/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Mr. Richard K. Null		
Abstract: Ballistic Missile Discrimination Simulation and Analysis A key problem in ballistic missile defense is being able to discriminate the actual warhead from other debris or decoys traveling along with the “real” warhead. This presentation will discuss a high-level simulation and analysis capability designed to conduct rapid assessments of ballistic missile discrimination given differing object discrimination logic, probability of discrimination and number of Kill Vehicles (KV’s) employed. The presentation includes a description of the ballistic missile discrimination simulation and sample parametric analysis.		

Classification: UNCLASSIFIED
Working Group: WG09 Air and Missile Defense

59981 - The Weighted Intruder Path Covering Problem

Start Date: 6/15/2022	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Dr. Adam Haywood; Dr. Brian Lunday; Dr. Matthew JD Robbins; Dr. Meir N Pachter

Abstract: Effectively detecting and interdicting intruders within a defender's territory is a common security problem. Often, the defender's territory is decomposed into spatially distinct stages for organizational convenience. Given an intruder attempting to traverse a spatially-decomposed region via multiple possible paths, this research aims to effectively and cost-efficiently identify a defensive strategy that locates sets of detection resources and interdiction resources, each of which has different types of resources that vary by cost and capability. We formulate and validate a mixed-integer nonlinear programming model to solve the underlying problem first using a leading commercial solver (BARON) and then via two genetic algorithms (RWGA and NSGA-II). Computational testing first identifies instance size limitations for identifying a global optimal solution via BARON, motivating the use of metaheuristics. Subsequent testing demonstrates the superior performance of RWGA and NSGA-II on 10 randomly generated instances for each of 20 various instance sizes. For each 20 of these instance sizes, both RWGA and NSGA-II produce higher-quality and more non-dominated solutions than BARON while using much less computational effort. Subsequent testing of only RWGA and NSGA-II over a designed set of test instances identifies NSGA-II as the recommended technique to solve larger-sized instances of the underlying problem.

Classification: UNCLASSIFIED
Working Group: WG09 Air and Missile Defense

60045 - Efficient Response Surface Estimation through Adaptive Sampling

Start Date: 6/15/2022	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Dr. Benjamin G. Thengvall; Dr. Michael Deskevich

Abstract: The Missile Defense Agency (MDA) is creating a new high-fidelity, high-accuracy digital simulation capability to model the Missile Defense System (MDS). This accuracy, however, comes with high computational expense. There are many more simulation trials desired to perform different types of analysis than there are computing resources available to execute them. OptTek Systems is providing tools to use the high-fidelity digital simulation capability to generate heat maps to measure the effectiveness of different MDS system configurations while executing a minimal number of simulation runs. Traditional approaches to response surface estimation have relied on parametric enumeration or static sampling approaches with a fixed number of Monte Carlo replications at each design point. In this effort a custom, adaptive sampling optimization algorithm has been created to generate accurate heat maps with orders of magnitude fewer simulation runs. Efficiently generating heat maps can be more generally described as efficient response surface estimation. The techniques and software developed in this effort can be used for more generally applicable response surface estimation problems. The approach combines optimized adaptive sampling of the operational space with geospatially accurate regression and interpolation techniques derived from Kriging. This approach can take any number of sample points and both estimate the response surface and measure the uncertainty in that estimate. Furthermore, computational expense is minimized with dynamic Monte Carlo run management to determine how many replications should be executed at any sample

point. In recent work, the sampling approach has been augmented to generate heat maps that minimize the uncertainty across multiple metrics at once making this a multi-objective optimization approach. This presentation will provide updates on this effort and include a methodological overview and sample results.

Classification: UNCLASSIFIED
Working Group: WG09 Air and Missile Defense

60074 - Enhancements to Air and Missile Defense Analysis Using AFSIM

Start Date: 6/15/2022	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Carla Ortega		

Abstract: Using the Advanced Framework for Simulation, Integration, and Modeling (AFSIM), the Center for Army Analysis (CAA) established a modeling framework to provide more effective and efficient Air and Missile Defense (AMD) analysis. The objective of this initiative was to allow analysts the ability to manipulate and analyze the model's inputs and outputs without an in depth knowledge of coding. CAA currently uses the results from the analysis to support the annual Quantitative War Reserve Requirement for Munitions (QWARRM) study. This brief will outline the use of AFSIM in constructing, designing, and implementing the framework in CAA's Air and Missile Defense analysis.

Classification: UNCLASSIFIED
Working Group: WG09 Air and Missile Defense

59204 - It's Your Move: Introducing a Framework for Measuring Relative Costs in the Precision Missile Versus Air Base Peacetime Competition

Start Date: 6/15/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Mr. Jacob Heim		

Abstract: Contemporary U.S. defense strategy has a renewed focus on assessing peacetime, long-term military competitions to identify U.S. military advantages relative to those of other great powers. Policymakers, strategists, and analysts need tools to help them diagnose U.S. advantages and disadvantages relative to competitors. This brief introduces a framework for estimating the cost to each side of maintaining a peacetime military operational competition and uses that framework in an analysis of the cost to the DoD and PLA of maintaining the ongoing precision missile versus air base competition.

The growth in Chinese precision missile capabilities over the past twenty years threatens the air bases used by U.S. forces to project power in the event of a conflict. A natural question for policymakers is whether it is possible to reverse this eroding U.S. position in a cost-effective manner. This briefing demonstrates a way to answer this question using a framework that combines modeling and simulation, intelligence assessments, and cost estimation techniques.

Classification: SECRET NOFORN
Working Group: WG09 Air and Missile Defense

59203 - Air Base Resilience: Cost-Effective Mixes of Active and Passive Defenses for Pacific Air Forces

Start Date: 6/15/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Mr. Jacob Heim		

Abstract: Precision missiles threaten U.S. potential operating locations and Pacific Air Forces (PACAF) seek solutions to improve theater-wide air base resilience in the face of these threats. This briefing summarizes an analysis conducted for PACAF that used modeling and simulation to estimate the vulnerabilities of air bases in key scenarios. The analysis also used a genetic optimization algorithm to identify cost-effective measures for mitigating those vulnerabilities.

The candidate mitigations included mixes of infrastructure (e.g., new parking aprons), active defenses (e.g., THAAD), and deployable passive defenses (e.g., fuel bladders).

This project used an analytic framework developed at RAND over the past decade called Combat Operations in Denied Environments (CODE). CODE enables analysts to evaluate the operational impact of adversary missile attacks on key air base capabilities such as runways, parked aircraft, fuel infrastructure, and munitions storage. CODE provides a framework to evaluate the effectiveness, cost, and supportability of disparate mitigation options including: air base posture, deployable passive defense, infrastructure, active missile defense, deception options, and force maneuver concepts of operation.

Classification: SECRET NOFORN
Working Group: WG09 Air and Missile Defense

60232 - Campaign Effects of Base Defense and Resiliency Mixes

Start Date: 6/15/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Melissa Wickers		

Abstract: The United States Air Force relies on the Joint Force's ability to defend air bases against missile attacks in order to generate combat power. Cost-effective base defense and resiliency mixes that improve effectiveness metrics such sortie generation, aircraft attrition and airbase operations are critical for Joint Force campaign success. This analysis screened a variety of bases defense and resiliency mixes using a designed experiment and were executed in the TAB-VAM base defense model. The results of this experiment were plotted against cost and campaign effectiveness, which resulted in a Prado curve of promising defense and resiliency mixes at different cost points. A subset of these promising mixes were selected for deep-dive campaign analytics in the STORM campaign model to determine overall impact on high-level campaign metrics. This presentation highlights our analytical approach and presents the initial findings of the analysis.

Classification: SECRET NOFORN
Working Group: WG09 Air and Missile Defense

60144 - Integrated Air and Missile Defense (IAMD) Asset Defense Design Improvement Analysis

Start Date: 6/16/2022	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: David Halloran		

Abstract: The Missile Defense Review states that "the threat environment faced by the United States has become more complex and volatile, marked by the return of Great Power competition, including Chinese and Russian revisionism and military expansion, in addition to the destabilizing ambitions of rogue states." This complex adversarial environment requires different types of innovative analysis to assess different aspects of the missile defense mission set. As the Army's Air and Missile Defense (AMD) Enterprise lead, the United States Army Space and Missile Defense Command (USASMDC) is working with Warfighters across the Combatant Commands (CCMDs) to provide Modeling,

Simulation, and Analysis (MS&A) relevant to the decision process for building site specific defense designs. Providing data to decision makers regarding site specific defense designs requires a more iterative process, compared to campaign level analysis, working closely with the Warfighters and stake holders to narrow options and inform the decision process with metrics and insights. This briefing will outline the methodology and metrics developed by the SMD Center of Excellence (SMD CoE) Studies and Analysis team to apply force-on-force level modeling techniques to this unique problem set.

Classification: SECRET NOFORN
Working Group: WG09 Air and Missile Defense

60143 - There Is No Crystal Ball: Modeling Air and Missile Defense in a Joint All-Domain Command and Control (JADC2) Environment

Start Date: 6/16/2022	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: David Halloran		
Abstract: Joint All-Domain Command and Control (JADC2) represents a fundamental shift in military operations. While senior DoD leaders develop doctrine, restructure operations and develop/reorganize forces to account for this new way of war, the analysis community must find ways to adapt and provide usable analyses from conceptual JADC2 effects. As the Army's Air and Missile Defense (AMD) Enterprise lead, the United States Army Space and Missile Defense Command (USASMDC) develops new approaches in modeling future combat operations to answer the question "What impact does JADC2 have on AMD operations in 5, or even 10 years?" When conducting future analysis, the SMD Center of Excellence (SMDCoE) Studies and Analysis Division leverages friendly programmatic capabilities from project or program offices to measure future or extant capability within a desired scenario/epoch. Integrating JADC2 capabilities makes this approach challenging due to the unique transformational change effecting all systems/domains and how we fight. If we cannot identify select future JADC2 capabilities for AMD, what can we do? The answer/s must combine: 1. Understanding of current and future AMD challenges/limitations; 2. Integration of all-domain support to AMD; and 3. Instantiation of accurate adversarial capabilities and effects JADC2 has on those capabilities. In this brief, we will discuss how to examine new methods and approaches to modeling future-epoch AMD studies within the context of a JADC2-realized future. Classification: SECRET NOFORN Working Group: WG09 Air and Missile Defense		

WG10 Joint Campaign Analysis

60209 - Achieving Multi-Resolution Campaign Modeling in AFSIM

Start Date: 6/15/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Alexander Braafladt; Dr. Alicia Sudol; Professor Dimitri Mavris		
Abstract: This work is a continuation of the efforts presented previously at MORS Symposiums evolving a ‘Campaign-Lite’ methodology for aggregating information across fidelity levels in simulation. This aggregation supports effective analysis of means and ways options in a design context for large-scale military operations. The aggregation of information is used to provide analysis scope at the decision-level of interest (e.g., campaign-level), while maintaining technical credibility and transparency through traceable connection to the other levels (e.g., physics, engagement, and		

mission). Ongoing research efforts are working to better support analysis by tailoring fidelity – resolution, scope, and abstraction – to the specifics of the case, while working within runtime constraints and providing improved re-usability and re-configurability of simulation. The Advanced Framework for Simulation, Integration, and Modeling (AFSIM) provides an open architecture for these efforts and is successfully in use supporting simulation and analysis focused on the engagement and mission levels. The work presented here continues the evolution of an approach to supporting campaign-level analysis using AFSIM – the Campaign-Lite approach. The advances presented here involve extending the object-oriented, higher-level operational information framework to include intelligence management and involves planning, collection, and processing of campaign-level intel information dynamically in the AFSIM agent-based structure. This provides a set of modular interfaces for managing and using intel information in the loop to support analysis looking at larger-scale operational activities – in addition to classic AFSIM interfaces for mission, engagement, and physics-level modeling. The scenario considered in this work builds on a multi-domain, large-scale operation to specifically follow an analytic path through the intel collected and utilized during the initial stages of a large-scale operation. The analysis considerations are based in a data-driven dashboard enabled by surrogate models that is directed at supporting or integrating data with other simulations at the campaign level.

Classification: UNCLASSIFIED
Working Group: WG10 Joint Campaign Analysis

60078 - Enhancements to Air and Missile Defense Analysis Using AFSIM

Start Date: 6/15/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Carla Ortega		
Abstract: Abstract: Using the Advanced Framework for Simulation, Integration, and Modeling (AFSIM), the Center for Army Analysis (CAA) established a modeling framework to provide more effective and efficient Air and Missile Defense (AMD) analysis. The objective of this initiative was to allow analysts the ability to manipulate and analyze the model's inputs and outputs without an in depth knowledge of coding. CAA currently uses the results from the analysis to support the annual Quantitative War Reserve Requirement for Munitions (QWARRM) study. This brief will outline the use of AFSIM in constructing, designing, and implementing the framework in CAA's Air and Missile Defense analysis. Classification: UNCLASSIFIED Working Group: WG10 Joint Campaign Analysis		

60233 - Campaign Effects of Base Defense and Resiliency Mixes

Start Date: 6/16/2022	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: Melissa Wickers		
Abstract: The United States Air Force relies on the Joint Force's ability to defend air bases against missile attacks in order to generate combat power. Cost-effective base defense and resiliency mixes that improve effectiveness metrics such sortie generation, aircraft attrition and airbase operations are critical for Joint Force campaign success. This analysis screened a variety of bases defense and resiliency mixes using a designed experiment and were executed in the TAB-VAM base defense model. The results of this experiment were plotted against cost and campaign effectiveness, which resulted in a Prado curve of promising defense and resiliency mixes at different cost points. A subset of these promising mixes were selected for deep-dive campaign analytics in the STORM campaign		

model to determine overall impact on high-level campaign metrics. This presentation highlights our analytical approach and presents the initial findings of the analysis.

Classification: SECRET NOFORN
Working Group: WG10 Joint Campaign Analysis

60110 - Anti-Submarine Warfare (ASW) Weapon Procurement Mix Study - Results Overview

Start Date: 6/16/2022	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Mr. Craig Andrew Preston, Jr.; Thomas Karnezos; Jonathan Celaya; Deanne McPherson; Andrew Kosiba; Matthew D. Vonada

Abstract: As the U.S. Navy develops new weapon capabilities for Anti-Submarine Warfare (ASW), resourcing and investment decisions must consider current and future expected operational and logistical needs. Procurement numbers should account for the proper mix of legacy and new weapon loads, the total numbers required per variety, and for maintenance and storage considerations. This study examined Theater ASW weapon demands for potential areas of future conflict utilizing likely Tactical Situations (TACSITS) to determine the required MK 54 Lightweight Torpedo (LWT) inventory (as primary weapon), considerations for alternatives to the MK 54, and proposed mixed load requirements for ships and aircraft employing all variations of LWTs. The objective was to provide clarity towards future resourcing decisions based on legacy LWT inventory as well as the impacts from fielding viable alternatives. The technical approach selected for this study used a custom built Discrete Event Simulation (DES) model with Monte Carlo Analysis to determine the required loads for ASW surface ships and aircraft engaging submarine threats. The model was sensitive to geographic / physical constraints, operational timelines, platform utilization, and platform survivability. The DES model was applied to several geographical diverse scenarios. Within each scenario, a sensitivity analysis explored how variations in a number of key input parameters impacted the overall metrics and results. The study further quantified a metric of risk as the likelihood that a platform does not have enough weapons for a given TACSIT, and explored how LWT inventory requirements were impacted as a function of varying levels of risk. The overall number of LWTs recommended by the study was a summation of combat requirements, homeland defense requirements, and maintenance requirements. Results were compared to projected LWT inventory levels currently planned for procurement to inform future resourcing. This presentation focuses on the results and the key analytic observations.

Classification: SECRET NOFORN
Working Group: WG10 Joint Campaign Analysis

59738 - BEAM: Opening Doors for Campaign Analysis

Start Date: 6/16/2022	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Stephen Sturgeon; Dr. Mark A. Gallagher, FS; David Quick

Abstract: The Bayesian Enterprise Analysis Model (BEAM) is a campaign tool that provides an opportunity to break the paradigm of how and where campaign analysis has been used across the analytic landscape. BEAM was designed to allow for easy military strategy, joint force structure, or infrastructure changes and its intuitiveness allows new users to learn to use it in a couple of days with no formal training. This combination of attributes makes it accessible to a broad spectrum of analytic functions. Additionally, BEAM enables the ability to search scenario tradespace faster than in the more traditional application of campaign analysis to focus analysis with more detailed models. This

presentation provides an example analysis to demonstrate components of BEAM (inputs, strategy changes, outputs, etc.) and to illustrate how it can be used to inform decision.

The views expressed in this paper represent the personal views of the author and are not necessarily views of the Department of Defense or the Department of the Air Force.

Classification: UNCLASSIFIED
Working Group: WG10 Joint Campaign Analysis

60234 - Measuring Escalation through HQ Crowd Sourcing

Start Date: 6/16/2022	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Mr Richard Peter Hoyes; Maddy Taylor

Abstract: Defence has increasing been adjusting its position to focus efforts on deterrence below the threshold to class the situation as war. Typically the situation between two opposing states can easily escalate or deescalate in tension and actions, as we have seen with recent events. To understand how a planned operation may impact this tension or how it may progress, a standardisation is need to help the "measurement" or estimates of this into the future and across different Operational Headquarters. Without this, a description of the level of tension can be highly subjective to an individual and their perception.
We have developed a framework for understanding and tracking the tension and actions between two players: nations, factions or simply two people. This escalation framework builds on existing methodologies and allows an objective approach to encapsulate a range of opinions or judgements of a situation. This standardised framework allows different people to use the same tool to either measure the current state or progress and also able to explore how an operation may escalate or deescalate into the future.
This escalation framework approach for measuring progress and supporting planning was put into action on a multinational deterrence exercise using key subject matter experts. Furthermore, an alternative approach was run in parallel – to crowd source the measurement of escalation/de-escalation through the understanding of the whole HQ, thereby capturing the perceptions and situational awareness of all the staff involved. This allowed to open discussions into how future actions or operations designed to deter or de-escalate may play out on the world stage.

Classification: UNCLASSIFIED
Working Group: WG10 Joint Campaign Analysis

59786 - C2IE: Facebook + Database = Global Linkage & Visibility of Data

Start Date: 6/16/2022	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Rebecca Porinsky

Abstract: Command and Control of the Information Environment (C2IE) is an Office of the Secretary of Defense (OSD) Strategic Capabilities Office (SCO) sponsored web-based system accessible from NIPR and SIPR that is designed to enable commanders to sense, understand and respond to the information environment (IE) in near real time. C2IE enables global integration and collaboration supporting Department of Defense (DoD) shaping efforts from peacetime through armed conflict.

This demonstration, from a COCOM perspective, will describe uses of C2IE and demonstrate platform features including both vertical and horizontal linkage and global visibility of data between plans, activities and assessments at various levels from the Components to the COCOMs to the Joint Staff.

Classification: UNCLASSIFIED
Working Group: WG10 Joint Campaign Analysis

WG11 Land and Expeditionary Warfare

60166 - (U) Fermi Estimate and Problem Decomposition – Feasibility of Employing Forces in Scenario 2.x

Start Date: 6/14/2022	Start Time: 1:30 PM	End Time: 2:30 PM
Authors: Joshua J Krause		

Abstract: 90th Symposium
"Innovative Analysts Supporting Integrated Deterrence"
Author: Major Joshua Krause (joshua.j.krause.mil@army.mil)
Briefer: Major Joshua Krause
Classification of Presentation: Secret
Distribution Statement: D
Length of Presentation: 45 Mins
Suggested Working Group: WG 11 (Land and Expeditionary Warfare), WG 16 (Strategic Deployment and Distribution)

(U) Fermi Estimate and Problem Decomposition – Feasibility of Employing Forces in Scenario 2.x

(U) Keywords: Order of Magnitude Estimation, Feasibility Assessment, Scenario Development, Campaign-level Planning, Army Scenario 2.x, JFOS 2.2040, JF CONOPS, Army Division Unit of Action Force Design Update, Military Decision Making Process, NDS Critical Challenge Areas.

(U) Problem Statement. Scenario 2.x campaign planning requires initial analysis of the employment of forces in an area of operations. Determine the feasibility of employing multiple divisions, across operational distances, and in a contested maritime environment to maintain operational tempo (OPTEMPO) for large-scale ground combat operations (LSGCO).

(U) Scenario 2.x depicts a campaign-level concept of operations (CONOPS) where the United States builds and leverages Allies and Partners to deter and defeat a peer threat. The scenario development leveraged previous scenario efforts to generate a baseline concept and a distributed operational planning team (OPT) to provide the detail and fidelity of a broad regional scenario.

(U) The design of the employment of forces started prior to (required) in-depth analysis of the logistically feasible force flow (LF3). The OPT analysts divided between two groups, aligned to the feasibility of employing forces through multiple logistic system bottlenecks. To break the impasse, the OPT required initial analysis to overcome their intuitive, 'gut-based' decision-making. The team turned to a Fermi estimate of the answer.

(U) The Scenario 2.x planners turned to problem decomposition and Fermi Estimates of the answer to support the OPT with more information, prior to using more sophisticated methods to calculate the answer. In this application, the estimate holds significant inaccuracies; however, the simple calculation enabled the team to find errors in the employment details and uncover faulty assumptions in the system. The team systematically approached increasingly precise results by refining the initial

assumptions and initial estimates and then rerunning the simple feasibility model. When the team reached a feasible solution, the OPT benefited from bounded system estimates and refined planning assumptions. The simple calculations cleared the fog of the unknowns in the system, and provided the information to continue planning subsequent stages of the operation.
(U) This presentation will detail the methodology and approach to decomposing the employment problem, development challenges and insights, and generalized scenario challenges and

Classification: SECRET//REL TO FVEY
Working Group: WG11 Land and Expeditionary Warfare

60141 - Future Study Program 2022 (FSP 22) Scenario Framework Development – Creating a campaign-level scenario framework to provide operational context for conducting future joint and coalition experimentation and analysis against a peer-threat.

Start Date: 6/14/2022	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Mr. Kenneth Hartman

Abstract: 90th Symposium
"Innovative Analysts Supporting Integrated Deterrence"
13 - 16 June 2022
Marine Corps University, Quantico, VA

(U) Author: Rick Sanders (richard.d.sanders32.civ@army.mil)
(U) Briefer: Mr. Rick Sanders
(U) Classification of Presentation: S//REL TO USA, AUS, CAN, GBR, NZL
(U) Distribution Statement D: Distribution authorized to the Department of Defense and U.S. DOD contractors only, per the TRAC Security Classification Guide as of 20 Oct 2021. Other requests for this document shall be referred to TRAC Security Manager at: The Research and Analysis Center, ATTN: Security Office, 255 Sedgwick Avenue, Fort Leavenworth, KS 66027-2345.
(U) Length of Presentation: 30 Minutes
(U) Suggested Working Group: WG 11 (Land and Expeditionary Warfare)

(U) Future Study Program 2022 (FSP 22) Scenario Framework Development – Creating a campaign-level scenario framework to provide operational context for conducting future joint and coalition experimentation and analysis against a peer-threat.

(U) Subject Terms: Scenario Framework, Operational Context, Joint Forces Operating Scenario (JFOS), Campaign-level, Operational Scenario, Operational Environment, Concept of Operations (CONOP).

(U) Problem Statement: The Army requires a campaign-level operational scenario in order to credibly underpin analysis and experimentation that supports development and refinement of the Army operating concept at 2035 and beyond. The scenario framework must include the Army operating as part of the Joint Force in conjunction with multi-national partners within regional campaigns against a peer threat.

(U) Description: The FSP 22 Scenario Framework depicts a campaign-level, concept of operations (CONOP) where the United States builds and leverages Allies and Partners to deter and defeat a peer threat. This scenario framework development effort expanded upon a previous joint forces operating

scenario to generate a FVEY-releasable scenario framework with a challenging threat conducting large-scale ground combat in a believable operational environment.

(U) Process: The development process captures the challenges and interdependencies encountered during the development of the FSP 22 Scenario Framework. The scope of the operation includes Joint competition activities, Joint deterrence operations, Joint force projection, and large-scale, ground combat operations against a peer adversary.

(U) Conditions: The FSP 22 Scenario Framework needed to be FVEY releasable, finished within three months, provide an operational environment where the Army supported Joint operations and the Joint Forces supported Army operations, occur in a specific area of operations at a specific timeframe, and have National Defense Scenario/Defense Planning Scenario traceability (linkage).

(U) The presentation outlines the scenario framework development process; challenges encountered and lessons learned; and presents the scenario framework to include appropriate uses.

Classification: SECRET//REL TO FVEY
Working Group: WG11 Land and Expeditionary Warfare

60177 - How Operational Research is Deciding the UK's Next Generation of Land Equipment

Start Date: 6/15/2022	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Mr Samuel George Genge, BA (Hons) MA

Abstract: The UK's Land Forces are currently undergoing significant equipment changes. This is predominately being driven by a requirement to meet the objectives laid out in the UK's Integrated Operating Procedure 2025 (IOpC25). IOpC25 specifies the need for the British Army to be persistently engaged worldwide, whilst also being able to generate the mass required to engage in 'War Fighting at Scale'. This has resulted in a renewed focus on identifying and adopting emerging land concepts that can provide the UK land force a competitive advantage.

The Defence Science and Technology Laboratory's (Dstl) Land Environment Group (LEG) provides Operational Research in support of decision making by the British Army. It primarily supports force structure and procurement decision making. IOpC25 provides an opportunity for Operational Research (OR) to shape the direction Science and Technology (S&T) in support of Land Forces. LEG's Future Land Concepts Project is employing OR to understand which land concepts could have the greatest impact.

This submission will illustrated the project's analytical processes, and provide examples of specific OR methods employed. The project takes a threat focused approach, measuring the performance of the UK land forces against a range of threats. By engaging with Dstl's network of subject matter experts, new land concepts have been identified which could fill capability gaps. Through Wargaming and capability analysis, concepts are down selected for further analysis and testing. In summary the project ensures that analytical decision making drives Land S&T in the UK. This submission will only use illustrative examples due to classification.

Classification: UNCLASSIFIED // FOUO
Working Group: WG11 Land and Expeditionary Warfare

60171 - Starting Conditions

Start Date: 6/15/2022	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Mr. Kenneth Hartman		

Abstract: Keywords: starting conditions; wargaming; modeling; scenario

Professional, analytic scenarios outline potential future events. They contain the history, key events, region, and key players concerned with these future events and serve as the bedrock for professional wargaming and plans development.

While the scenario serves as the foundation of a wargame it can also be validated and advanced through the wargaming process with the refined scenario being the product of a wargame. Effective wargames require sophisticated scenarios with a great deal of detailed information so that players can provide defensible decisions and courses of action. For example, the scenario and wargame must have a defined time setting, terrain (the gamebox), event history leading up to the situation, as well as force capabilities for all players (including technical capacity and capabilities of physical assets, networks, and integrated systems). This foundational information establishes the credibility of any scenario and is summarily described as setting the starting conditions.

TRAC has developed a methodology for establishing starting conditions for scenario building and wargaming through collaborative workshops involving multiple agencies and organizations to ensure high quality analysis and accurate information is fed into these scenarios that will later provide the basis for numerous high visibility analytic efforts and acquisition decisions. This presentation will walk through an example of one of these workshops and provide an actionable outline of key considerations for developing your own starting conditions for scenario building and/or wargaming efforts.

Classification: UNCLASSIFIED
Working Group: WG11 Land and Expeditionary Warfare

59851 - Army Aviation Air Movement Automation for the Mission Planner

Start Date: 6/15/2022	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Russell Nelson		

Abstract: Although lacking the same preeminent status of air assault planning, air movement operations comprise a majority of Army utility and cargo helicopter combat aviation operations in terms of volume of customers and the endless appetite for rapid movement of troops across the battlespace. For routine air movement operations, the bulk of the planning falls on the shoulders of a few mission planners with limited and often rudimentary planning tools, frequently leading to inefficiencies in air movement plans. Ultimately, air movement planning inefficiencies put a greater resource burden on aviation units and reduce lift capacity to the supported commanders at echelon. We seek to create an Army aviation air movement mission planning model to assist the mission planner by rapidly providing courses of action based on the commander's priorities. Features of the problem include priority demand, multi-node refueling, aircraft and passenger time windows, maximum passenger transportation time, and the minimization of unsupported demand, aircraft utilization, and total flight time. The mathematical model is an extension of the dial-a-ride problem (DARP) that will coordinate air mission requests (AMRs) at the combat aviation brigade-level or lower to generate courses of action that optimize helicopter fleet resourcing and routing decisions against mission variables, while supporting the optimal number of AMRs that sustain combat power over

time. Additional work includes a well-designed heuristic required to generate feasible solutions in near real-time.

Classification: UNCLASSIFIED
Working Group: WG11 Land and Expeditionary Warfare

60255 - Bradley Modernization Assessment

Start Date: 6/15/2022	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Zack Martin		

Abstract: The Commanding General (CG), Army Futures Command (AFC) requested an assessment to determine Bradley Infantry Fighting Vehicle (BIFV) modernization program impacts for potential delays in new ground combat fighting vehicle (GCFV) fielding. TRAC developed potential courses of action for further BIFV investment strategy options for maintaining and improving the BIFV fleet in the event that the new GCFV fielding is delayed to a later date. The investment strategy options included addressing BIFV Fleet Operational Readiness by funding Obsolescence and Readiness and M2A3 Recapitalization, as well as fielding additional M2A4-equipped armored brigade combat teams (ABCT) before and/or aligned with potential new GCFV fielding. The study further defined three BIFV M2A4 (+) variants options created by optimizing solutions given a certain budget and a subject matter expert value-based proposition of capabilities.

This presentation will provide an overview of the context that manifested the requirement to assess BIFV fleet modernization. Additionally, the study problem statement, study issues, scope, limitations, and assumptions that shaped the study approach and methodology will be discussed. Lastly, the methods, models, tools, key terms, fielding constraints, and screening criteria utilized for the study analysis will be included in the presentation that enabled the team to provide the CG, AFC with BIFV investment strategy options.

Classification: UNCLASSIFIED
Working Group: WG11 Land and Expeditionary Warfare

WG12 Maritime Operations

60448 - Hold Time Statistics for Theater Undersea Warfare

Start Date: 6/15/2022	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: CAPT (Ret) Jeffrey R. Cares, USN		

Abstract: In wartime, fleets conduct Offensive Antisubmarine Warfare (ASW) to find and kill submarines that are not actively hunting a defended asset (such as a convoy, logistics train or other high value unit (HVU)). In operations short of war, the goal of Offensive ASW is to find and maintain contact; not to kill. The classic wartime Offensive ASW measures of effectiveness (MOEs) are contact rate and kill rate, which do not apply to peacetime operations.

This presentation presents new MOEs, Hold-time and Regain-time statistics, and the Hazard Function, an associated measure of performance (MOP), which were recently developed to support Theater Undersea Warfare Commander (TUSWC) and Scene of Action Commander decision sets. Hold-time and Regain-time statistics are useful for describing overall Hold-time effectiveness, while their associated Hazard Functions are very valuable tools for forensic analysis of peacetime Offensive ASW performance.

Classification: UNCLASSIFIED
Working Group: WG12 Maritime Operations

60043 - Modeling the Operational Feasibility of Synfuel from Seawater

Start Date: 6/15/2022	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Stephanie Brown; Brant Horio; Michael Anderson; Simon Whittle; Lucas McCabe; Christopher Johnson; Stuart Funk

Abstract: A critical factor for deterrence is the ability to resupply our forces to maintain extended physical presence and to support sustained military operations. Given continued National interest in the Pacific, future marine and aviation fuel generated from alternative sources such as seawater, is a potential game changer for naval replenishment logistics. In addition to the engineering challenges for making this technology a reality, the impact on logistics and operations must be fully understood. In this talk, we discuss how modeling and simulation may be used to support feasibility studies of sustainable aviation fuel.

Classification: UNCLASSIFIED
Working Group: WG12 Maritime Operations

60108 - Anti-Submarine Warfare (ASW) Weapon Procurement Mix Study - Results Overview

Start Date: 6/15/2022	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Mr. Craig Andrew Preston, Jr.; Thomas Karnezos; Jonathan Celaya; Deanne McPherson; Andrew Kosiba; Matthew D. Vonada

Abstract: As the U.S. Navy develops new weapon capabilities for Anti-Submarine Warfare (ASW), resourcing and investment decisions must consider current and future expected operational and logistical needs. Procurement numbers should account for the proper mix of legacy and new weapon loads, the total numbers required per variety, and for maintenance and storage considerations. This study examined Theater ASW weapon demands for potential areas of future conflict utilizing likely Tactical Situations (TACSITS) to determine the required MK 54 Lightweight Torpedo (LWT) inventory (as primary weapon), considerations for alternatives to the MK 54, and proposed mixed load requirements for ships and aircraft employing all variations of LWTs. The objective was to provide clarity towards future resourcing decisions based on legacy LWT inventory as well as the impacts from fielding viable alternatives. The technical approach selected for this study used a custom built Discrete Event Simulation (DES) model with Monte Carlo Analysis to determine the required loads for ASW surface ships and aircraft engaging submarine threats. The model was sensitive to geographic / physical constraints, operational timelines, platform utilization, and platform survivability. The DES model was applied to several geographical diverse scenarios. Within each scenario, a sensitivity analysis explored how variations in a number of key input parameters impacted the overall metrics and results. The study further quantified a metric of risk as the likelihood that a platform does not have enough weapons for a given TACSIT, and explored how LWT inventory requirements were impacted as a function of varying levels of risk. The overall number of LWTs recommended by the study was a summation of combat requirements, homeland defense requirements, and maintenance requirements. Results were compared to projected LWT inventory levels currently planned for procurement to inform future resourcing. This presentation focuses on the results and the key analytic observations.

Classification: SECRET NOFORN Working Group: WG12 Maritime Operations

60142 - AEGIS Combat System Optimization and Analysis using HLA Simulation

Start Date: 6/15/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Shane N Hall, PhD; Dr. Benjamin G. Thengvall; Jeff Smith		
Abstract: The US Navy has stated a need to develop modeling and analysis software to optimize software-only changes in the Anti-Air Warfare (AAW) system design to address Anti-Ship Cruise Missile (ASCM) threats. Tweaks in the AEGIS Combat System (ACS) design can provide quick software-only fixes that provide large gains in overall system performance. Current processes involve human-driven engineering analysis to determine the best options for inserting new upgrades or system improvements; and hence, this process is manual, labor intensive, and has inputs from disconnected sources slowing the timeline associated with analysis and decisions for software insertions. Therefore, the Navy seeks to automate current processes and make them more data-driven to field capability more quickly, make the most optimal improvements to AAW within the capabilities of current weapons, and provide integrated data analysis to better integrate and ensure performance of future weapons. More specifically, a software tool is desired that integrates outputs of current and future models and uses goal-seeking behaviors to improve recommendations for software-only optimization of the AAW capability within the ACS. OptDef is a simulation optimization and analysis software technology that integrates with existing simulations to quickly determine the system configurations that produce the best possible outcomes and improve analytic insights. Thus, it is ideal for modeling and simulation environments that are used for system design, trade space assessments, and test and evaluation. OptDef is integrated and verified with multiple DoD simulations, most recently with the Navy's AEGIS Combat System Test Bed (CSTB), which is a high-level architecture (HLA) federation of complex system simulations that are critical to the Navy's ability to effectively and efficiently perform developmental test and evaluation (DT&E) and operational test and evaluation (OT&E) for the ACS. Here we present the status of the OptDef software tool integration with the CSTB to enable effective investigation of the nearly unbounded set of scenarios in a limited timeframe. This optimization capability makes it possible to identify outcomes that will quantifiably improve key system metrics related to countering ASCM threats such as miss distance, probability of kill, and probability of raid annihilation. This OptDef software tool with its prototype integration with CSTB and with its embedded industry-leading simulation optimization algorithms will be delivered to Navy CSTB environments later this year. Classification: UNCLASSIFIED Working Group: WG12 Maritime Operations		

60447 - The Enduring Fundamentals of ASW Analysis

Start Date: 6/15/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: CAPT (Ret) Jeffrey R. Cares, USN		
Abstract: Antisubmarine warfare (ASW) is a complex technological and operational competition that has been a primary activity of most of the world's major navies for more than a century. Throughout its long history, the practice of ASW has entailed tremendous material and tactical innovation, and spurred the invention of new platforms, sensors, integrated combat systems and communications networks. Tactics, techniques and procedures – for both ASW forces and the submarines they attempt to defeat		

– are in an almost constant state of flux. Throughout all this change, however, three main ASW processes have endured virtually unchanged ever since operations analysts first recognized and described them during World War II.

This presentation describes the three ASW processes in their analytical context so that ASW professionals can observe that although most of the details of ASW practice are always changing, the analytical processes themselves, as well as the goals and the measures of the effectiveness (MOEs) of forces conducting ASW, endure.

Classification: UNCLASSIFIED
Working Group: WG12 Maritime Operations

59804 - Station Allocation Scheduling Assistant (SALSA)

Start Date: 6/16/2022	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Mr. Matthew S Cosner; Dr. Sandra Beaulieu; Alexander Phan

Abstract: The Naval Air Warfare Center Aircraft Division, Warfare Effectiveness Department (WED) leads studies examining crewed and uncrewed aircraft which inform aircraft design and science and technology investment decisions. A common metric used to evaluate future designs and concepts of operations is persistence: the ability to remain on-station for extended durations in support of a mission. Historically, persistence analysis has been conducted via subject matter expert (SME)-developed spreadsheet flight schedules. These spreadsheets often took a day or more to complete, lacked intuitive visualization, and did not enable comparison across many options nor sensitivity analysis.

In response, a team of analysts initiated the Station Allocation Scheduling Assistant (SALSA) project to develop a MATLAB-based tool to evaluate multi-aircraft persistence as a function of user-defined inputs. The goal was a model that could run persistence analysis cases in minutes vice days, reduce reliance upon SME assumptions, produce deeper and richer metrics, facilitate parametric and sensitivity analysis, and provide intuitive visualizations and playbacks for briefings.

SALSA is specifically designed for analysis of sea-based aviation operating from distributed sea bases. Inputs include air vehicle performance; aircraft maintainability; aviation manpower; the number of aircraft, surface ships or bases; command and control capabilities; and the desired mission and duration. SALSA outputs include flight schedules; percentage time on-station; coverage over time; aircraft and manpower utilization rates; and a playback animation of the mission. In addition, SALSA outputs can be imported into constructive simulation tools to show the impacts of persistence on mission / kill-chain success.

The model has been used to support multiple studies for the Office of the Chief of Naval Operations, Naval Air Systems Command and Naval Sea Systems Command. Key insights include the relationship of station keeping capability to aircraft characteristics such as transit speed, payload and endurance, and the importance of aircraft maintainability and maintenance manpower on sustained flight operations. These insights are helping to shape future crewed and uncrewed aircraft requirements, designs, and concepts of operation.

Issues encountered during model development were maintaining version control, operating across multiple levels of security, the requirement for user familiarity with MATLAB to run the model, and

managing a large design trade space. Recently implemented methods to address these issues include the use of an online code repository to facilitate code-sharing and version control across numerous developers, a modular approach to coding to enable transfer of required features and implementation of new features, the development of a graphical user interface and the employment of a design of experiments approach for sensitivity analysis and trade space exploration.

Classification: UNCLASSIFIED // FOUO
Working Group: WG12 Maritime Operations

WG13 Power Projection and Strike

60253 - Rapid Technology Evaluation Using CWS

Start Date: 6/14/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Christopher Jarvis; Andrew Crete; Ty Dylan Granberry		
Abstract: Maintaining a technological advantage is a critical element of a credible integrated deterrence. In order to determine which technologies are most beneficial to promoting and building deterrence, analysts must have powerful toolsets to rapidly evaluate the impact of the emerging or disruptive technologies. CWS is a cross platform, fast, high fidelity kinematic simulation environment suited to evaluating the effects of munition technologies such as airframe design, propulsion, navigational subsystems and guidance algorithms. CWS enables evaluation of the technologies at a detailed engagement simulation level and by integrating with AFSIM, at the mission and broader focused simulation levels. This presentation will provide an overview of CWS and cover recent improvements to include a new python interface to provide direct access to simulation results which significantly improves "in-the-loop" processing time for large trade space studies. Classification: UNCLASSIFIED Working Group: WG13 Power Projection and Strike		

60259 - Autonomous Munition Simulation via CWS-AFSIM Integration

Start Date: 6/14/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Christopher Jarvis; Ty Dylan Granberry; Andrew Crete		
Abstract: The AFSIM architecture provides a powerful framework to rapidly create platforms for demonstration and evaluation within a mission level simulation. However, to ensure simulation accuracy, there must be high fidelity models for entity, subsystems and their interactions. The integration of AFRL/RW's CWS framework into AFSIM allows users to have access to high fidelity munition kinematics in a mission level simulation environment. The integration also enables new levels of modularity by combining CWS's high fidelity equations of motion with a vast and extensible set of other AFSIM platforms, sensors and functionality. In particular, this presentation will provide details of the updated interface that allows for high fidelity weapons to incorporate and respond to autonomy commands through waypoint generation and tracking to simulate a novel collaborative target strike capability. Classification: UNCLASSIFIED Working Group: WG13 Power Projection and Strike		

59528 - DCA Study

Start Date: 6/15/2022	Start Time: 8:30 AM	End Time: 9:00 AM

Authors: Bud Bishop
Abstract: DCA Study ABSTRACT: Defensive Counter Air (DCA) capabilities in relevant theaters of the world are dependent on a variety of factors rarely considered during strategic planning. Using critical path analysis, we applied systems engineering processes to study the product flow of sorties from a number of airfields in various theaters of operations. Where some of these airfields are purportedly capable of providing overwhelming numbers of aircraft sorties and a dense DCA environment, when studied against weapons processes, maintenance processes, runway and air control capabilities, aircrew capabilities and limitations, and refueling processes, we discovered that the reported 'dense DCA environment' was anything but dense… that airfields will not produce the large numbers of sorties that inventory figures would otherwise imply. In this analysis effort, a set of parallel processes influences airfield operations. We took the processes, one at a time, and developed a set of calculations to replicate their individual capabilities. For instance, the weapons process (one of the more simple ones) includes 72 weapons personnel, a number of vehicles that move weapons, and aircraft weapons loading equipment to ensure sorties are launched with a warfighting capability in the air. The processes that support weapons being present and capable of use at DCA stations include weapons breakout (unpacking from storage / protective crates and bunkers), weapons assembly (fueling or adding fully charged batteries for target sensors), weapons testing (to ensure proper function prior to flight), transporting the weapons to aircraft, then loading the weapons). Other factors affecting DCA postures include: pilot-ratio-to-aircraft, pilot monthly flight time limits, maintenance requirements: manning of maintenance support departments is usually guided by maintenance-manhours-per-flight hour (MMH/FH) requirements…whether 10 MMH/FH or 40 MMH/FH, maintenance turnaround of tactical aircraft is dependent on having enough personnel to meet the needs given flight hours assigned to those aircraft, and refueling. Assessing all of these processes in parallel allows critical path identification and results in more accurate estimates of DCA capabilities. The presenter will discuss DCA capabilities and provide insight into an EXCEL tool used to identify the critical path of any airfield and allow the user to alter aspects of manning and equipping of that airfield to increase production to the next critical path limitation. Classification: UNCLASSIFIED Working Group: WG13 Power Projection and Strike

60777 - Modeling, Simulation, & Analysis of Multi-Domain Dynamic Targeting Operations

Start Date: 6/15/2022	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Kimberly Sharon Avery		
Abstract: Air, Land, Maritime, Space, and Cyber are the domains within the US military. Multi-domain operation is a joint warfighting concept that will combine both kinetic and non-kinetic effects in combat. The primary target of interest is dynamic. Dynamic targets are platforms that are unknown when the Air Tasking Order (ATO) was created. These unknown platforms threaten friendly assets and the capability to complete the mission to engage assigned deliberate targets. Multi-domain operations increase the complexity of assigning available assets to engage the dynamic targets, so the planned mission against deliberate targets can be accomplished. Other factors that need to be taken into consideration when assigning an asset to engage a dynamic target is target type (i.e., tracking radar or weapon site), time target appears, proximity to the striking aircraft, commander's intent etc. These factors also play into which effect (kinetic or non-kinetic) is the most suitable. A solution to quickly provide a weapon to dynamic target pairing solution is needed to determine and provide options to the warfighter.		

Radiance Technologies is working with AFRL/RI and various performers to evaluate optimized weapon to dynamic target pairing solutions for the Multi-Domain Dynamic Targeting (MD2T) project. MD2T consists of two efforts: Modeling & Simulation (M&S) and Optimization Development & Integration Environment (ODIE). M&S is creating an unclassified, highly contested environment based on the Pacifica scenario in AFSIM (Advanced Framework for Simulation, Integration and Modeling). This scenario currently consists of Air, Space, and Cyber domains. The Air domain has both simple and advanced striker models, the Space domain has an LEO constellation with power-based noise jamming, and the Cyber domain has various effects to include network alteration, false track & exfiltration, toggle platform part, and propagation. AFSIM interacts with the external weapon to dynamic target pairing optimization algorithms. The optimizer will determine the priority of attack and type of attack against dynamic targets to enable the completion of the mission against deliberate targets defined in an ATO. ODIE is the test bed environment used to manage execution and data collection of the optimization experiments. The purpose is to provide repeatable experiments to properly evaluate the performance of multiple optimization algorithms. It can execute thousands to millions of constructive simulated runs, while aggregating, condensing, and summarizing output from those runs. ODIE links the necessary components (Dakota, AFSIM, Optimizer's, Dr. Eval) needed to achieve this purpose into one environment.

Classification: UNCLASSIFIED // NOFORN
Working Group: WG13 Power Projection and Strike

60133 - The Naval module of the Center for Army Analysis Accelerated Wargaming System (CAAAWS)

Start Date: 6/15/2022	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Mr. Stuart T Wilkes

Abstract: Title: The Naval Module of the Center for Army Analysis Accelerated Wargaming System (CAAAWS)
Keywords: wargaming, naval warfare, naval search & detection, naval combat.
Author Information: Mr. Stuart T. Wilkes, Center for Army Analysis, 6001 Goethals Road, Fort Belvoir, VA 22060, 703-806-5679, stuart.t.wilkes.civ@army.mil

Abstract: The Center for Army Analysis (CAA) uses its CAA Accelerated Wargaming System (CAAAWS) to conduct operational-level wargaming for the joint community. CAA developed the naval module in-house but incorporated input from the U.S. Navy's own analytical agencies, as well as from Navy warfighters at United States European Command, United States Indo-Pacific Command, and United States Central Command. This input included information on the naval processes for movement, search, tactical detection, strikes on land targets, logistics, and engagements in the aerial, surface, and subsurface naval warfare domains. Further, the data used in CAA operational-level wargames draws, to the extent possible, from U.S. Navy sources and through direct U.S. Navy inputs to CAA. The result is an operational naval wargaming subsystem that the joint community and combatant commands have found acceptable as a tool for operational-level course of action comparison and for drawing broad operational insights from the estimated tactical outcomes that CAAAWS produces. This presentation will cover the various functions of the CAAAWS naval module, and how it uses the provided data to produce its estimated tactical outcomes.

Classification: UNCLASSIFIED Working Group: WG13 Power Projection and Strike

59207 - Air Base Resilience: Cost-Effective Mixes of Active and Passive Defenses for Pacific Air Forces

Start Date: 6/16/2022	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Mr. Jacob Heim		
Abstract: Precision missiles threaten U.S. potential operating locations and Pacific Air Forces (PACAF) seek solutions to improve theater-wide air base resilience in the face of these threats. This briefing summarizes an analysis conducted for PACAF that used modeling and simulation to estimate the vulnerabilities of air bases in key scenarios. The analysis also used a genetic optimization algorithm to identify cost-effective measures for mitigating those vulnerabilities. The candidate mitigations included mixes of infrastructure (e.g., new parking aprons), active defenses (e.g., THAAD), and deployable passive defenses (e.g., fuel bladders). This project used an analytic framework developed at RAND over the past decade called Combat Operations in Denied Environments (CODE). CODE enables analysts to evaluate the operational impact of adversary missile attacks on key air base capabilities such as runways, parked aircraft, fuel infrastructure, and munitions storage. CODE provides a framework to evaluate the effectiveness, cost, and supportability of disparate mitigation options including: air base posture, deployable passive defense, infrastructure, active missile defense, deception options, and force maneuver concepts of operation. Classification: SECRET NOFORN Working Group: WG13 Power Projection and Strike		

60212 - Directed Energy Utility Concept Experiment

Start Date: 6/16/2022	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Dr Garrett Darl Lewis; Mr. Joseph Allen Aldrich		
Abstract: There is an urgency to rapidly integrate and field viable Directed Energy (DE) weapons and advanced Kinetic Energy (KE) effectors to Areas of Responsibility (AORs) in response to unprecedented changes in adversary capabilities and intent. In 2020, the Air Force Research Laboratory Directed Energy Directorate's Wargaming and Simulation Branch (AFRL/RDMW) initiated a series of virtual wargames in support of this goal. These Directed Energy Utility Concept Experiments (DEUCEs) identify capability and joint integration gaps to be closed prior to Initial Operational Capability (IOC), introduce the warfighter to emerging technology, and inform senior AFRL leadership about military utility of current DE and KE concepts while bringing together stakeholders across the Research and Development (R&D) and warfighter communities. We present the methodology and initial findings from three DEUCEs focused on evaluating the employment of game-changing High Energy Laser (HEL) and High Power Electromagnetic (HPEM) technology alongside current and future KE effectors. During the inaugural HEL DEUCE in January 2021, RDMW brought together fighter pilots, Weapon Systems Officers (WSOs), and an Airborne Warning and Control System (AWACS) air battle manager (ABM) to evaluate the capabilities of two variants of airborne HEL in Airbase Air Defense (ABAD) and Platform Protect (PP) scenarios in the future battlespace. The warfighters provided excellent		

assessments through a series of vignettes exploiting virtual-reality capabilities to identify and characterize potential military utility of DE weapons. They further provided valuable operator inputs and engagement tactics to supplement ongoing technical analyses. Together, these provide critical information to the Air Force to evaluate new technologies, support investment decisions, and provide warfighters with insight into the capabilities of emerging technologies.
The second event focused on the employment of HPEM systems alongside current KE capabilities as part of an integrated Air Defense System (IADS). This event brought together over one dozen ABMs and Army Air Defense Artillery Fire Control Officers (ADAFCOs) in tabletop and simulated environments to explore synergies between DE and KE systems in a base defense role and to identify gaps HPEM systems are capable of filling.

RDMW most recently executed a DEKE DEUCE playing HEL alongside two KE concepts under development at AFRL's Munitions Directorate (RD) in a similar scenario to the HEL DEUCE. Multiple ABMs, pilots, and WSOs provided excellent inputs on the employment of the DE alongside next generation KE, with a special emphasis on the tactics and missions that the effectors are best suited for both individually and jointly.

Classification: SECRET NOFORN
Working Group: WG13 Power Projection and Strike

60002 - Air-launched Stand-off Weapon (ASW) Modeling Simulation and Analysis (MS&A) Study

Start Date: 6/16/2022	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Kathryn Flynn; Emily Power

Abstract: The Air Force Research Laboratory (AFRL) Aerospace Systems Directorate (AFRL/RQ) and Munitions Directorate (AFRL/RW) have joined together to develop a high speed weapon system concept with technologies from both directorates under the Air-launched Responsive Strike Missile (ARSM) program. Modeling, Simulation, and Analysis (MS&A) is being utilized to identify the key weapon parameters that show military utility for this new concept under the Air-launched Stand-off Weapon (ASW) study. The ASW study, like the ARSM program, is a joint cross-directorate effort with MS&A leads from both RQ and RW. The ASW study is being conducted in two phases. The first phase consists of concurrent parametric analyses at campaign, mission, and engagement levels of modeling to determine the key parameters that have the most impact to success across all three levels. Once these parameters are identified, the technologies needed to achieve the identified parameter requirements will be coordinated across the directorates. In phase II, 3-4 weapon concepts that meet the parameter requirements identified in phase I will be assessed concurrently across campaign, mission, and engagement levels at higher fidelity and higher classification. Concepts of operation (CONOPs) for new weapon concepts for both phases of the ASW study will be informed by government-run tabletop exercises (TTX) or wargames. Finally, the study will be supported by continuous Intel support for scenario development and modeling as part of the Digital Intelligence for Science & Technology (DIST) Initiative. Through this unique approach, the ASW study aims to "flip the script" on traditional modeling and simulation and system engineering practices by starting with high level requirements defined through military utility analysis and steering system design appropriately to meet the identified gaps.

Classification: SECRET NOFORN
Working Group: WG13 Power Projection and Strike

60350 - Air Base Airborne Layered Defense

Start Date: 6/16/2022	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Ethan King; Kathryn Flynn		
Abstract: Over the last few years, the U.S. Air Force has become increasingly interested in Air Base Air Defense (ABAD) to maintain Air Superiority in adverse theaters. By leveraging modern MS&A tools like the Analytical Framework for Simulation, Integration, and Modeling (AFSIM), MySQL, and Python, the Air Force Research Laboratory (AFRL) Munitions Directorate (AFRL/RW) completed an analysis that ranked different combinations of airborne conceptual weapons by return of investment. This presentation will discuss the MS&A tools, the scenario of interest, the conceptual weapons, and the results. Classification: SECRET NOFORN Working Group: WG13 Power Projection and Strike		

WG14 Air Warfare

61269 - The Technical Cooperation Program (TTCP) 2022 Scrum Event Process, Analysis Methodology, and Results

Start Date: 6/14/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Kindra Bane		
Abstract: The Technical Cooperation Program (TTCP) is a five-nation defense innovation network that harnesses science and technology (S&T) in support of the defense and national security of the participant nations. The 2022 TTCP Scrum Event was sponsored by the Aerospace Systems (AER) group with the objective to enhance the military capability of current and future aerospace systems through collaborative research and innovation. This event is a follow-on from the 2019 TTCP Scrum event and was hosted by Defence Science Technology Laboratory (DSTL) at the Portsdown West (PDW) facility in the UK. The primary goal of this effort was to contribute to a shared understanding of the benefits of a Modeling, Simulation, and Analysis (MS&A)-powered wargame-like event. This was a collaborative event exploring CONOPS and evaluating the effectiveness of various concepts in the prosecution of time-sensitive targets within a complex, contested and degraded environment to enable further constructive analysis. This presentation will discuss the resultant simulation environment, provide an overview of the scrum's purpose and composition, provide results/outcomes, and lessons learned from the event. Classification: SECRET//REL TO FVEY Working Group: WG14 Air Warfare		

60563 - AFSIM Surface-to-Air Engagement Analysis Representation Expansion

Start Date: 6/14/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Alaina McHale		
Abstract: Engagement analysis is a critical process in the evaluation of a model from a capability standpoint, but also from a modeling perspective. Robust mission analyses ensure that proper engagement analysis has occurred to help inform and supplement the mission representation. It is important to decompose the evaluation of a system into sets of subsystems to better understand the layered effects of those individual components. A typical surface-to-air missile (SAM) model in AFSIM is generally represented by two major components, the physics and sensor models. The kinematics behind the physics drive the trajectory to a target and the sensor drives how accurately the first is		

done. A modular engagement analysis firing range was created in AFSIM using the Mission environment that not only provides the adaptability to service various models and model types, but also the capability to evaluate a model as a function of its layered components. Typically, weapon event data is recorded from AFSIM and is statistically summarized into two products; the Weapon Engagement Zone (WEZ) and Defended Area (DA). During a recent study, these data representations were adapted to better inform the mission team of the expectations of weapon performance. The additional products created were the Terminal Defended Area and the Hybrid Defended Area. This demonstration will examine the rationale behind needing additional representations of the engagement data, an overview of the Terminal and Hybrid Defended Area plots, as well as the takeaways for the transition from engagement to mission analysis.

Classification: SECRET//REL TO FVEY
Working Group: WG14 Air Warfare

60427 - Not All Real Times Are Created Equal

Start Date: 6/15/2022	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: Richard M. Buchter		

Abstract: Ever wonder why two systems having different performances are both “Real Time”? The simple answer is that the term real time has no metrics associated with it which has allowed things with different performance to be considered the same. Aristotle’s Observation states “One cannot say something is, and is not, in the same respect and at the same time”, which leads to the observation that real time is not useful for acquisition or scientific purposes, for if anything can be real time it fails Aristotle's Observation. Presentation discusses the current definitions of “Real Time” and suggest a method for retaining the term by binning performance to one of four “Real Times” (these being: Best effort; Human speed; Latency hard times; and Machine speeds). This discussion prepares the attendee for a wider discussion of the importance of time and latency reduction methods presented in “Battlefield Wall Street: Lessons Learned From HFT Practices For MDO”.

Classification: UNCLASSIFIED
Working Group: WG14 Air Warfare

60036 - Space Sensitivity Assessments Using Multi-Domain Kill Webs in AFSIM

Start Date: 6/15/2022	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Dr. Jason Reiter		

Abstract: In a collaboration effort between AFRL/RV, AFLCMC/EZJA, and SSDP Enterprise Division, a multidomain kill web was developed in AFSIM to analyze the timing needed for data collection, fusion and transmission of Missile Warning (MW) messages from space-based ISR systems to blue high valued air assets (HVAA) to increase blue survivability. The model analyzed differences between legacy GEO/HEO MW architectures and future proliferated, resilient LEO and MEO MW/MT architectures. The specific sensor capability to detect a threat was evaluated outside of the simulation for model simplicity. The timing from detection, through a SATCOM relay to a ground fusion center and back into theater was evaluated. The amount of time data took to fuse and transmit out was varied for each architecture. Upon receipt of a missile warning message, the blue HVAA aborted mission. For the red threat, an airborne ISR platform was used to cue fighters to the location of the blue HVAA. The red fighters pursued the HVAA given data updates from the ISR platform. The fighters fired upon the HVAA when within an acceptable weapon range and outside the blue defended area. The model was able to show with enough missile warning and short fusion timing,

the survivability of the HVAA was much greater for long range engagements and immediate detections. If MW was not available or the delay was too great, the HVAA would not be able to abort in time or would have to operate further away from the threat which could have additional CONOPS consequences.

Classification: UNCLASSIFIED
Working Group: WG14 Air Warfare

59735 - Polar Operations: Search and Rescue Distributed Table Top Exercise

Start Date: 6/15/2022	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Mr. Michael W. Garrambone, FS; Mr. Matthew Ledwith; Mr. Vince Raska		
Abstract: Our OR group was tasked to look at the highly dangerous and time sensitive mission of Search and Rescue (SAR) in the harsh climates of the Polar Arctic. We were asked to create a scenario of downed pilots in polar night with characteristic weather, complete with vast distances, solar storms, frozen terrain, and the threat of bears and arctic wolves. The mission was of international importance pulling limited resources from diverse rescue centers with unique and varied assets, jurisdictions, and operating procedures. Six new and novel system concepts were provided to the blue and maple planning cells who had minutes to plan and move air, land, and maritime teams into harm's way. The hotwash discussions and material assessments are both interesting and priceless—but don't let the bears get you! Classification: UNCLASSIFIED Working Group: WG14 Air Warfare		

59856 - Exploring Quality Versus Quantity for the Fighters and Drones

Start Date: 6/15/2022	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Dr. Mark A. Gallagher, FS		
Abstract: Consider a future where he Air Force is going to have some expensive, possibly manned systems, and deployed with a squad of low-cost drones. How should the Air Force determine the balance between the limited high-cost control system and the low-cost drones? This presentation uses this issue as an example how to decompose a complex issue into analytic tasks: - Defining the issue with stakeholder values and processes. - Framing the topic with a Venn diagram of significant factors - Relating aspects with a simple diagram - Evaluating tradeoffs with simple models - Proposing final charts to focus analysis Classification: UNCLASSIFIED Working Group: WG14 Air Warfare		

60418 - AFSIM Surface-to-Air Engagement Analysis Tool

Start Date: 6/15/2022	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Christopher Huffman		
Abstract: An understanding of the capabilities of Surface-to-Air shooter systems is essential to model capabilities evaluation and mission simulation planning and results interpretation. A surface-to-air analysis tool was developed as a testbed to observe the effectiveness of a weapon system engaging various airborne targets. The robust nature of the tool allows the user to alter characteristics of the		

target and analyze the effects of speed, altitude, signature, and trajectory on the shooter's ability to engage. The shooter weapon system may be configured to run as a shooting platform only, or as a system with sensing capabilities. The first method provides the kinematic capability of the weapon and the second demonstrates how that capability changes when constrained by that particular systems sensors. Products of the analysis are plots of the Weapon Engagement Zone (WEZ) and Defended Area (DA). The WEZ and DA plots provide maps of weapon performance and quantify the area the system is capable of successfully defending respectively. Utilizing the outputs in combination, the kinematic and system effects of a shooter against a particular target provide insight into model capabilities and inform mission-level results. This briefing will describe the processes, methods of configuration, and the resulting plots with an emphasis on why these results are important in a mission simulation environment.

Classification: UNCLASSIFIED // FOUO
Working Group: WG14 Air Warfare

59854 - Develop and Analysis of a Cost Imposing Strategy

Start Date: 6/15/2022	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: 2d Lt Kevin Cruz; 1st Lt Glen Drumm; 1st Lt Norma Ghanem; Dr. Mark A. Gallagher, FS		
Abstract: We present a systematic approach to identify potential military cost-imposing actions and possible adversary responses. The cost imposition is in terms of budgets and resources over an extended period of time. Hence, the decisions of actions and responses are force mixes and strategies that affect a potential future conflict. The cost imposer takes an initial action, such as deploying an advanced system with new technology, intended to cause the targeted opponent to expend more resources in countering this initiative. We determine the extent of the adversary's response to maintain their overall effectiveness in the projected military campaign. We evaluate the ratio of costs for the adversary response that is sufficient to achieve the original effectiveness over the cost of military actions of imposition; these ratio are the relative cost incurred. Ratios greater than one represent viable cost-imposing actions with higher ratios being better for the cost imposer. Classification: UNCLASSIFIED Working Group: WG14 Air Warfare		

60260 - Air-launched Stand-off Weapon (ASW) Modeling Simulation and Analysis (MS&A) Study

Start Date: 6/15/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Kathryn Flynn; Emily Power		
Abstract: The Air Force Research Laboratory (AFRL) Aerospace Systems Directorate (AFRL/RQ) and Munitions Directorate (AFRL/RW) have joined together to develop a high speed weapon system concept with technologies from both directorates under the Air-launched Responsive Strike Missile (ARSM) program. Modeling, Simulation, and Analysis (MS&A) is being utilized to identify the key weapon parameters that show military utility for this new concept under the Air-launched Stand-off Weapon (ASW) study. The ASW study, like the ARSM program, is a joint cross-directorate effort with MS&A leads from both RQ and RW. The ASW study is being conducted in two phases. The first phase consists of concurrent parametric analyses at campaign, mission, and engagement levels of modeling to determine the key parameters that have the most impact to success across all three levels. Once these parameters are identified, the technologies needed to achieve the identified parameter requirements will be coordinated across the directorates. In phase II, 3-4 weapon concepts that meet the parameter requirements identified in phase I will be assessed concurrently across campaign,		

mission, and engagement levels at higher fidelity and higher classification. Concepts of operation (CONOPs) for new weapon concepts for both phases of the ASW study will be informed by government-run tabletop exercises (TTX) or wargames. Finally, the study will be supported by continuous Intel support for scenario development and modeling as part of the Digital Intelligence for Science & Technology (DIST) Initiative. Through this unique approach, the ASW study aims to "flip the script" on traditional modeling and simulation and system engineering practices by starting with high level requirements defined through military utility analysis and steering system design appropriately to meet the identified gaps.

Classification: SECRET NOFORN
Working Group: WG14 Air Warfare

59797 - Tools and Concepts for M&S-Powered Wargames

Start Date: 6/15/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Mr. Chris R. Linhardt		
Abstract: With the advent of the Warlock capability in AFSIM several novel and very promising use cases for Warlock have surfaced. One of those use cases is the development of M&S-powered wargames to support Tactics, Techniques, and Procedures (TTP) development, mission rehearsal, and operator-in-the-loop mission simulation for new technology concepts as well as legacy systems. Warlock panels (operator user interfaces) are typically more quickly developed than traditional simulation interfaces to enable operator interactions in the simulation. In addition, a number of re-usable widgets are available in the library providing the simulation developer a ready-to-use library of useful interfaces. As a result, the AFSIM community has realized a paradigm shift where a scenario developed to support constructive mission analysis can be used to support virtual mission simulation with little or no modification. Use of Warlock in M&S-powered wargames further inspired the development of the Mission Planning Wizard. This operator user interfaces provides the capability for AFSIM scenario modification to support mission planning tasks by wargame participants with little to no AFSIM experience. This capability can be used as part of the environment for M&S-powered wargames as well as in operator-driven constructive analysis. This presentation will describe Warlock and the Mission Planning Wizard as well as the analysis concepts for M&S-powered wargames and operator-driven constructive analysis. Finally, the presentation will provide example results to illustrate the power of these tools and concepts. Classification: SECRET NOFORN Working Group: WG14 Air Warfare		

61266 - Assessing the Capacity Limit of Concepts in an ABAD Mission

Start Date: 6/15/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Michelle Kulasekera		
Abstract: Title: Assessing the Capacity Limit of Concepts in an ABAD Mission Working Groups: WG-14 Air Warfare Authors: Jamieson Thompson, AFRL/RQSA, jamieson.thompson.1@us.af.mil Dean Baker, AFRL/ RQSA, dean.baker.1@us.af.mil Co-Authors: Michelle Kulasekera, Infoscitex Corporation, michelle.kulasekera.ctr@us.af.mil		

Abstract: Assessment of the number of concepts required to defend an airbase is a critical step in determining promising defense constructs for Airbase Air Defense (ABAD). Due to the necessity of this information, the Expected Kill analytic capability was designed to assess the capacity limit of an individual concept to negate a specific threat type. This capability assesses the capacity limit by utilizing
an overwhelming number of incoming threats. The number of threats that are destroyed will inform the
capacity limit for that concept-target combination. The results of the assessment can then be applied to
inform the quantity of each concept needed for ABAD. This analytical approach utilizes Advanced Framework for Simulation, Integration, and Modeling (AFSIM) to model the components of each system.
This presentations focus will be on AFSIM capability development as well as the application of this tool
at Aerospace Systems Directorate of AFRL.

Classification: SECRET NOFORN
Working Group: WG14 Air Warfare

60597 - HADeRACH: A Multi-Target Routing and Threat Avoidance Tool for AFSIM

Start Date: 6/16/2022	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: Dean Joseph Geisel; Ms. Kristi Bane		
Abstract: The task of creating multiple acceptable routes for an air platform within physical performance limits can be time consuming, especially in a stochastic environment where essential locations may change between simulations. The development of HADeRACH (Heap's Algorithm-based, Deterministic Routing and Avoidance Computation Heuristic) is a solution to this problem. HADeRACH routes an air concept through multiple target points while avoiding threats and remaining within performance bounds. HADeRACH achieves this while only using standard release AFSIM. HADeRACH provides a route and associated data for each permutation of order of targets so that the analyst can make an informed decision on the flight path of their concept. HADeRACH also allows for easily swappable objective functions to allow the analyst to define what "best route" means. I present the process of creating the base algorithm and improving it based on challenges presented by using out-of-the box script methods from AFSIM. I also present the design preferences (in-simulation routing vs. pre-processing routing) and the resultant effect on data collection for analysis. Classification: UNCLASSIFIED // FOUO Working Group: WG14 Air Warfare		

WG15 Health Service Support, Force Health Protection, and Casualty Estimation

59739 - Forecasting Limited Duty Burden on Navy Units

Start Date: 6/14/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Mr. James Young; LT Karl Matlage; Billy Walters		
Abstract: Service members are placed on limited duty (LIMDU) status when they have a temporary medical condition that prevents the full execution of their duties. Personnel placed on LIMDU can		

have a significant impact on readiness at the unit level, as these personnel are typically non-deployable, but are not replaced because of their anticipated return to a fully deployable status. A forecast of future LIMDU levels is needed to allow commanders to anticipate shortfalls and act proactively to address them.

The Navy Bureau of Medicine and Surgery (BUMED) Consolidated Information Center (CIC) has developed a preliminary forecasting methodology for projecting Navy LIMDU levels at the unit level. The forecast integrates data from multiple information systems, including the Medical Readiness Reporting System (MRRS) and the Sailor and Marine Readiness Tracker (SMART). One of the largest challenges to this modeling effort has been validating the accuracy and consistency of data across different DoD systems.

For each active-duty Sailor, a probabilistic forecast of being on LIMDU status in each of the next four months is generated. For Sailors currently on LIMDU at the beginning of the forecast, a probability distribution of their remaining time on LIMDU, conditional on the amount of time they have already spent on LIMDU, is calculated from historic data on Sailors with similar medical conditions. For Sailors not currently on LIMDU, historic data is used to calculate both the probability of being placed on LIMDU each month of the forecast and the anticipated duration of any new LIMDU assignment. This information is combined to produce an expected value forecast of the probability of each member of the Navy being on LIMDU each month.

While this forecast is of little predictive value on the individual level, when aggregated to the unit or command level, it can be used to identify future trends in readiness that may be of interest to commanders. The current implementation relies primarily on empirical data aggregated across the entire active-duty Navy population. However, it provides a framework for future refinement that can account for the impact of demographic factors on the frequency and duration of LIMDU assignment. This presentation will review the forecasting methodology and discuss challenges and lessons learned.

Classification: UNCLASSIFIED
Working Group: WG15 Health Service Support, Force Health Protection, and Casualty Estimation

59741 - Forecasting Navy Total Force Medical Readiness Levels

Start Date: 6/14/2022	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Billy Walters; LT Karl Matlage; Mr. James Young

Abstract: The readiness of individual personnel to deploy greatly impacts the capability of the entire force. The Department of Defense (DoD) requires each service to track the Individual Medical Readiness (IMR) of all service members to determine whether the service member currently meets the medical requirements necessary to be deployed. Personnel are placed in one of four IMR statuses based on criteria in six categories: periodic health assessment (PHA), deployment-limiting medical conditions (LIMDU), dental readiness, immunization status, laboratory studies, and individual medical equipment. Each of these categories can have multiple specific requirements that combine to give the Total Force Medical Readiness (TFMR).

While the Navy tracks and reports current TFMR status, it lacks the capability to forecast future readiness levels. Commanders must react when readiness drops below acceptable thresholds, rather than being able to proactively anticipate upcoming issues and take corrective action. To address this

issue, the Navy Bureau of Medicine and Surgery (BUMED) Consolidated Information Center (CIC) has developed a preliminary forecasting methodology for projecting Navy TFMR levels at the unit level. To develop the individual forecasts, data from at least five disparate DoD medical and readiness information systems must be collected and integrated.

The future probabilities of individuals entering and exiting multiple IMR components (including PHA, dental readiness, and LIMDU) are first forecast individually by building empirical conditional probability distributions based on historical data. Additional regression and machine learning techniques have also been explored and may be integrated into the model as future enhancements. After accounting for dependencies between the IMR components, these individual forecasts are then integrated into an overall TFMR forecast. The current implementation relies primarily on empirical data aggregated across the entire active duty Navy population, or some of the larger Commands. However, it provides a framework for future refinement that can account for the impact of demographic factors on the frequency and duration of various IMR statuses. This presentation will review the forecasting methodology and discuss challenges and lessons learned.

Classification: UNCLASSIFIED
Working Group: WG15 Health Service Support, Force Health Protection, and Casualty Estimation

59753 - Applying Machine Learning Algorithms to Predict Active Duty Coast Guard Service Member Retention Among Members Seeking Outpatient Mental and Behavioral Healthcare

Start Date: 6/14/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Mr John Gary Allen		

Abstract: Mental and behavioral conditions can impact fitness for duty and reduce active duty service member retention. From 2014-2019, more than 10,000 active duty Coast Guard service members (ADCG) made 176,000 visits to Department of Defense and TRICARE Network mental and behavioral health services providers. This analysis sought to identify demographic and career factors and groups of mental and behavioral diagnoses among ADCG that were predictive of discharge before completion of obligated service. Six machine learning algorithms were applied to data (obtained from the DHA-maintained M2 database) on ADCG who sought outpatient mental and behavioral healthcare in 2016. Findings from this analysis demonstrated 26.4 of every 1,000 members who sought mental and behavioral health services did not complete their service obligation within four years. Three of the six machine learning algorithms applied to the data sets-logistic regression, bagging classifier and decision tree classifier- were predictive of discharge before completion of obligated service. Among these models, the best performing was logistic regression. Approximately one out of forty active duty Coast Guard members who sought mental or behavioral health care left the service prematurely, representing a large burden of attrition for a relatively small military service. Predictive analyses such as this one can be used to better target efforts needed to improve service member retention.

Classification: UNCLASSIFIED
Working Group: WG15 Health Service Support, Force Health Protection, and Casualty Estimation

59836 - The Medical Requirements Capability and Logistics (MRCL) Model: A High-Resolution Model of Patient Care on a Role 2E Afloat MTF

Start Date: 6/15/2022	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Ranny Maurer; Abbie Jane Merkl		

Abstract: The Medical Resource Capabilities and Logistics (MRCL) model is a high-resolution representation of a military Role 2 Enhanced (2E) medical treatment facility (MTF) built in a commercial off-the-shelf simulation package by the Naval Health Research Center and Teledyne Brown Engineering. MRCL is designed to provide an accurate representation of an afloat Role 2E capability and lend insight into how staffing, facility capacity, and medical allowance lists impact patient care timelines and events. MRCL output will help decision makers understand the sensitivities of resources required to maximize the facility's capabilities.
MRCL is a data-driven model that accepts a custom patient stream from the Joint Medical Planning Tool and follows each patient from arrival to departure, while cataloging tasks performed, providers, equipment and supplies employed, and dynamic patient routing and care decisions made during the simulation. MRCL integrates blood modeling and lab work capabilities with the patient care profiles for a wide-angle look at the Role 2E MTF's needs.
This presentation will include a discussion of the features and development process, and an MRCL model demonstration.

Classification: UNCLASSIFIED
Working Group: WG15 Health Service Support, Force Health Protection, and Casualty Estimation

60525 - Evaluation of Long-Term Health Effects from Acute Exposure to Toxic Chemicals

Start Date: 6/15/2022	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Ms. Theresa Pennington

Abstract: Since 2016, the Chemical Security Analysis Center of the Department of Homeland Security Science and Technology Directorate and the Army Public Health Center (APHC) have partnered to develop guidelines for acute exposure to chemicals of concern resulting in chronic effects. The Acute Exposure/Chronic Effect (AECE) project utilizes a toxic syndrome (i.e., toxidrome) based approach where the likelihood of long-term health outcomes are evaluated as a function of the acute exposure level (mild, moderate, severe, life-threatening). Six toxidromes (Cholinergics, Blood, Opioid, Irritant/Corrosive – Upper Pulmonary, Irritant/Corrosive – Lower Pulmonary, and Vesicants) have been completed and three toxidromes are planned for FY22-23 (Convulsant, Hemolytics, Metabolic). Collecting data based on a toxidrome rather than a single chemical addresses the issue of sparse data, as findings made for a toxidrome can be leveraged for any chemical in that toxidrome. The supporting assumption for this generalization is that chemicals in the same toxidrome elicit similar acute effects, and that long-term health effects can be estimated based on the extent of the injury demonstrated by acute effects. This project utilizes Subject Matter Experts (SMEs) and peer reviewed journal articles to identify the acute exposure symptoms, which are categorized by health effect severity. SMEs then identify potential long-term symptoms which are separately categorized by health effect. Then the probability of a long-term health effect based on each level of acute exposure can be elucidated by the SMEs and combined into a single probability for each acute exposure level. These effect probabilities are combined with acute effect dose-response estimates to yield long-term health effect curves for each chemical in the toxidrome. APHC will utilize these calculations to expand on the military exposure guidelines (MEGs). Currently, MEGs only consider the acute effects of acute exposures despite documented evidence that acute exposures can lead to long-term effects. Such evidence includes incidences with military relevance, such as exposure to mustard agents during World War I and sarin attacks in Syria from 2012 until present day. Better knowledge of how an acute exposure can lead to long-term effects allows for better military planning, as long-term effects could manifest during the course of a deployment in ways that would impact operational readiness. The

CSAC will apply these values to modeling potential harm to civilian populations to inform the Homeland Security Enterprise (HSE).

Classification: UNCLASSIFIED
Working Group: WG15 Health Service Support, Force Health Protection, and Casualty Estimation

59624 - Using Survival Analysis to Assess the Impact of Musculoskeletal Injuries on Military Discharge Among U.S. Navy Enlisted Personnel

Start Date: 6/15/2022	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Mr. Trevor Alan Elkins; Andrew MacGregor; Mr. James M. Zouris

Abstract: Musculoskeletal (MSK) injuries are ubiquitous in the U.S. Armed Forces. As the leading cause of treatment-seeking and disability across all military service branches, MSK injuries pose a substantial threat to operational readiness, and are reported as a major concern for the Department of Defense. Little is known regarding the impact of specific MSK injuries on overall military retention, as measured by discharge, which could highlight potential areas for refinement of clinical care and injury rehabilitation. A retrospective analysis was performed using personnel and medical databases to investigate whether certain MSK injuries lead to earlier discharge from the military. U.S. Navy personnel enlisting for service between January 2003 and December 2013 (n = 434,917) comprised the study population. Military discharge data through 2018 was abstracted from administrative information maintained by the Defense Manpower Data Center, and the overall discharge rate was 69.8% (n = 303,752 / 434,917). Records were cross-referenced with the Military Health System Medical Data Repository to acquire inpatient and outpatient health encounters. The Barell Injury Diagnosis Matrix will be used to categorize medical data into MSK injury categories, specifically fractures, dislocations, and sprains/strains, and analyses will be conducted by body region (e.g., foot/ankle, spine/back, shoulder). A survival analysis methodology using Kaplan-Meier survival curves and log-rank statistical tests will examine the impact of MSK injuries on time to military discharge. Results from this study will identify MSK injuries with the greatest impact on staffing loss, which may lead to improvements in clinical management of these injuries. Mitigating the effects of MSK injuries is of strategic importance as the military plans for future operations, as it will further build military readiness and maximize a fit and capable force.

Classification: UNCLASSIFIED
Working Group: WG15 Health Service Support, Force Health Protection, and Casualty Estimation

59589 - Requirements for the Implementation of COVID-19 Control Measures Given Prevailing Rates of Vaccine Compliance

Start Date: 6/15/2022	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Mr Robert Cubeta

Abstract: In this presentation, we describe our analytical approach to determining the requirements and opportunities for using various measures to control outbreaks of COVID-19, assuming the primary objective is to reduce the average number of infections caused by a contagious individual in any given outbreak (R) to below one. We establish relationships between a set of parameters describing characteristics of both disease and response measures, from which we are able to determine the circumstances in which outbreak control measures could be effective. In particular, we explore how the requirements for various control measures, such as isolation and quarantine, can vary given different rates of vaccine compliance in a population.

We begin by developing a profile of mean individual COVID-19 transmission over time that accounts for both pre-symptomatic and asymptomatic transmission. We then use that profile to determine the point in time, relative to both exposure and mean symptom onset, when an individual would, on average, transmit COVID-19 to one other person. Next, we assess the requirements for implementing control measures such that they would, collectively and on average, stop transmission at or before that point in time. We consider a layered approach, beginning with vaccination and adding isolation, triggered by either symptom onset or as a result of diagnostic testing, and finally quarantine.
Our work shows that COVID-19 outbreaks cannot be controlled solely through isolation of symptomatic individuals, given the high transmissibility of COVID-19 combined with asymptomatic and pre-symptomatic transmission. Vaccines can overcome this challenge if they are sufficiently effective, and if compliance rates are sufficiently high. Yet if vaccine compliance rates remain low in certain regions, or if the effectiveness of vaccines is compromised by the emergence of variants, transmission of COVID-19 may continue or even increase. Should that be the case, our assessment shows that—assuming prompt isolation of symptomatic individuals continues—implementation of quarantine and/or population-wide diagnostic testing can cause an outbreak to wane. While more burdensome than vaccination and isolation, these measures can be effective if limited to quarantine of readily identifiable household contacts, or screening tests administered weekly. Screening in particular may avoid the disruption that comes from quarantine and other forms of restriction of movement.

Classification: UNCLASSIFIED
Working Group: WG15 Health Service Support, Force Health Protection, and Casualty Estimation

59685 - The Derivation of Disease and Nonbattle Injury Rates for Medical Planning During Combat Operations in Iraq and Afghanistan

Start Date: 6/15/2022	Start Time: 11:30 AM	End Time: 12:00 PM

Authors: Mr. James M. Zouris; Mr. Edwin William D'Souza; Mr. Trevor Alan Elkins; Abbie Jane Merkl

Abstract: As a result of the advances in electronically captured medical data during the combat operations in Iraq and Afghanistan, casualty rate estimation can be achieved with a great deal of precision. The Theater Medical Data Store has electronically captured over 8 million records of patient encounters from overseas contingency operations. These encounters include everything from vaccinations, medication refills, follow-up visits, sick-call visits, disease encounters, and nonbattle and battle injuries for both forces ashore and afloat. Over 99% of these encounters are disease and nonbattle injuries (DNBIs). Typically, DNBI encounters do not require the same medical resources as battle injuries; however, due to the sheer volume of patient encounters, they are the leading cause of morbidity during conflicts and military operations. For medical planning, development of enhanced DNBI predictive models are required based on the patient condition code, type of deployment, location of deployment, duration of deployment, troops types, and command elements. The Medical Planners' Toolkit (MPTk) was included in Joint Publication 4-02 Joint Health Services as an approved means for casualty estimation and calculating health services requirements. MPTk is an approved and accredited suite of casualty estimation tools used by combatant commanders and military planners. Most recently, the Office of the Joint Staff Surgeon requested Naval Health Research Center provide updated DNBI rates in MPTk for both ground and afloat forces. The objective of this study will be a retrospective analysis of the recent ground force DNBI rates compared with the baseline DNBI rates incorporated in MPTk. DNBI rates are calculated by selecting representative units stratified by service, operation, command elements, deployment year, and duration of deployment.

Disclaimer: I am a military service member or employee of the U.S. Government. This work was prepared as part of my official duties. Title 17, U.S.C. §105 provides that copyright protection under this title is not available for any work of the U.S. Government. Title 17, U.S.C. §101 defines a U.S. Government work as work prepared by a military service member or employee of the U.S. Government as part of that person's official duties. This work was supported by the Joint Operational Medical Information Systems (JOMIS) Program Office under work unit no. N1214. The views expressed in this article are those of the authors and do not necessarily reflect the official policy or position of the Department of the Navy, Department of Defense, nor the U.S. Government. The study protocol was approved by the Naval Health Research Center Institutional Review Board in compliance with all applicable Federal regulations governing the protection of human subjects. Research data were derived from an approved Naval Health Research Center Institutional Review Board protocol, number NHRC.2006.0012.

Classification: UNCLASSIFIED
Working Group: WG15 Health Service Support, Force Health Protection, and Casualty Estimation

59792 - Daily Critical Care Air Transport Team Estimator

Start Date: 6/15/2022	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Andrew Gravel; Abbie Jane Merkl

Abstract: Daily Critical Care Air Transport Team Estimator
Andrew Gravel1,2; LT Abbie Merkl2
1Teledyne Brown Engineering, Huntsville, AL; 2Naval Health Research Center, San Diego, CA

Abstract
A Critical Care Air Transport Team (CCATT) is required to care for patients as they evacuate from intensive care units at a theater medical treatment facility. Accurate ventilator estimates are critical considerations for medical planning. The Joint Medical Planning Tool (JMPT), which is a discrete-event simulation software that models the treatment of casualties from point of injury through more definitive care, has a treatment task to put a patient on a ventilator when necessary. However, there is no task to take them off the ventilator, and JMPT does not report how many ventilators are in use. In response to this deficit, the Daily CCATT Estimator was developed to estimate the number of evacuating casualties requiring CCATT per day and to track the number of evacuees that need ventilation.
The Daily CCATT Estimator was developed in Microsoft Excel and uses patient-code-specific ventilation requirement data developed by the Naval Health Research Center. For all 410 patient codes modeled in JMPT, data on the approximate length of time each patient would spend on a ventilator were developed for the estimator.
The tool uses output from a JMPT scenario in the form of casualties flowing through Role 3 facilities and estimates the overall ventilation requirement. The results are stored in a separate sheet that lists total evacuations and evacuations requiring ventilation per day at each medical facility. This output can then be used by medical planners to approximate the number of ventilators required to support various size patient streams. This presentation will review model functionality and output, and highlight the benefit of tracking ventilation requirements in theater.

Classification: UNCLASSIFIED
Working Group: WG15 Health Service Support, Force Health Protection, and Casualty Estimation

60121 - Medical Planners' Toolkit Demonstration

Start Date: 6/15/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Patrick Andrew Givens; CDR Kevin Patrick McMullen		
Abstract: Effective military medical planning relies on four interrelated capabilities: (1) the ability to generate daily casualty estimates for a scenario, (2) the ability to accurately estimate the distribution of specific illnesses and injuries that comprise a casualty population, (3) the ability to estimate the medical resources necessary to support the theater hospitalization requirements of an operation, and (4) the ability to estimate the consumption of Class VIII medical supplies. The Medical Planners' Toolkit (MPTk) is an accredited Department of Defense medical planning and programming tool developed by the Naval Health Research Center that enables medical planners to perform each of these functions in an integrated environment. This presentation will feature a live demonstration of the software to showcase its capabilities in support of military medical planning and analysis. It will highlight a typical workflow, perform each of the above functions for a single notional operation, and generate outputs compatible with other planning and analysis tools. The demonstration will highlight new features and improvements in the latest MPTk version. Current software limitations and planned future enhancements will also be discussed. Classification: UNCLASSIFIED Working Group: WG15 Health Service Support, Force Health Protection, and Casualty Estimation		

59727 - Joint Medical Planning Tool Demonstration

Start Date: 6/15/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Mr. Christopher Guida; CDR Kevin Patrick McMullen		
Abstract: The Joint Medical Planning Tool (JMPT) was accredited for Department of Defense (DoD) medical planning, operational risk assessments, and theater medical course of action assessments by the Force Health Protection Integration Council in 2012. Since that initial accreditation, JMPT has been the primary modeling and simulation tool supporting medical planning in a variety of DoD settings. The model is operational at the Combatant Commands to facilitate the development of medical requirements. JMPT output has augmented wargaming efforts conducted by the Marine Corps Warfighting Laboratory and the Navy Warfare Development Command, and regularly supports ongoing studies and analyses for various DoD organizations. This presentation will feature a live model demonstration to facilitate awareness among the medical analysis community and solicit feedback from other analysts. The demonstration will briefly cover basic software operations, high-level model features, key assumptions and limitations, and model output. Recently added features and planned future enhancements will also be discussed. Classification: UNCLASSIFIED Working Group: WG15 Health Service Support, Force Health Protection, and Casualty Estimation		

60089 - Mild Effects Estimates for PC Liquid Exposures to Nerve Agents for Use in Evaluating Protective Equipment

Start Date: 6/16/2022	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: Mr. Douglas R. Sommerville		
Abstract: Updated human proxy mild effect dose–response-probability (DR-P) curves were derived for percutaneous (PC) liquid exposures to several nerve agents. In the absence of any observable mild clinical signs, acetylcholinesterase (AChE) inhibition was chosen as the proxy because it is the first		

known health-based effect. The dose–response (DR) curves are needed for modeling and requirements purposes, which were not addressed in previously derived values for laboratory safety. A new statistical method, tolerance interval derived dose–response curves (TIDRC), was used to convert minipig intravenous (IV) AChE inhibition dose–response severity (DR-S) curves (fitted via a four-parameter logistic (4PL) equation) into DR-P curves for specific AChE inhibition levels. The resulting minipig IV DR-P curves were converted to a human basis via an updated allometric model fit of existing mammalian nerve agent IV lethality data. Ratios of minipig PC and IV median effective doses (ED50 values) (either sub-lethal or lethal) were calculated and then used to derive human PC ED50 values for 20, 50, and 80% AChE inhibition levels. To complete the DR-P curves, the previously derived probit slope for human VX PC liquid AChE inhibition was assumed to be appropriate for all nerve agent exposures.

Classification: UNCLASSIFIED // FOUO
Working Group: WG15 Health Service Support, Force Health Protection, and Casualty Estimation

59676 - People and Platforms: The Medically Equipped Surface Connector Model

Start Date: 6/16/2022	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Dr. Gregory Reed; Jonathan Davis; CDR Kevin Patrick McMullen		

Abstract: The Navy has invested in medically equipping Expeditionary Fast Transport (T-EPF) ships to deliver Damage Control Resuscitation and Surgery in forward vessels during Distributed Maritime Operations. These vessels function as both patient movement platforms and medical facilities, providing far-forward interventions and keeping patients stable during transit to a hospitalization capability. Although these vessels have some medical capability, patients often ultimately require hospitalization upon arrival.

The Naval Health Research Center (NHRC) has developed the Medically Equipped Surface Connector (MESC) model to facilitate trade analyses on T-EPF inventory, laydown, and medical capabilities. MESC uses discrete-event simulation to schedule adverse events, patient transfers, deaths, and treatments. Vessel entities in the simulation use A* pathfinding and authoritative bathymetry data to navigate around land masses and avoid user-specified “no-go” areas. This navigation component is crucial in assessing the amount of medical capability provided by a particular T-EPF laydown because travel time—toward downed vessels to retrieve patients and to hospital facilities for escalated care—has a significant impact on patient time to care and survivability. This is especially important in environments taking place in island chains, as a straight-line distance approximation may severely underestimate travel time.

NHRC has used MESC to analyze several real-world scenarios and excursions to determine, for example, the efficacy of embedded medical care T-EPFs versus relying on logistics vessels that may incidentally be able to pick up and transport patients. Time to first care is an especially important metric, and it has been the focus of most analyses that use MESC. Results of these analyses have indicated that embedded medical support is crucial for best time to care.

Classification: UNCLASSIFIED
Working Group: WG15 Health Service Support, Force Health Protection, and Casualty Estimation

60085 - What is Left After the Dust has Cleared?—Final Human Toxicity Estimates for the Classical Agents in the Wake of the ECBC Low-Level Toxicology Program and Related Efforts (1998-2008)

Start Date: 6/16/2022	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Mr. Douglas R. Sommerville		

Abstract: When the US Army Field Manual (FM) 3-11.9 (2005) was published, human chemical warfare (CW) agent toxicity estimates were still being re-evaluated because of the on-going Edgewood Chemical Biological Center (ECBC) Low-Level Toxicology Program (1998 to 2008). The FM suffered from not having the data subsequent to about 2003 available. A technical manual (TM) was published in 2017 which included updated toxicity material (other related subject material). However, the TM does not explicitly state the parameters required for defining the dose-response curve (DRC) for toxicity estimates (ex. median effective dose, probit slope and toxic load exponent (TLE) (for inhalation (IH) exposures)). Instead, the TM presents time—concentration profiles for the various agents. Thus, this TM is not user-friendly for operators of transport and dispersion models and related applications.

In response to the TM update, several ECBC authors decided to include in a book chapter on CW agent toxicology (Hulet et al., 2019) their recommendations for updates of FM 3-11.9 (2005)'s human CW agent IH/ocular (OC) toxicity estimates, the agents addressed being GA, GB, GD, GF, VX, mustard, phosgene, and chlorine. The chapter included the proper DRC parameter values for mild and severe effects and lethality—all based on the total state of knowledge upon the conclusion of the Low-Level Program. The estimates are for both the healthy human subpopulation (SP) and the general population. FM 3-11.9 only had addressed the healthy SP. In addition, the talk will present updated DRC parameter values for World War I era CW agents not originally addressed by Hulet et al.: arsine, cyanogen chloride and hydrogen cyanide.

This talk will review the toxicity estimates of Hulet et al. (2019), as well as the general history of and basic philosophy behind the development of these estimates from the data generated by the Low-Level Program and other sources. The Department of Defense (DoD) had started the Low-Level Program in response to the recommendations of Reutter-Wade (1994)(as cited by Bakshi (1997)). The pre-1994 toxicity estimates were a product of an offensive CW mindset (from when the US had an offensive CW agent program), with an emphasis on short exposure durations and the need to incapacitate the most resistant individual as quickly as possible. With the new defensive CW mindset, Reutter-Wade had recommended updating the human toxicity estimates since the emphasis had changed. DoD needed estimates appropriate for defending the average to most sensitive individual, which involved exposure to lower agent concentrations over longer durations. Such estimates were the final product of the Low-Level Program.

Classification: UNCLASSIFIED
Working Group: WG15 Health Service Support, Force Health Protection, and Casualty Estimation

59793 - Improving Characterization and Modeling of Combat Casualty Morbidity and Medical Resource Needs over Time in Prolonged Care Scenarios

Start Date: 6/16/2022	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: LCDR Karl Matlage; Francisco Jose Aldarondo Valle, PhD; Andrew Olson; Donald Richardson; Jamie Yannayon

Abstract: Casualty morbidity (CM) modeling and simulation (M&S) is designed to estimate how in-theater casualties progress to outcomes of return to duty (RTD), survival with complications, and mortality rates. This capability allows for testing various scenarios to understand the likelihood that casualties will survive and RTD based on medical resource investment in the battlespace. Military medicine has a critical need to more accurately understand how limited patient movement in anticipated combat casualty care environments affect patient outcomes. By incorporating the effects of morbidity over time, greater insight will be gained on casualty survival and in-theater RTD outcomes in simulated scenarios leveraged by military medical and combat planners.

The CM model employed a Markov decision process technique with condition states verified by subject matter experts. This study focused on a small sample of relatively high incidence, life-threatening clinical condition groups – mapping the possible pathophysiology from point of injury, through a variety of possible subsequent clinical conditions, until reaching a final outcome. A key innovation in the CM model is the incorporation of time-driven characterization of casualty health status, instead of a purely event-driven (static) characterization.

Study results showed improved stratification fidelity of modeling existing doctrinal combat casualty outcome metrics (e.g., died of wounds rates by complications) and identified new casualty metrics not available in existing modeling tools (e.g., injury progression pathways and complication rates). The model quantified in-theater RTD delay due to secondary injury effects, and dependence of mortality and in-theater RTD rates on medical resource levels because casualties surviving austere prolonged care are at higher risk for complications. This new approach enabled analysis of complications secondary to delayed or austere prolonged care treatment due to theater resource limitations, providing valuable data to inform medical resource planning. A future opportunity to apply CM modeling includes trade-off analysis for impact of medical resource investment in the battlespace compared to other combat resources.

Classification: UNCLASSIFIED
Working Group: WG15 Health Service Support, Force Health Protection, and Casualty Estimation

60077 - Best Practices for Evaluating the Readiness of Technology Could Benefit DHS Efforts to Pursue Innovative Approach to Biodetection

Start Date: 6/16/2022	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Mr. John Mendez Ortiz, Jr

Abstract: In response to the 2001 anthrax attack, the Department of Homeland Security (DHS) started the BioWatch program—designed to provide early indication of an aerosolized biological weapon attack to prevent casualties on a mass scale. The Countering Weapons of Mass Destruction (CWMD) was established within DHS to protect against the dangers posed by hostile state and non-state actors who seek to acquire and use nuclear, chemical, radiological or biological materials in the form of weapons of mass destruction to harm Americans or U.S. interests. Since BioWatch's inception, DHS has pursued enhancements and replacements but without much success. Having a robust biodetection capability is a critical component of the National Biodefense Strategy. However, essential technologies needed to provide early detection have inherent limitations. DHS has proposed the use of a new and novel capability through artificial intelligence / machine learning technology that, if successfully developed, could be an improvement over the existing system. The Government Accountability Office (GAO) evaluated BD-21 technology readiness approach and made several recommendations to improve technology readiness assessments across the agency and for the BD-21 acquisition.

GAO is an independent, nonpartisan agency serving the Congress by helping to improve performance and ensure accountability in the federal government. To this end, GAO has developed a Technology Readiness Assessment Guide (GAO-20-48G) to provide a better understanding of technology maturity and a framework for conducting high-quality TRAs. GAO's TRA guide establishes a methodology for evaluating critical technologies, such as those being proposed by DHS, based on best practices that

can be used across the federal government to determine a project's readiness to move past key decision points that typically coincide with major commitments of resources.

Classification: UNCLASSIFIED
Working Group: WG15 Health Service Support, Force Health Protection, and Casualty Estimation

59821 - Knowledge Management Capability for Navy Medicine Consolidated Information Center

Start Date: 6/16/2022	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Dr. Brad Randall Atkinson; LCDR Karl Matlage; Kevin Parker		

Abstract: Knowledge Management Capability for Navy Medicine Consolidated Information Center
Kevin Parker, M.A. PMP1; Brad Atkinson, DBA1; LCDR Karl Matlage2
1Teledyne Brown Engineering, Huntsville, AL; 2Navy Bureau of Medicine and Surgery, Falls Church, VA

Abstract
The Navy Bureau of Medicine and Surgery (BUMED) Consolidated Information Center (CIC) currently does not have an organized system to store, organize, catalogue, and share their current and historical knowledge product files. These knowledge products consist of studies, work products, working papers, and data sets on a wide variety of topics. They are in a variety of formats: PDF, Word, Excel, PowerPoint, text, and csv. They are currently stored in an ownership-based flat file structure on a network shared drive, making finding and accessing information difficult. The universe of knowledge products is not published; the products are not easily searchable, not labeled for content, not available to all necessary users, and not properly protected from change and/or deletion. As part of a strategic Cloud Data Architecture Framework initiative, BUMED CIC is implementing a cloud-based Knowledge Management (KM) capability that stores knowledge products in a secure cloud environment. It enables rich, context-based searches; tagging of documents by owner, use, subject, etc.; searching by key document meta-data; and role-based access controls with a robust user management interface. The capability uses an intuitive web-based user interface in a scalable platform. It will modernize the ability to locate and utilize information from a large and disparate collection of unstructured data. The KM capability will innovate the process of answering leadership questions with that information, enhancing the effectiveness of decision-support, and fostering the cultural shift toward a more data-centric organization.

Classification: UNCLASSIFIED
Working Group: WG15 Health Service Support, Force Health Protection, and Casualty Estimation

WG16 Strategic Deployment and Distribution

60081 - Improving the Early Deployer Time-Phased Force and Deployment Data (TPFDD) Analysis Process

Start Date: 6/14/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Danford Smith; Mr. Christopher Lynn Hopkins		

Abstract: As part of the Total Army Analysis (TAA), the Army must determine an acceptable mix of Army Active Component and Reserve Component units. To help inform these decisions, the Early Deployer TPFDD Analysis identifies early deploying unit types required in combatant commanders' operation plans and translates these into the TAA baseline future force structure designs. These translated unit demands are portrayed both in terms of timing of demand and absolute quantity of demand by unit type. The Center for Army Analysis is examining methodologies to improve the Early

Deployer TPFDD Analysis process to better analyze different combatant commander TPFDD formats and develop a user interface for the analysis conducted in the Microsoft database.

This presentation will describe the techniques and tools used to improve the Early Deployer TPFDD Analysis and provide lessons learned. We hope to inform and solicit feedback from those interested in TPFDD analysis.

Classification: UNCLASSIFIED
Working Group: WG16 Strategic Deployment and Distribution

60228 - Logistics Modeling Suite-Combat Logistics from the Fighting Base to Theater

Start Date: 6/14/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Lawrence C Parthum		

Abstract: What if the Air Force had a suite of models that enabled us to quickly examine the feasibility and capability of a set of bases to meet the logistics requirements of the operational demand for an OPLAN or future scenario? The goal would be to model from the individual base to an interactive theater-wide capability. The Combat Logistics Branch of SAF/SAW has been working on this for several years and we're getting very close. We're developing one model that evaluates the airfield infrastructure before attack, matching the capacity of runway, ramps, fuel support, and other infrastructure to the desired mission set of type and number of aircraft. A second model then evaluates what we'd need to send to that location to open and generate the sorties. It sends that evaluation to the Mobility modelers to examine the movement requirements. A third model, really a connected suite of models, examines the degradation after the enemy attacks and what recovery would look like. We're partnering with other Air Force analysis agencies and their models so to look at what it takes to get theater movement of re-supply and sustainment all the way back to the enterprise requirements. Ambitious? Yes, but it's a worthwhile challenge.

Classification: UNCLASSIFIED
Working Group: WG16 Strategic Deployment and Distribution

60301 - Telling Stories with Data- Operation Allies Refuge

Start Date: 6/14/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: MAJ Brian Harris		

Abstract: In the midst of Operation Allies Refuge, Air Force Air Mobility Command requested help visualizing operational data to tell the story around the approximately 9k missions flown by the command. Using Tableau Prep to clean and shape the data and Tableau Desktop to visualize the team was able to develop a 2 minute "playback" of the operation suitable for senior leaders to use in talk tracks and presentations. This presentation will cover the techniques used and lessons learned.

Classification: UNCLASSIFIED
Working Group: WG16 Strategic Deployment and Distribution

59833 - Modeling and Simulation of Mobility Challenges – Development of Logistically Feasible Force Flow (LF3) for JFOS Scenario 2.2040

Start Date: 6/15/2022	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Jason R Logsdon		

Abstract: (U) Problem Statement. The campaign plan for the JFOS Scenario 2.2040 requires the delivery and sustainment of a large, dispersed force operating in areas without an interconnected Ground-Lines-Of-Communication (GLOC) network for maneuvering and sustaining the force. The scenario contemplates a significant strategic maneuver of forces that blurs the lines between strategic mobility movement and tactical maneuvers supporting combat employment. Determine the physical capabilities of the mobility enterprise for conducting and supporting the JFOS scenario deployment and employment of forces and identify the potential mobility Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, Facilities and Policies (DOTMLPF P) changes that may be required allow the mobility enterprise to adapt to changing strategic roles and requirements.

(U) The Joint Force Operating Scenario 2.2040 depicts a campaign-level, concept of operations (CONOPS) where the United States builds and leverages Allies and Partners to deter and defeat a peer threat. The scenario development leveraged previous scenario efforts to generate a baseline concept, and a distributed operational planning team (OPT) to provide the detail and fidelity of a broad regional scenario.

(U) The design of the employment of forces started prior to (required) in-depth analysis of the logistically feasible force flow (LF3). A Logistics Working Group (LWG) was started to collect the joint force deployment and sustainment requirements implied by the desired CONOPs of the JFOS 2.2040 scenario. In addition to gathering the data and information, the LWG developed a Logistically Feasible Force Flow (LF3) analysis using modeling and simulation techniques to determine whether the mobility system could meet the deployment, strategic maneuver, and sustainment requirements.

(U) The mobility and logistics challenges inherent to the JFOS 2.2040 CONOPS are a web of interdependencies that required modeling and simulation to fully understand and assess the demands and capabilities of the mobility enterprise. Further, modeling and simulation, along with tangential analysis identified gaps in our current doctrine and programmed forces that would need to be satisfied to employ the mobility enterprise as contemplated in the JFOS 2.2040 scenario. The LWG identified the required changes to the mobility Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, Facilities and Policies (DOTMLPF P) necessary to perform the non-traditional expectations of the mobility enterprise implied by the CONOPs.

(U) The proposed presentation demonstrates the methodology and approach to creating the LF3, and highlights the identified changes to DOTMLPF-P that would be required to employ strategic mobility assets in order to meet the maneuver requirements implied by the JFOS 2.2040 CONOPS.

Classification: SECRET NOFORN
Working Group: WG16 Strategic Deployment and Distribution

59748 - Agile Combat Employment Assessment

Start Date: 6/15/2022	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Ms Susan Swink		
Abstract: Agile Combat Employment (ACE) is “a proactive and reactive operational scheme of maneuver executed within threat timelines to increase survivability while generating combat power throughout the integrated deterrence continuum.” A critical component for the Pacific Air Forces (PACAF), the ACE concept enables Air Operations to project power across the Pacific theater with a		

lean and mobile force. ACE is an evolving concept which requires a flexible assessment methodology to inform key doctrinal and implementation decisions. To illustrate the ACE assessment process, this presentation will show attendees how PACAF has assessed the early stages of ACE from concept development to recommendations.

Classification: SECRET NOFORN
Working Group: WG16 Strategic Deployment and Distribution

60377 - Optimization Modeling to Assess Sustainment in Theater

Start Date: 6/15/2022	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Dr. Omer Alper; Leon CUI; Dr. Matthew Grund

Abstract: Prior naval logistics requirement analyses have typically taken stove-piped perspectives: they have not considered interactions and trade-offs across the logistics enterprise. Such enterprise-level trade-offs inform choices about the overall mix of transport assets, developing new transport capabilities or divesting of old ones, how to structure the distribution network, and how much inventory combatants should hold. To analyze the effects of these decisions on combat effectiveness and cost, we developed the Constrained Optimization for Assessing Sustainment in Theater (COAST) model and open-source software tool. The COAST model takes user-specified scenario input and identifies wartime logistics solutions that maximize combatants' time on station for a given logistics transport fleet and network of available supply nodes. It can also inform future force planning by identifying the mix of transport assets and the frequency and size of deliveries that meet combatants' future required time on station cost-effectively. The COAST model accounts for the procurement and operating costs of the transport fleet, the holding costs of replenishment item inventories, and potential attrition costs. We present hypothetical scenarios that illustrate the flexibility of the model and highlight the trade-offs it is intended to capture, as well as the potential gains from adopting an enterprise perspective.

Classification: UNCLASSIFIED // FOUO
Working Group: WG16 Strategic Deployment and Distribution

60091 - Stochastic Optimization for Military Transportation Logistics Under Uncertainty

Start Date: 6/15/2022	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Thomas Karnezos; Jonathan Celaya; Deanne McPherson

Abstract: Mission-Level Optimization (MLO) for the military often involves the utilization/allocation of large numbers of platforms and payloads of varying types to achieve warfighting objectives. The current practice for addressing the logistical challenges in these types of problems relies primarily on either deterministic mathematical programming models, such as Mixed Integer Linear Programming (MILP), or simulation models, such as Monte Carlo analysis of a Discrete Event Simulation (DES). The advantage of mathematical programming models is that they can quantify the optimality of solutions, but they require all aspects of the modeled scenario to be known a priori as inputs. As a result, deterministic mathematical programming cannot model uncertainties, such as platform attrition, which are important to consider in combat scenarios. On the other hand, simulation techniques have the advantage that they can account for uncertainty, but the immense solution space of complex missions is often too large to use simulation techniques efficiently to guarantee an optimal allocation of resources. Stochastic programming (SP) leverages advantages of both techniques by incorporating uncertain mission-level elements while preserving the ability to quantify the optimality of results. However, SP is computationally intensive, limiting its presence in the current MLO literature. With

ongoing advances in computing power and improvements in solution algorithms, SP may now be a viable tool for MLO. To investigate the utility of SP in MLO, this study developed and executed a small SP model in the context of a Naval resource allocation mission occurring over multiple time periods. Sources of uncertainty taken into account include the possibility that exact resource requirements may only become known partway through the mission, as well as potential platform malfunctions or attrition on route to their destinations. Computational results and comparisons to deterministic optimization models were obtained to illustrate the effectiveness of SP as a mission-level modeling tool. Algorithms to reduce model solution time and extensions to a larger, more realistic mission were also explored.

Classification: UNCLASSIFIED
Working Group: WG16 Strategic Deployment and Distribution

61305 - Contested Sustainment Wargaming and Modeling

Start Date: 6/15/2022	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Dr. Suzanne Marie DeLong; Adwoa Gyekye; Adam Patterson		
Abstract: Given a contested sustainment scenario and pilot wargame, a simulation was built to replicate the steps of the wargame where the purpose is to deploy and sustain forces in a forward operating area to model throughput of forces and supplies. Red disrupts Blue sustainment plans with frustrations. Blue then counter acts red frustrations, if possible. Monte Carlo simulation is used to find the best strategy to deploy and sustain blue forces over the course of a series of game turns. The simulation is analyzed to gain an understanding of friction points in the Army Sustainment network at the theater and operational levels. The model will examine the ability of Blue to provide required sustainment, the effectiveness of Red frustrations on impeding Blue sustainment operations, and the effectiveness of Blue reactions to Red frustrations that still allow Blue to sustain required forces. Classification: UNCLASSIFIED Working Group: WG16 Strategic Deployment and Distribution		

60167 - (U) Fermi Estimate and Problem Decomposition – Feasibility of Employing Forces in Scenario 2.x

Start Date: 6/16/2022	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Joshua J Krause		
Abstract: 90th Symposium “Innovative Analysts Supporting Integrated Deterrence” Author: Major Joshua Krause (joshua.j.krause.mil@army.mil) Briefer: Major Joshua Krause Classification of Presentation: Secret Distribution Statement: D Length of Presentation: 45 Mins Suggested Working Group: WG 11 (Land and Expeditionary Warfare), WG 16 (Strategic Deployment and Distribution) (U) Fermi Estimate and Problem Decomposition – Feasibility of Employing Forces in Scenario 2.x		

(U) Keywords: Order of Magnitude Estimation, Feasibility Assessment, Scenario Development, Campaign-level Planning, Army Scenario 2.x, JFOS 2.2040, JF CONOPS, Army Division Unit of Action Force Design Update, Military Decision Making Process, NDS Critical Challenge Areas.

(U) Problem Statement. Scenario 2.x campaign planning requires initial analysis of the employment of forces in an area of operations. Determine the feasibility of employing multiple divisions, across operational distances, and in a contested maritime environment to maintain operational tempo (OPTEMPO) for large-scale ground combat operations (LSGCO).

(U) Scenario 2.x depicts a campaign-level concept of operations (CONOPS) where the United States builds and leverages Allies and Partners to deter and defeat a peer threat. The scenario development leveraged previous scenario efforts to generate a baseline concept and a distributed operational planning team (OPT) to provide the detail and fidelity of a broad regional scenario.

(U) The design of the employment of forces started prior to (required) in-depth analysis of the logistically feasible force flow (LF3). The OPT analysts divided between two groups, aligned to the feasibility of employing forces through multiple logistic system bottlenecks. To break the impasse, the OPT required initial analysis to overcome their intuitive, 'gut-based' decision-making. The team turned to a Fermi estimate of the answer.

(U) The Scenario 2.x planners turned to problem decomposition and Fermi Estimates of the answer to support the OPT with more information, prior to using more sophisticated methods to calculate the answer. In this application, the estimate holds significant inaccuracies; however, the simple calculation enabled the team to find errors in the employment details and uncover faulty assumptions in the system. The team systematically approached increasingly precise results by refining the initial assumptions and initial estimates and then rerunning the simple feasibility model. When the team reached a feasible solution, the OPT benefited from bounded system estimates and refined planning assumptions. The simple calculations cleared the fog of the unknowns in the system, and provided the information to continue planning subsequent stages of the operation.
(U) This presentation will detail the methodology and approach to decomposing the employment problem, development challenges and insights, and generalized scenario challenges and in

Classification: SECRET NOFORN
Working Group: WG16 Strategic Deployment and Distribution

WG17 Logistics, Reliability and Maintainability

60287 - A Probabilistic Approach to Monitor Supervised Machine Learning Models with Natural Language Processing in Production

Start Date: 6/14/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Abhishek Paul; Joshua Mutugi; Neel Shah		
Abstract: Over the past several years, there have been many advancements with machine learning (ML) and identifying the impact this new technology can have across industries. Through this process, supervised ML and natural language processing (NLP) have proven to be effective for automating tasks in logistics, reliability, and maintainability through predictive maintenance with problems such as multi-class text classification. As organizations move to productionizing ML models, they will have to identify methods to monitor and ensure quality of the ML model in production. A major underlying		

assumption with supervised ML models is that they work well in environments that are similar to the environment in which the model was trained and tested. If the environment changes while the machine learning model is in production, this could cause erroneous predictions from the model. To mitigate this risk, new tools will need to be created to monitor production environments. The purpose of this study is to propose and demonstrate a probabilistic approach to monitoring a supervised ML model with NLP in production; a notional aircraft maintenance dataset is applied. The effort produces a new methodology that measures the textual environment in production and compares the measure to the model training environment, to provide an end user a signal that alerts of a potential environmental change for the model. This probabilistic monitoring approach can be tailored for use on supervised ML applications with NLP.

Classification: UNCLASSIFIED
Working Group: WG17 Logistics, Reliability and Maintainability

59222 - A Decision-Making Framework for the USAF KC-46A Maintenance Program

Start Date: 6/14/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Mr. Kyle Blond		

Abstract: The KC-46A Pegasus is a USAF tanker, transport, and medical evacuation commercial derivative aircraft based on the Boeing 767 series. It is a top acquisition priority to modernize the USAF's refueling capabilities and relies on a traditional lifecycle sustainment strategy directed by DoD and USAF policy. While this approach does provide robust mechanisms to manage and enhance the KC 46A's performance during its operations and support phase, opportunity exists to better design and develop the KC-46A sustainment enterprise via its maintenance program. This research explores enterprise and service system engineering applications focusing on the KC-46A's maintenance program as the primary execution vehicle of KC-46A sustainment activities. A technical and programmatic roadmap detailing improvement opportunities will be produced to inform a decision making architecture for KC-46A maintenance program stakeholders. This product is intended to evolve the program's static corrective and preventative maintenance approach to an adaptive and agile one that is responsive to its environment. Additionally, opportunity to formalize the design, development, and deployment of a modern maintenance program will be investigated to determine the validity of maintenance systems engineering as a unique discipline of systems engineering.

Classification: UNCLASSIFIED
Working Group: WG17 Logistics, Reliability and Maintainability

60087 - Stochastic Optimization for Military Transportation Logistics Under Uncertainty

Start Date: 6/14/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Thomas Karnezos; Jonathan Celaya; Deanne McPherson		

Abstract: Mission-Level Optimization (MLO) for the military often involves the utilization/allocation of large numbers of platforms and payloads of varying types to achieve warfighting objectives. The current practice for addressing the logistical challenges in these types of problems relies primarily on either deterministic mathematical programming models, such as Mixed Integer Linear Programming (MILP), or simulation models, such as Monte Carlo analysis of a Discrete Event Simulation (DES). The advantage of mathematical programming models is that they can quantify the optimality of solutions, but they require all aspects of the modeled scenario to be known a priori as inputs. As a result, deterministic mathematical programming cannot model uncertainties, such as platform attrition, which are important to consider in combat scenarios. On the other hand, simulation techniques have

the advantage that they can account for uncertainty, but the immense solution space of complex missions is often too large to use simulation techniques efficiently to guarantee an optimal allocation of resources. Stochastic programming (SP) leverages advantages of both techniques by incorporating uncertain mission-level elements while preserving the ability to quantify the optimality of results. However, SP is computationally intensive, limiting its presence in the current MLO literature. With ongoing advances in computing power and improvements in solution algorithms, SP may now be a viable tool for MLO. To investigate the utility of SP in MLO, this study developed and executed a small SP model in the context of a Naval resource allocation mission occurring over multiple time periods. Sources of uncertainty taken into account include the possibility that exact resource requirements may only become known partway through the mission, as well as potential platform malfunctions or attrition on route to their destinations. Computational results and comparisons to deterministic optimization models were obtained to illustrate the effectiveness of SP as a mission-level modeling tool. Algorithms to reduce model solution time and extensions to a larger, more realistic mission were also explored.

Classification: UNCLASSIFIED
Working Group: WG17 Logistics, Reliability and Maintainability

59767 - ANT Saugerties Location Alternative Simulation Analysis

Start Date: 6/15/2022	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: David Kent; Mr. Joseph W Kidwell		

Abstract: Aids to Navigation Team (ANT) Saugerties is currently located in Saugerties, NY. ANT Saugerties' area of responsibility (AOR) includes 212 aids from Peekskill to Waterford on the Hudson River. The current location of ANT Saugerties is highly susceptible to flooding, and housing availability for personnel attached to ANT Saugerties is limited. Floods to the ANT Saugerties location cause substantial expenditures to repair water damages. Nevertheless, ANT Saugerties accounts for much of the limited search and rescue and law enforcement capabilities located on the Hudson River. Because the current location of ANT Saugerties is unappealing due to floods and given the operational demands of aid maintenance, the Civil Engineering Unit (CEU) tasked with ANT Saugerties' maintenance posed, "Is there an alternate location for ANT Saugerties along the Hudson River that improves ATON operations response time?"
The research team developed a simulation model to study the operational impacts of placing ANT Saugerties in various location alternatives along the Hudson River. The simulation analysis provided operational impact results on location scenarios drawing from aid failure data. This information will accelerate the CEU's six year planning and execution timeline by at least a year, bringing faster solutions to the hardships and costs burdens at ANT Saugerties.

Classification: UNCLASSIFIED
Working Group: WG17 Logistics, Reliability and Maintainability

59979 - Software Defect Discovery and Resolution Modeling incorporating Severity

Start Date: 6/15/2022	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Maskura Nafreen; Dr. Ying Shi; Dr. Lance Fiondella		

Abstract: Traditional software reliability growth models only consider defect discovery data, yet the practical concern of software engineers is defect removal. Past attempts to model defect resolution emphasize approaches based on differential equations [1] and queueing theory [2]. However, these models do not explicitly identify the activities performed to remove defects and resources allocated

to these activities according to their severity. To enable more detailed resource allocation and planning, models should consider these practical factors.

This talk presents a model to predict the number of defects resolved according to the discrete Cox proportional hazards model with covariates, demonstrating the approach with covariates on the number of low, medium, and high severity defects that were discovered but not yet resolved in successive intervals. Comparison with differential equation-based and distributional approaches reveals that the covariate model achieves an order of magnitude better performance on each measure of goodness of fit considered and requires less time to apply. The covariate model also tracks unresolved defects much better and exhibits low predictive error, even when as little as 10-20% of testing has been completed. These results suggest that collecting information on defect resolution activities and the corresponding effort dedicated could substantially improve defect resolution modeling to guide process improvement.

References

[1] Lo J, Huang C (2006) An integration of fault detection and correction processes in software reliability analysis. Journal of Systems and Software 79(9):1312-1323.
[2] Dohi T, Matsuoka T, Osaki S (2002) An infinite server queuing model for assessment of the software reliability. Electronics and Communications in Japan (Part III: Fundamental Electronic Science) 85:43-51.

Classification: UNCLASSIFIED
Working Group: WG17 Logistics, Reliability and Maintainability

60432 - PROBABILISTIC ISOLATION OF FAULTS USING ANALYTICAL, PREDICTIVE, AND HISTORICAL DATA-DRIVEN ALGORITHMS

Start Date: 6/15/2022	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Mr. Kyle Christensen

Abstract: Commercial and military platforms are becoming more intelligent with the incorporation of Integrated Vehicle Health Management (IVHM) constructs that use complex sensing techniques to provide real-time diagnostics and prognostics capabilities. These intelligent systems can identify faults with high accuracy and isolate down to a specific Line Replaceable Unit (LRU). However, many systems today are constructed using more simplistic electro-mechanical or purely mechanical components that do not contain fault diagnostic software. Thus, countless hours can be exhausted in referencing troubleshooting manuals and wiring diagrams in an effort to identify the failed LRU. If the fault is not correctly isolated, additional time passes and feelings of frustration leads to repetitive attempts of trial and error in hopes of inexplicably uncovering the failure.
It is evident in the maintenance community of any industry that the skill of accurately identifying the source of failure improves with time and experience (i.e. tribal knowledge). Those with years of experience can isolate failures with high confidence without even glancing at a troubleshooting manual or diagram. As a result, this transfer of knowledge is paramount to the success of a business and is what this fault isolation engine is focused on capturing and harnessing for increased system availability. This novel approach provides an opportunity to increase the probability of a successful repair on the first attempt, reducing the number of unsuccessful fault isolation permutations.
A data-driven and predictive algorithm/engine will collect and process information such as system generated fault codes (BIT), part life data, predicted component reliability, failure mode distributions, and historical maintenance data from similar platforms to intelligently compute the most probable

failure mode. Before a single wrench is retrieved from the tool box, this algorithm will display to the user the most probable cause(s) of failure, displayed with a percent confidence, and upon selection will direct the user to the appropriate Data Modules (DM) to conduct repair. As more data is collected and failure symptoms are correlated to LRUs, the algorithm will store, update, and improve the fault isolation process over time. Additionally, as the maintainer progresses through the maintenance tasks, the algorithm will use the response of what the maintainer is experiencing (continuity checks, voltage levels, failed ops checks, etc.) to adjust the course of troubleshooting in real-time. If necessary, the program would prompt the maintainer to pursue a new path of troubleshooting steps as soon as the originally selected failure mode is discovered to be an unlikely cause.
When fully mature, this algorithm will provide an accurate, data driven solution to misguided troubleshooting. The hope is to provide even the most novice maintainer with the resources to perform as if they have worked on the platform for decades.

Classification: UNCLASSIFIED
Working Group: WG17 Logistics, Reliability and Maintainability

59839 - Using Model Based Systems Engineering (MBSE) Tools to Represent Sustainment Architecture to Support Digital Transformation for Major Acquisition Programs

Start Date: 6/15/2022	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Dhwani Khambhati

Abstract: With introduction of the Digital Transformation process, companies within aerospace industry have been undergoing major changes in their software architectures. As systems become more complex, there is an emergent need to capture system architectures and the digital thread for contractual requirements, knowledge sharing, and communication purposes. Model Based Systems Engineering (MBSE) provides an integrated approach using tools like Cameo to represent physical architectures in contrast to the traditional Document-Intensive Systems Engineering (DISE) approach which mainly utilizes disintegrated tools like Visio to document architectures that rely on the reader's ability for interpretation.

Engineers at Northrop Grumman Aeronautics Systems in Melbourne, Florida have developed a tool-centric model that captures the physical architecture of all of Product Support (PS) tools. The model has been developed in Cameo – UPDM which features Department of Defense Architecture Framework (DoDAF). It lays out a foundation of the tools' architecture and the digital thread, which shows the connectivity between tools at a high level while also capturing detailed information exchanges between these tools. It can also utilize PS processes to support the formulation of use cases for each tool. This model has been extremely useful in explaining the complexity of the architecture to customers, programs, upper management, and various stakeholders. Multiple programs within Northrop Grumman Corporation have utilized this architecture as the starting point to support their contractual needs including as a part of their Contract Data Requirement List (CDRL) deliverables.

Classification: UNCLASSIFIED
Working Group: WG17 Logistics, Reliability and Maintainability

60245 - Assessing Impacts of Preventative Maintenance on Operational Availability and Operating and Support Cost

Start Date: 6/15/2022	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Andria Palmer; Dorian Alan Grey-Angeles
Abstract: Maintenance plans for complex in-service DoD weapons systems are a constantly evolving balance of preventive and reactive/restorative maintenance tasks, with resultant impacts to support costs and availability of the systems. Traditional maintenance programs tend to be based on Reliability Centered Maintenance, Condition Based Maintenance, and other approaches determined early during the development phase. Some of these programs encounter challenges once in-service that require updated analyses that provide options for longer term weapon system readiness impacts. Decision makers charged with ensuring continued readiness of systems need an approach that holistically examines maintenance plan impacts on weapon system Operational Availability (Ao) and Operating and Support (O&S) costs over the life cycle. This study provides an approach to assess mitigation solutions, compare their benefits holistically across the logistics elements, and to analyze their potential impact on weapon system availability and O&S cost. This approach could be tailored for use on similar problems to assess impacts of maintenance plans over the life cycle of a system. Classification: UNCLASSIFIED Working Group: WG17 Logistics, Reliability and Maintainability

60284 - Digital twin approach to system reliability-driven demand forecasting

Start Date: 6/15/2022	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Dr. Sarah Lukens; Dr. Michael Lujan; Damon Rousis		
Abstract: Weaknesses in accurate demand forecasting of spares needed for the maintenance of military equipment have contributed to excess inventory in the Department of Defense (DoD), who had an estimated $98 billion in secondary item inventory in 2015. Across a fleet, available data may vary in quality and availability depending on the criticality and complexity of the various spare parts, parent assets and data collection approaches. The ability to develop forecasts optimized on available information and data comes needs to come from models which are tailored to individual assets and their available data as well as integrated with systematic approaches for measuring and managing uncertainty. To address these challenges, we developed an end-to-end pipeline which consumes available raw data sources, and based on the characterization of assets, their missions and available data uses the appropriate analytical approaches. Model selection is based on available data, and models may range from classic statistical reliability analysis to sensor-based prognostic models. A modular approach is used for flexibility in deployment and to support model sustainability. The results of the pipeline are probabilistic demand forecasts driven by component reliability, usage and health and individualized to an asset based on the available data. Probabilistic outputs enable better assessment of risk through systematically incorporating measures of uncertainty in the full system. Classification: UNCLASSIFIED Working Group: WG17 Logistics, Reliability and Maintainability		

60319 - (U) New Sustainment Analysis Capabilities for Next Generation Army Aircraft

Start Date: 6/15/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Ms. Geetha Vallabhapurapu Chary		
Abstract: (U) The U.S. Army is currently developing a new generation of aircraft to replace legacy rotary-wing aircraft fleets, specifically UH-60 Black Hawks, AH-64 Apaches and CH-47 Chinooks. This new generation of aircraft, ranging from light to heavy weights, includes new and improved capabilities affecting most combat functions. To ensure undisrupted flight operations during future Multi-Domain Operations, the Army is aligning some sustainment requirements to focus on a		

Maintenance Free Operation Period (MFOP). To help inform this MFOP requirement, the Combat Capabilities Development Command DEVCOM Analysis Center (DAC) performed an analysis that included estimating MFOP metrics for a currently fielded system and for the next generation aircraft. This analysis approach consisted of three steps. The first step was to process maintenance data collected on a legacy aircraft and develop downtime and time between visit distributions to estimate that legacy system's MFOP. The next step was to collaborate with Cross Functional Team (CFT), United States Military Academy (USMA), Army Aviation and Missile Command (AMCOM) and DEVCOM Aviation & Missile Center (AvMC) experts to determine expected MFOP improvements associated with the new generation aircraft technologies. The last step was to generate the probability to achieve different levels of MFOP. Based on resulting analysis curves, the probability to achieve MFOP for the new generation aircraft was extracted and contrasted with the requirement. This analysis has applicability to support trade studies, dynamic maintenance studies, cost benefit analyses and more.

Classification: UNCLASSIFIED
Working Group: WG17 Logistics, Reliability and Maintainability

60547 - Aviation Predictive Supply and BCM Optimization

Start Date: 6/15/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Glenn Turner; Dr. Greggory Schell		

Abstract: The Navy relies on programmed funding to pay for the operation and repair of its fleet of aircraft. When the budget is insufficient to meet the operational demand for aircraft and the costs of repairs, difficult decisions must be made on how to eliminate and defer costs to future fiscal years. To support leadership during budget shortfalls, CNA developed a decision support tool that determines repair policies which minimize the impact to readiness while deferring enough cost to mitigate the budget shortfall. The decision support tool is a combination of a supply chain digital twin, Predictive Supply, and a binary integer optimization model, Beyond Capable Maintenance (BCM) Optimization. This presentation will summarize the methodology and preliminary findings of the Predictive Supply and BCM Optimization models.

Classification: UNCLASSIFIED
Working Group: WG17 Logistics, Reliability and Maintainability

59761 - Demand Modeling in Contractor Logistics Support (CLS) Programs

Start Date: 6/15/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Ms. Kelly Bush		

Abstract: The Air Force has a significant amount of experience forecasting spare part demands for organic programs, but we do not always have as an informed approach when modeling for Contractor Logistics Support (CLS) programs. Many CLS programs leave the demand modeling to the contractor and do very little to validate or challenge their findings.
In recent years, the F-35A Fleet Management Office has supported F-35 sustainment contract technical evaluations and negotiations. Since repair of repairables (RoR), is one of the largest segments of the sustainment contract, having an accurate demand forecast is critical to keeping the contract cost down. Through demand modeling, the team has validated and/or challenged the contractor's proposals resulting in significant savings on the resulting contracts.
This presentation will focus on the F-35A FMO's experience in demand modeling and its importance in CLS sustainment contracts.

Classification: UNCLASSIFIED
Working Group: WG17 Logistics, Reliability and Maintainability

59842 - Measuring the Effects of Technology Readiness on Rotorcraft Operating Periods

Start Date: 6/15/2022	Start Time: 3:30 PM	End Time: 4:00 PM

Authors: MAJ Courtney E Razon; Andrew Bellocchio

Abstract: The Future Vertical Lift (FVL) Program is developing rotorcraft that leverage new technology and materials to gain additional capability for combat operations in the Multi Domain Operations environment. In addition to the physical aircraft design, the FVL program is exploring new approaches in aviation sustainment to gain the greatest operational benefit from emerging and mature technologies. One such approach is the Limited Maintenance Operating Period (LMOP). The LMOP seeks to maximize operational availability by minimizing or deferring scheduled maintenance actions disruptions. This research explores the impact of maturing technologies as quantified by their Technology Readiness Level (TRL) on an aircraft's LMOP. These technologies improve system reliability, hasten fault detection and identification, and reduce repair times. While these technologies are promising, their final impacts on the fielded aircraft are uncertain; therefore, a probabilistic methodology was appropriate where the impacts of lower TRL technologies have greater variance. A simulation built on the ProModel software examined the impact varying TRL levels on aircraft performance as measured by the probability to successfully complete the operating period, the ratio of maintenance manhours to flight hours, and the recovery period duration. The results of this research provided program managers and aircraft manufacturers with a clear understanding of the probabilities of achieving LMOP success and the associated uncertainty due to technology implementation.

Classification: UNCLASSIFIED // FOUO
Working Group: WG17 Logistics, Reliability and Maintainability

59694 - Understanding Risk in Complex Engineered Systems

Start Date: 6/16/2022	Start Time: 8:30 AM	End Time: 9:00 AM

Authors: Willie Brown; Dr. Jonathan Alt; Dr. John Richards; George Edward Gallarno; Titus Rice

Abstract: Complex socio-technical systems incorporate engineered and technical systems as well as human operators to provide required capabilities in a number of settings, often interacting with the environment. Decision makers require an understanding of the current state of these systems, and the interaction between sub-systems, in order to best allocate resources to maintain a high operational condition and prevent future system degradations. This research 1) developed a novel methodology to assist decision makers in understanding the likelihood that an engineered system would be degraded given the state of its components and 2) employed design-of-experiments methods with consequence models to develop estimates of the consequences of a sub-system outage on the system's mission. The combination of likelihood of degradation and consequence of outage facilitates an understanding of the relative risk of each component of the system. Risk-based prioritization of components, constrained by resources, is enabled through the development of a mathematical optimization program. This presentation includes proof-of-concept results for two case study watersheds.

Classification: UNCLASSIFIED
Working Group: WG17 Logistics, Reliability and Maintainability

60331 - Using Discrete Event Simulation to Aid in Sustainment Analyses

Start Date: 6/16/2022	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Alexander Bertram		
Abstract: Aberdeen Proving Ground, MD 21005-5071Discrete Event Simulation is a powerful tool in any analyst's toolbox because of the flexibility that it provides in modeling and evaluating process flows. Too often, sustainment analyses are completed using deterministic approaches that do not leverage this capability. Discrete event simulations provide the capability to explicitly model processes while not requiring the expansive costs and time that typical testing would require. There are many low cost and easy to obtain COTS software packages that enable the analyst to model in this fashion. Over that past several years, the Combat Capabilities Development Command DEVCOM Analysis Center (DAC) has developed the capability to leverage the strength of a well-built discrete event simulation to model a wide array of sustainment related issues. Modeling of this type has been used to evaluate Sustainment KPP metrics (Operational and Materiel Availability), kill chain technologies and timelines, maintenance burdens placed on personnel within units, and spares optimization and placement, to name a few. This presentation will highlight major accomplishments as well a present a path forward on new and improved implementations of this modeling technique. Classification: UNCLASSIFIED Working Group: WG17 Logistics, Reliability and Maintainability		

59846 - Utilizing flight recorder data for predicting aircraft engine maintenance

Start Date: 6/16/2022	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Erin Mitchell		
Abstract: Title: Utilizing flight recorder data for predicting aircraft engine maintenance * Authors: Erin Mitchell, Cynthia Engholm, Brian Bassham, Qinxian Chelsea Curran, Yan Glina, Emily Joback MIT Lincoln Laboratory is working with the Air Mobility Command (AMC) to leverage artificial intelligence and machine learning algorithms to derive insights from aircraft flight and maintenance data. One example of this research effort is the development of a machine learning model to improve aircraft mission readiness by predicting future maintenance needs. The base model — developed for the KC-135 Stratotanker — relies on input features from two aircraft maintenance datasets: the first captures each maintenance task performed on the airframes, and the second details each airframe's mission capability status and daily activities. A companion set of flight recorder data, consisting of sensor data collected while in-flight, was then incorporated into the data model to test the hypothesis that the addition of flight data will make a more accurate predictive model than maintenance data alone. To further model development, a specific maintenance action was selected as a case study. Engine coke buildup, or "coking," refers to the accumulation of solid oil residue on the aircraft engine over time. The engine coke cleaning maintenance action — performed on all aircraft in our dataset — is of interest because optimizing its frequency and timing offers the potential to reduce unscheduled aircraft maintenance and therefore improve mission readiness. In-flight events expected to be correlated with increased engine coking were extracted from the flight recorder data and added as input features with the goal of improving the model's ability to predict when coke buildup will		

negatively affect aircraft engine performance. This talk will discuss the feature development process and the impact on accuracy and timeliness of the machine learning model predictions.

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Classification: UNCLASSIFIED
Working Group: WG17 Logistics, Reliability and Maintainability

60111 - Modeling Prognostic and Predictive Maintenance (PPMx) Effects on ABCT Readiness

Start Date: 6/16/2022	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: MAJ Robert Martin		

Abstract: The study examines increased maintenance capacities which would enable an armor brigade combat team (ABCT) to complete a 96-hour combat operation at or above 90% equipment operational readiness (OR). This objective is advantageous for the success of the Army's Multi-Domain Operations concept. Variables of interest for the analysis are maintenance man-hours and the proximity of repair-parts stocks to the point of failure. The study question will be examined using The Research and Analysis Center's (TRAC) Dynamic Maintenance (DM) model. DM is a discrete event simulation built in Java around the NPS-developed Simkit. It is used to represent the reliability, availability, and maintainability (RAM) of a unit's combat systems for comparative assessments.
The study also seeks to quantify potential efficiencies which may result from the Army Materiel Command's prognostic and predictive maintenance capabilities (PPMx) effort. PPMx will enable real-time transmission of maintenance data, using data links between a vehicle's on-board sensors and its battlefield sustainment support. This data will feed machine learning algorithms to predict vehicle health—improving situational awareness for tactical commanders and reducing diagnostic and ordering times for maintainers. The cumulative effect of PPMx on unit readiness will be examined using the best current predictions with the DM simulation. This analysis will inform several Army modernization lines of effort, including current force design, the Army of 2030, and PPMx development.
This presentation will focus on the relationship of the factors—man-hours and repair parts—with unit OR: the measure of merit. It will then explain findings from the portrayal of fully-implemented PPMx capabilities in the ABCT.

Classification: UNCLASSIFIED // FOUO
Working Group: WG17 Logistics, Reliability and Maintainability

59868 - Panel ARMOR and Other Analytic Support to F-35 Logistics and Sustainment Management

Start Date: 6/16/2022	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Matthew Sewell		

Abstract: As the largest, most complex, and most expensive weapon system acquisition in US history, the F-35 Joint Strike Fighter program is in constant need to improve performance and drive down costs through analysis and assessment of the processes, products, and procedures used in logistics and sustainment management. LinQuest provides data analysis support and technical assessment products to assist the US Air Force F-35 Fleet Management Office, F-35 Hybrid Product Support

Integrator, and Air Force Life Cycle Management Center with F-35 logistics and sustainment evaluations, strategic planning, and program management. This combined government and contractor team develops tools, conducts analyses, and provides insights to support the F-35 enterprise.
An example of this support is the F-35 Panel ARMOR tool. The Joint Program Office (JPO) requested a "user-friendly" planning tool to inform the Reliability and Maintainability Improvement Program (RMIP) of F-35 maintenance actions that require panel removals. When F-35 panels are removed, the low observable coating must be reapplied and allowed to cure causing significant down time. The JPO is investigating certain ways to reduce the number of panel removals during maintenance events. The Tableau dashboard that integrates data from disparate sources into an innovative aircraft-shaped heatmap and decision-worthy visualizations highlighting statistics on access to F-35 panels and the actions driving those actions. This tool enables leaders at all organizational levels to make data-driven resource prioritization decisions.
This presentation will discuss the F-35 Panel ARMOR tool and other additional projects in work to support F-35 logistics and sustainment.

Classification: UNCLASSIFIED
Working Group: WG17 Logistics, Reliability and Maintainability

59810 - Performance Variability of Maintenance Predictions for the KC-135 Tanker

Start Date: 6/16/2022	Start Time: 11:30 AM	End Time: 12:00 PM

Authors: Cynthia Engholm

Abstract: Title: Performance Variability of Maintenance Predictions for the KC-135 Tanker
Authors: Cynthia Engholm, Yan Glina, Brian Bassham, Qinxian Chelsea Curran, Emily Joback, Erin Mitchell
Topics: WG17 Logistics, Reliability and Maintainability, WG34 Data Science and Analytics

Due to an aging airframe and operational demands, KC-135 fleet maintenance is a challenge for the Department of Defense—making fleet mission readiness an elusive standard to achieve and maintain. To address this, MIT Lincoln Laboratory is working with Air Mobility Command to demonstrate the utility of flight recorder data for a variety of applications related to aircraft operational effectiveness and efficiency. One such application seeks to derive predictive insights for maintenance issues. The predictive capability, which is based on survival forest modeling, ingests features drawn from maintenance log entries, daily aircraft status metrics, and flight recorder data. To make predictions for a targeted issue, related maintenance activities are grouped into case studies of varying specificity, and a model is built for each grouping to assess the likelihood of near-term maintenance. These likelihoods can be combined in various ways to provide guidance on maintenance scheduling. While one set of groupings emerge naturally from hierarchical component numbering, alternative groupings from the free text were generated via natural language processing techniques. This talk will cover the advantages and disadvantages of the various grouping strategies as well as ways of combining likelihood estimates to generate the most informative results.

Classification: UNCLASSIFIED
Working Group: WG17 Logistics, Reliability and Maintainability

60333 - Importance of Conducting Sound Provisioning Analysis and its Role in Ensuring Optimal Materiel Readiness

Start Date: 6/16/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Ashley Brown		
Abstract: Initial provisioning analysis is an Army requirement based on Army Regulation 700-18 and Army Regulation 700-19 and is conducted to determine the range and quantity of spare and repair parts required to operate and maintain an End Item (EI) for an initial period of service while achieving desired readiness goals. A sound analysis plays an important role in helping to plan for EI sustainment and to ensure optimal materiel readiness. In order to perform a sound provisioning analysis, it is imperative to understand how provisioning fits within the acquisition process. An initial provisioning analysis needs to be performed multiple times throughout an EI's acquisition life cycle to reflect the state of its maturity and availability of better data. To accomplish this task, the Combat Capabilities Development Command DEVCOM Analysis Center (DAC) applies a rigorous analytical approach that involves the use of a readiness-based sparing model, the Selected Essential-Item Stock for Availability Method (SESAME) in order to support provisioning analyses conducted for various Army programs throughout the acquisition life-cycle. This approach also leverages a repository of logistics/maintenance data managed by DAC along with authoritative Army data sources to help inform provisioning analyses conducted for Army equipment to be deployed in both current and future combat operating environments. Classification: UNCLASSIFIED Working Group: WG17 Logistics, Reliability and Maintainability		

60222 - Logistics Modeling Suite- Combat Logistics from Fighting Base to Theater

Start Date: 6/16/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Lawrence C Parthum		
Abstract: What if the Air Force had a suite of models that enabled us to quickly examine the feasibility and capability of a set of bases to meet the logistics requirements of the operational demand for an OPLAN or future scenario? The goal would be to model from the individual base to an interactive theater-wide capability. The Combat Logistics Branch of SAF/SAW has been working on this for several years and we're getting very close. We're developing one model that evaluates the airfield infrastructure before attack, matching the capacity of runway, ramps, fuel support, and other infrastructure to the desired mission set of type and number of aircraft. A second model then evaluates what we'd need to send to that location to open and generate the sorties. It sends that evaluation to the Mobility modelers to examine the movement requirements. A third model, really a connected suite of models, examines the degradation after the enemy attacks and what recovery would look like. We're partnering with other Air Force analysis agencies and their models so to look at what it takes to get theater movement of re-supply and sustainment all the way back to the enterprise requirements. Ambitious? Yes, but it's a worthwhile challenge. Classification: UNCLASSIFIED Working Group: WG17 Logistics, Reliability and Maintainability		

60211 - Enhancing Information System Integration in DoD Simulation-Based Training Environments through Robotic Process Automation

Start Date: 6/16/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Matthew M Morse		
Abstract: The stalled Russian advance, just days into their invasion of Ukraine, illustrates the vital importance of timely, responsive logistics on the modern battlefield. It also illustrates the importance		

of decision-makers maintaining a clear-eyed understanding of the capabilities and limitations of their supply chain management processes on the battlefield. While some advances have been made in the representation of logistics considerations in DoD staff training and wargaming simulations, logistics information systems remain underrepresented. Unlike many command and control (C2) systems, which can be integrated with simulations through common protocols (e.g., OTH-Gold) and Sim-C2 research efforts, many logistics ISs require manpower-intensive human-in-the-loop (HitL) processes for integration with simulations. Where automated Sim-IS integration has been achieved (e.g., Joint Deployment Logistics Model [JDLM] and Battle Command Sustainment Support System [BCS3]) the information exchange does not simulate important sociotechnical system (STS) dynamics, such as information latency and simple human error, presenting decision-makers with an unrealistic representation of their logistics C2 capabilities in context.

This research seeks to overcome the limitations of conventional simulation-information system (Sim-IS) interoperability approaches by developing and validating a new approach for Sim-IS information exchange through robotic process automation (RPA) technology. RPA technology, commonly found in commercial off the shelf software from companies such as UiPath, Automation Anywhere, and Blue Prism, supports the automation of integrated business processes by replicating human operator interactions with information systems through graphical user interfaces. This “outside-in” approach to information system integration mitigates the need for engineering changes in operational information systems (or simulations) to support integration of information system. Instead, existing HitL processes are modeled and automated through a combination of tools such as screen scraping and virtual keyboard/mouse actions.

In addition to discussing technical opportunities and challenges associated with an RPA-based approach to Sim-IS integration, this research also addresses conceptual modeling considerations for designing Sim-IS environments to simulate complex integrated business processes and associated STS dynamics. Discussion of RPA-based Sim-IS environment design and development presents recommendations for an envisioned Sim-IS overlay for the Distributed Simulation Engineering and Execution Process (DSEEP). This discussion will include initial results in validation of an RPA-based Sim-IS information exchange prototype and the degree to which such an outside-in approach can simulate the way information delay and degradation manifests in sociotechnical systems.

Classification: UNCLASSIFIED
Working Group: WG17 Logistics, Reliability and Maintainability

WG18 Manpower and Personnel

59773 - Predicting Army Post-IET Attrition using Time-Varying Covariates

Start Date: 6/14/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Josephine Cammack		
Abstract: The Army is trying to reach a force of 500,000 by 2030. The Army needs to play a balancing act of figuring out how many soldiers will retire, attrit, or not reenlist; how many will leave for medical or other reasons; and determine how many soldiers need to be recruited every year. Military leaders need to know why and which factors cause soldiers to attrit before their first term is complete. This presentation uses multiple logistic regressions to determine if a soldier will attrit using data from the PED database. Soldiers who attrit have more variables in common by year in contract than by their contract duration. Thus, the models are by year in contract due to the changing nature of time-varying covariates. As the year in contract increases, the effects of demographic indicators		

generally decrease, and the effects of medical-related indicators largely increase. This model can help leaders determine how to prevent attrition and increase the likelihood of success for soldiers.

Classification: UNCLASSIFIED
Working Group: WG18 Manpower and Personnel

59852 - Partially Autoregressive Machine Learning: Development and Testing of Methods to Predict United States Air Force Retention

Start Date: 6/14/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Maj Joseph Hoecherl; Dr. Matthew JD Robbins; Dr. Brett Borghetti; Dr. Raymond R. Hill, Jr.		

Abstract: Establishing effective personnel management policies in the United States Air Force (USAF) requires methods to predict the number of personnel remaining in the USAF for different lengths of time in the future. Defined as the Personnel Retention Problem (PRP), determining this type of aggregate survival rate is a time series regression problem that shares many characteristics with binary classification problems. The limitations of this structure are particularly difficult to overcome for problems with limited data like the USAF PRP. We develop and test several machine learning models to produce improved retention predictions compared to the USAF's current Kaplan Meier model. In addition to traditional random forest models and feedforward neural networks, we propose the inclusion of a partially autoregressive feature to extend the benefits of low-capacity autoregressive techniques to higher-capacity machine learning techniques. We present a Partially Autoregressive Neural Network (PARNet) and a Partially Autoregressive Random Forest (PARFor) and test the performance of each technique across a range of hyperparameter values. We select the superlative model using a validation dataset, compare results to the existing benchmark model, and find a 62.8% reduction in aggregate prediction error for the baseline neural network and 34.8% reduction for the PARNet.

Classification: UNCLASSIFIED
Working Group: WG18 Manpower and Personnel

60297 - Workforce Retention Modeling with Survival Analysis

Start Date: 6/14/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Craig Nilson		

Abstract: This presentation will provide an overview of how survival analysis is used by the U.S. Coast Guard's Office (USCG) of Strategic Workforce Planning & HR Analytics to estimate retention probabilities over time for service members. First, it will highlight examples of how the results of survival analysis have been used in the USCG. These results will include metrics that assess disparities between demographic groups as well as how policy has been strategically applied to improve the retention of underrepresented groups. Then, the presentation will briefly explore how the retention probability estimates produced by survival analysis provide a basis for sampling agent survival times in discrete, event-based simulation models.

Classification: UNCLASSIFIED
Working Group: WG18 Manpower and Personnel

59989 - The Assignment Marketplace: Balancing Readiness and Satisfaction

Start Date: 6/15/2022	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: Jonathan Paynter		

Abstract: The Army is working to better align the talents of its officers to the talents needed in certain jobs by providing more agency to officers and units in the assignment process. The Army's marketplace for assignments leverages established theory on the best use of participant preferences by determining assignments with an officer-proposing deferred acceptance algorithm.

A distinguishing feature of this market, as compared to a classic labor market example like medical residency, is that the Army has some control over the composition of the market. In particular, when the number of officers is less than the number of available jobs, a central decision maker limits the jobs that enter the market by selecting a subset of jobs equal in size to the number of officers. Currently, outside a few exceptions, this job subset decision is based entirely on the projected readiness of units, and not on specific talent alignment or preference. The selected subset of jobs might have some obviously high priority inclusions where if that job remained vacant a unit would have a critical readiness shortfall. However, the subset decision frequently includes choosing from a collection of jobs that each result in similar readiness gains. Thus, the central decision maker has the opportunity to consider two competing goals when faced with a shortage of officers for an upcoming assignment market: balancing the projected readiness of units and finding the best talent alignment possible between officers and jobs.

This talk presents an approach for characterizing this trade-off between unit readiness and officer job satisfaction based on a model that combines the job subset decision with the subsequent assignment matching. Marketplace preference information from the summer of 2020 is used for an example.

Classification: UNCLASSIFIED
Working Group: WG18 Manpower and Personnel

59626 - Developing Predictive Models of U.S. Army Career Pathways

Start Date: 6/15/2022	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Joshua Goldstein; Aritra Halder; Eric Oh; Nathaniel Ratcliff; Dr. Joel Thurston; Joanna Schroeder; Aaron Schroeder; Dr. Sallie Keller

Abstract: Responding to potential gaps in its talent management capabilities, the U.S. Army seeks new means to develop and assess Soldiers' activities, training, promotions, and other experiences across Soldiers' careers. The Army collects significant administrative and survey data about Soldiers, including training, positions held, deployments, command climate, accessions, pay, waivers, demographics, health, global assessments, and family characteristics. Our research leverages and integrates these data sources to develop predictive models and metrics describing Soldiers' career pathways. We are developing a longitudinal characterization of the nature and acquisition of Soldiers' knowledge, skills, and behaviors and their relation to Areas of Concentration (AOC) for Commissioned Officers and Military Occupation Specialty (MOS) for Enlisted Soldier assignments. To do this, we are creating profiles of career pathways based on individual Soldier and group characteristics.

A unique feature of this research is the data used. Predictive models that address Army career progression can lead to new quantitative approaches to personnel planning and talent management utilizing data collected routinely for the administration of the Army. The Army Analytics Group makes the data available in the Person-event Data Environment (AAG PDE). AAG PDE is a business intelligence platform that provides a secure repository for data sources on U.S. military personnel. We access U.S. Department of Defense (DOD) data within the PDE enclave.

Career pathway models are first developed and tested on data external to the PDE environment using Army veterans resume data obtained from Burning Glass Technologies' data aggregator. Then the models are ported into the PDE and modified for use with data for Army officers. We develop a discrete-time Markov model for the career pathways of soldiers in the Army. The model consists of a finite number of states and contains a finite number of time epochs at which individuals can transition between states. The states in our model are combinations of variables that describe a Soldier's career across time, e.g., rank and Soldier Military Occupational Specialty. This model is a transition probability matrix that represents the probability that an individual moves between states (e.g., probability of promotion in rank). Multinomial regression, including covariates on Soldier demographics, knowledge, skills, abilities, and other contextual factors, is used to estimate the transition probabilities.

Disclaimer: This work has been supported by Army Research Institute for the Behavioral and Social Sciences contract #W911NF-20-C-0024. The views, opinions, and/or findings contained in this presentation are those of the authors and shall not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documents.

Classification: UNCLASSIFIED
Working Group: WG18 Manpower and Personnel

59778 - Show Me the Money?

Start Date: 6/15/2022	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Luke Spurrier

Abstract: Selective Reenlistment Bonuses (SRBs) have been used by the Coast Guard (CG) to increase retention within enlisted ratings with current or forecast personnel shortages that could impact CG operations. Historically, these bonuses have ranged anywhere from $10,000 to 50,000 for 4- or 6-year reenlistment contracts. Two logistic regression analyses revealed SRBs have a statistically significant impact ($p = 0.05$) on reenlistment rates, but the magnitude of that impact averages only 4% across all ratings offered SRBs. Although impact varied among different ratings, a 4% increase in reenlistment rates is somewhat meager and warrants further examination of the Return on Investment (ROI) from SRBs moving forward.

Classification: UNCLASSIFIED
Working Group: WG18 Manpower and Personnel

59853 - Reinforcement Learning Approaches to Improve United States Air Force Accession Policies

Start Date: 6/15/2022	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Maj Joseph Hoecherl; Dr. Matthew JD Robbins

Abstract: The USAF's accession policies seek to maintain the required quantity of personnel in each career field, as measured by a constantly changing number of authorizations. However, large swings in accession policies create large oscillations in a variety of related systems, negatively impacting mission execution. As this system is constantly changing, equilibrium policies are inappropriate. We propose and test two approaches using Monte Carlo simulation to observe highly nonlinear stochastic outcomes and develop improved accession policies for the USAF. First, we propose a novel rolling direct lookahead approximation algorithm to leverage problem structure. This approach modifies the Concave Adaptive Value Estimation (CAVE) algorithm from the field of approximate dynamic programming to solve a constrained stochastic supply problem. Next, we propose an alternative

approach we call iterative anchoring, using a framework of successive deep reinforcement learning algorithms to recursively hone in on high quality policies. We compare the results of these two approaches and test them against an equilibrium model benchmark using real data from the Military Personnel Data System and the Manpower Programming Execution System.

Classification: UNCLASSIFIED
Working Group: WG18 Manpower and Personnel

59745 - Optimized USMC Individual Ready Reserve (IRR) Recruiting

Start Date: 6/15/2022	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: CDR Gary Lazzaro		

Abstract: After initial active duty service of 4 to 6 years, 75% of Marines leave active duty, but are required to complete 8 years of total service in the Individual Ready Reserve (IRR). A majority of separating Marines will return to their initial home of record. This situation gives an opportunity to recruit these prior service Marines into the Marine Corps Reserves. However, these potential reservists should possess a Program Enlisted For (PEF) code that matches an existing military occupational specialty requirement at a Reserve Center within commuting distance of their home of record. Usually, a mismatch occurs between prior service Marine codes and the nearby reserve center requirements. Our model targets the initial recruitment of active duty Marines to steer them towards selecting a PEF code that would be needed at a reserve center near their home of record if they decide to separate from active duty. We optimize the assignment of future reserve PEF requirements to present-day active duty Marine recruiters nationwide in order to solve the prior service recruiting assignment matching problem that will exist 4 to 6 years in the future.

Classification: UNCLASSIFIED
Working Group: WG18 Manpower and Personnel

60116 - Application of Network Flow Optimization to Accession Planning Challenges at Submarine Learning Center

Start Date: 6/15/2022	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: LT Kevin Lutz		

Abstract: COVID-19 caused major delays in the accession of Non-Nuclear Submarine Sailors in the second trimester of fiscal year 2020 requiring increased accessions in the third trimester to meet the annual accession mission. The third trimester accession plan led to an increased flow of Sailors to Submarine Learning Center (SLC) in the first trimester of fiscal year 2021 creating a sustained backlog that required the stand up of a weekly operations planning team (OPT) to mitigate the impact of the backlog. The OPT has representatives from Naval Education and Training Command (NETC), SLC, Recruit Training Command (RTC), and Navy Recruiting Command (NRC) and has required sustained effort to this day.
The backlog problem has emphasized the need for better tools to inform supply chain stakeholders of capacity limitations. We have addressed this need by developing a network flow optimization model that represents courses as nodes and uses arcs to create the required training paths over time. The network flow model will:
1. Provide a forecast of the execution of the current plan to identify potential backlogs.
2. Identify a flow of Sailors that maximizes supply chain throughput without exceeding capacity limitations.

3. Recommend an optimized flow of Sailors that satisfies production orders and other supply chain constraints.
The NETC N3 team will use this model to navigate the uncertainty of future supply chain challenges in accessions, recruit training, and delivery.

Classification: UNCLASSIFIED
Working Group: WG18 Manpower and Personnel

60027 - Hybrid Teams in Human Capital Processes: Enriching AFSOC's Commando Eagle Board with a Deep Neural Network

Start Date: 6/15/2022	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Rob Newton

Abstract: Commando Eagle is the annual squadron command selection board for Air Force Special Operations Command (AFSOC). It is an "all-in" board that considers all officers with Core Air Force Specialty Codes specific to AFSOC squadrons for command based on rank and time in grade via a review and scoring of each officer's personnel record, and currently takes days to complete. We propose the use of a deep neural network with a small dataset to rapidly assist officer record scoring and we provide an example using 2020 board results. Our proposed network utilized an existing AFSOC personnel database with columns as categorical variables to generate a score from 6 to 10 for each officer's record. In our example, our network's scores differed from actual board scores with a mean absolute error of 0.128 points and a standard deviation of absolute error of 0.113 points. The range of these errors was -0.629 to +0.370 points. Our findings suggest a deep neural network can enrich the Commando Eagle process, leveraging a hybrid approach to reduce the time spent reading and scoring records and provide more time for senior leaders to provide nuanced feedback to officers evaluated.

Classification: UNCLASSIFIED // FOUO
Working Group: WG18 Manpower and Personnel

60392 - A simulation model to support analysis of USMC Force Design 2030 transformation

Start Date: 6/15/2022	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Dr Chad W Seagren

Abstract: In his planning guidance, the Commandant of the Marine Corps states "We will ... accelerate our transformation from disconnected legacy systems to an integrated data architecture that treats data as it should be –a critical resource." In addition, the Commandant's Force Design 2030 describes numerous, major changes in the structure of numerous occupational fields. This project supports Headquarters Marine Corps, Manpower & Reserve Affairs (M&RA) in their attempt to carry out these substantial transformations. Our approach demonstrates how M&RA can leverage the latest technology in data architecture and decision support models to overcome these deficiencies. In this case, we formulate a simulation model to assist in analysis of changes in the structure of a given Occupational Field. Given a notional ideal inventory for that occupational field; the current inventory for that occupational field; historic attrition behavior; and the relevant Enlisted Career Force Controls; our model produces an estimate of the resultant promotion timing for each grade, as well as an estimate of the feasibility of obtaining the desired inventory levels.

Classification: UNCLASSIFIED
Working Group: WG18 Manpower and Personnel

60168 - Validating or Updating the United States Coast Guard Pilot & Aircrew Manpower Requirements for the MH60 Jayhawk

Start Date: 6/16/2022	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: Trent Ho		
Abstract: The Coast Guard's Aviation Resource Council is procuring MH60 helicopters to replace the MH65 helicopters within the service's aviation fleet. According to CIM 5312-11A Staffing & Standards manual, each MH60 shall be resourced with at least 5 pilots and 15 aircrew members. This requirement has not been updated since 1989, resulting in uncertainty regarding its appropriateness in today's operational environment. This study reviews and analyzes MH60 operations, maintenance publications, directives, and historical data to validate or update the required number of MH60 pilots and aircrew for organizational success. A combination of historical data analysis, subject-matter-expert interviews, and Coast Guard requirements were used to determine assumptions and constraints for modeling the manpower necessary within the service's aviation workforce. Utilizing methodologies and problem framing derived from CG-1B41, the Coast Guard Manpower Requirements Analysis Branch, this study describes a mathematical method/model towards validating or updating the MH60 manpower requirement. Classification: UNCLASSIFIED Working Group: WG18 Manpower and Personnel		

60053 - Armored Vehicle Gunnery Crew Dashboard and Performance Prediction Tool

Start Date: 6/16/2022	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: James Starling; Mary Bell; Seth Benson; Kevin J Quigley; Benjamin Wettstein		
Abstract: Tank and Bradley gunnery is the culminating event to ensure armored units are prepared to deploy and fight on our Nation's behalf. This research seeks to answer two current issues related to gunnery: 1) Can we provide an up-to-date crew gunnery status to commanders at echelon within an U.S. Army Armored Division? and 2) Can we provide a diagnostic/predictive model to assist commanders to prioritize their crew training effectively? In reference to the first issue, units devote a significant degree of man hours to tracking current crew status due to personnel-related challenges, to include Permanent Change of Station (PCS), Expiration Term of Service (ETS), injuries, promotions, and other disruptions lead to crew turnover and decertification. Our team presents a potential solution that incorporates readily available Microsoft products (PowerBI, SharePoint, Excel, etc.) integrated with the Army's Vantage personnel system of record to enable commanders at echelon within an Armored Division to have a snapshot of their crew statuses. To address the second issue, we provide various regression models consisting of salient explanatory variables based on crew and individual attributes. The solution consists of predicted gunnery scores prior to starting gunnery training and affords the ability to perform sensitivity analyses to identify the effects of additional training on a predicted post-gunnery score. The commander dashboard and prediction models developed in this study stem from real-world data provided by the U.S. Army's Third Infantry Division; However, the results of this research can be expanded across the Army to other Armored Divisions and potentially to Stryker and Light Infantry Divisions for squad and platoon qualifications. Classification: UNCLASSIFIED Working Group: WG18 Manpower and Personnel		

59826 - Identifying Diversity, Equity, Inclusion, and Accessibility (DEIA) Disparities in Personnel Actions: A Multi-Pronged Approach

Start Date: 6/16/2022	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Kira Lowe		
Abstract: Addressing issues in Diversity, Equity, Inclusion, and Accessibility (DEIA) has been a key priority of Air Force Materiel Command (AFMC) since 2020. AFMC ORAs have collaborated with the DEIA team in the Manpower, Personnel, and Services directorate to use a data-driven approach to identify disparities, drill down into key areas of concern, and determine root cause. The findings from the analysis are pushed to the MAJBAWG (Major Command (MAJCOM) Barrier Analysis Working Group) for formulation of initiatives to address known disparities. The aim is for AFMC to grow and maintain an inclusive, diverse workforce culture that promotes trust and ensures all Airmen have the opportunity to grow and succeed. This presentation will walk through an example of our methodology using data from personnel actions. The approach begins with identification of a high-level area where disparity may exist, then drills down into the area's sub-components using a combination of modelling and statistical tests. Though this analysis is specific to AFMC, any DoD organization could leverage the work here for internal study. Classification: UNCLASSIFIED Working Group: WG18 Manpower and Personnel		

59545 - Strategic Workforce Analysis and Management: Creating Employee Journeys by Leveraging Big Workforce Data

Start Date: 6/16/2022	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Dr. Daniel Thomas Maxwell; Mr. John Gugliotti; Mr. Peter Rogers		
Abstract: The work environment for Federal employees of the future will be quite different than before. Between COVID and the turnover in the workforce due to myriad reasons, leaders in the Federal Government will need to adapt their expectations and approach to strategically managing the workforce. This presentation describes how a Department of Treasury organization used data science techniques from the advertising industry and synthesized twenty years of employee and economic data into a dataset that describes the employees' journeys through the organization. A combination of machine learning and good old-fashioned analysis has generated insight into the workforce, including predictive models identify employees that are most likely to resign or retire. This has enabled leaders to adjust hiring and retention policies to improve recruiting effectiveness, workforce stability and productivity. Classification: UNCLASSIFIED Working Group: WG18 Manpower and Personnel		

60289 - Data-Driven Decision-Making at the Air Reserve Personnel Center

Start Date: 6/16/2022	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Matthew Gleason		
Abstract: The Air Force human talent management enterprise faces the dual challenge of overwhelming amounts distributed across a disparate set of smaller enterprises. CDO Transformation efforts currently underway in the Air Force may benefit from knowledge of existing field use cases and success stories. This presentation will examine how the Air Reserve Personnel Center's (ARPC)		

Readiness and Integration Organization leverage the A1 developed talent management data enterprise to transform their internal operations. Historically, struggles obtaining foundational data on resources and personnel added to the complexity of servicing a population of 8,000 individual reservists. The numerous systems containing legacy data continue to be the systems of record for manpower data and cannot be ignored, even as new systems are brought online. While DoD at large is working to put datasets easily accessible in the cloud, organizations can still seize the opportunity to determine which datasets are the most valuable and how to use them – even if these datasets are generated locally or in poorly integrated databases. This presentation will give real-world examples and success stories for this organization as well as how the broader manpower community can leverage emerging capabilities that can apply to any organization struggling to use their own data to empower their people and effectively engage their leadership. It will also explain at a high-level methodologies and approaches to that end. It will also demonstrate a use case that allowed processing time for customer tickets drop from an 3-month turnaround time down to 2 weeks. The briefing will also share insights about how to align data efforts with leadership at the Command and deploy these analytic systems in the hands of operational staff without backgrounds in analytics

Classification: UNCLASSIFIED
Working Group: WG18 Manpower and Personnel

59662 - Officer's talent development: Communicator, social skills and insider knowledge

Start Date: 6/16/2022	Start Time: 11:30 AM	End Time: 12:00 PM

Authors: Dr. Naiqing Lin; Dr. Ryan P. Royston

Abstract: The primary objective of the current work was to identify the talents, skills, and behaviors (KSBs) required for officer jobs and gain an in-depth understanding of those KSBs at different stages of an officer's career through analyzing officer responses to open-ended questions. The study used the archival dataset from STR (the Survey of Talent Requirements; n = 4,054). This study used qualitative data extracted from open-ended questions to identify themes and sub-themes related to officer career experiences, KSB definitions, thus providing a richer understanding of officer job requirements.

The goals of the current work were to:

-Extract and clean officer job-related narrative statements, and career experiences obtained through open-ended questions; and identify themes related to KSB definitions using search expressions and auto-coding methods, and to extract data based on previously identified theory and important classifiers.

-Discuss ways that text analysis and qualitative techniques could be used to better identify officer job requirements.

After extraction, cleaning, and coding, we compiled results from 25,470 qualitative analytical units and organized 513 officer career-related quotations,and encoded these quotations into themes and structures. We were able to identify existing duty-related and job-related themes and sub-domains covering five talent domains, seven sub-domains, and a dozen more specific job requirements and experiences that officers indicated facilitated success in their current position.

We discuss and provide insights into: (a) how qualitative data analysis has provided a more detailed understanding of Army job requirements above and beyond simple quantitative analysis alone, (b) job-related KSBs and talents requirements for successful officer performance, as well as quotations describing experiences that facilitated the development of these critical skills, (c) discussed future development of research methods related with qualitative analysis of open-ended data and suggested protocols for dealing with encumberments, inconsistencies, and analysis of qualitative data, especially in large-scale surveys.

Disclaimer:
The views expressed in this presentation are those of the author and do not reflect the official policy position of the Department of the Army, DOD, or US government.

Classification: UNCLASSIFIED
Working Group: WG18 Manpower and Personnel

60258 - Supply Corps Billet Structure Modeling

Start Date: 6/16/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Nicholas E Alvarez		

Abstract: Supply Corps Billet Structure Modeling
The Supply Corps is a community made up of 2,500 officers, comprised of seven subordinate officer specialty tracks. Various internal and external changes (e.g. COVID-19, officer authorizations, officer inventory, officer billet grade creep) have created a potentially unsustainable billet structure. Treating the community as a complex system, our team developed a deterministic model to confirm the extent of this problem. This model was used to identify alternative billet structures, with the goal of balancing system inputs to minimize risk to community health.

Classification: UNCLASSIFIED
Working Group: WG18 Manpower and Personnel

59899 - Delivering a more efficient workforce planning capability through simulation and data analytics

Start Date: 6/16/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Ms Katie Mortimer		

Abstract: The Australian Defence Force (ADF) currently faces a challenge in supplying and sustaining its workforce. New platforms and capabilities are driving changes in Defence, requiring robust workforce plans that will minimise workforce supply risks in the future. However, the complexity of the Defence workforce, with its hierarchical nature and highly interconnected structure, makes this advanced planning difficult. To assist in this planning, a decision-support environment has been created. This environment combines simulation, design of experiments, data analytics, and interactive visualisations to predict the future of the workforce, effectively demonstrate workforce supply risks, and perform what-if analysis on the workforce. A simulation engine was specifically designed and developed to model the Defence workforce. This engine is able to model and simulate the progression of personnel through their careers, including training courses, skill transitions, postings, promotions and loss of personnel through attrition, while respecting workforce-specific prerequisites and conditions. Design of experiments and data analytics techniques, including correlation and Bayesian network analysis, are then used to discover key dependencies, vulnerabilities and understand why they are occurring through the analysis of relationships between inputs and outputs,

and between different outputs. These techniques can then be used by workforce planners and analysts by providing them with a deployable software platform, containing highly interactive support tools and visualisations. While the tool suite is in the continuous research and development phase, a mature version has been deployed to the ADF network and used extensively by the Defence workforce planning organisations for both long-term workforce forecasting and risk analysis, as well as to inform critical workforce requirements and policy decisions.

Classification: UNCLASSIFIED
Working Group: WG18 Manpower and Personnel

59801 - The Utility of Data Science Applied to Military Assessment and Selection for Holistic Systems Improvement

Start Date: 6/16/2022	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Hayden Deverill; Dr. William T Scherer

Abstract: Elite military units use an in-depth assessment and selection (A&S) process to acquire the most qualified candidates. A unique challenge is to objectively evaluate the human dimension of attributes like leadership, resilience, and initiative in candidates. Additionally, the A&S process requires significant time and resources to execute. The specific A&S studied for this research is eight weeks long and has a high logistical demand between supplies, personnel, and facilities. Screening the best Soldiers prior to starting the A&S is essential, because candidates who are not selected are a high cost to the system. Likewise, selecting the best candidates during the A&S is essential, because the unit demands top performers to conduct the highly specialized missions. Thus, improving the system will reap dividends for the military.

Most studies about military A&S have used small, biased data sets, used descriptive statistics for analysis, and focused on identifying predictors of candidate success. This research is broader in scope. Our data set was large: we used 11,885 candidate records of archival data from an eight week US Military Special Operations A&S taken over a five years. The data has 90 total features that include administrative, performance, and psychological data on each candidate. We applied a robust data science approach involving feature engineering, feature selection, optimized predictive models, and data subsets analysis to extract more meaningful information from the data. Our objective for this research was to evaluate the utility of applying data science techniques to a specific military A&S data set with the goal of improving the holistic A&S system.

We applied multiple classification models to a variety of feature and candidate subsets created using data science techniques. Using all the data, model accuracy ranged between 62% and 77%. The strongest predictors of candidate success using all the data were performance features, specifically (number of push-ups, sit-ups, and 2 mile run time). Although prediction accuracy is not high (<90%), there is utility in applying data science techniques to the A&S. We discovered that there are distinct thresholds for features (such as fitness scores) that were highly predictive of candidate rejection. Likewise, the modest predictive capability using these features suggests that our data does not adequately capture important variables. For example, resilience may play a role in candidate success but is a challenging feature to measure and highly variable between subjects. Based on the data science techniques used and results, this study 1) validates the importance of having A&S to observe the human dimension of a candidate's response to challenges and 2) proposes several ways to modify the A&S for more effective candidate screening and evaluation.

Classification: UNCLASSIFIED Working Group: WG18 Manpower and Personnel

WG19 Readiness

59992 - Assessing Risk to Conflict under ReARMM

Start Date: 6/14/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Christine Krueger		
Abstract: In October 2021, the Army initiated the new force generation model, the Regionally Aligned Readiness and Modernization Model (ReARMM). The Army's urgent need to modernize at a scale unmatched for the past 50 years, while still maintaining a global presence for competition, was the motivation for the development and implementation of ReARMM. To accomplish this, the Army grouped like units into "mission lines" aligned to either a region (e.g., United States European Command) or a function (e.g., Immediate Response Force). Once aligned, each unit progresses through a unit life cycle offset with its sister units ensuring that at any given time a unit can either fulfill a competition demand or a prepare to deploy mission. This model ensures that the Army meets current demand; but does not analyze how this model generates readiness for a near-peer large-scale combat operation. The methodology used to understand this risk included forecasting projected readiness per unit based on its life cycle, determining according to the latest war plan which units were needed and when, and identifying which could not meet mission requirements as a result of their readiness. Furthermore, the analysts visualized the results for senior leaders to allow them to rapidly identify when the Army incurs the most risk and for which unit type. The impact of the analysis exceeded the initial intent and senior leaders leveraged it in discussions with the Secretary of the Army as to the amount of training readiness needed. In addition to the initial analysis, the Army has institutionalized a modified methodology into its updated quarterly risk analysis of strategic readiness tenets. Ultimately, this presentation will cover the latest example of how the Center for Army Analysis continues to provide timely and critical analysis as the Army implements ReARMM to ensure the Army meets today's demands without sacrificing readiness tomorrow. Classification: SECRET NOFORN Working Group: WG19 Readiness		

60306 - Progress towards a Holistic Assessment through developing Army Modernization Synthesis Framework

Start Date: 6/14/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: David Azari, Ph.D.		
Abstract: In assessing modernization progress, the Army analytic community lacks an integrated, sustainable, and reusable methodology that leverages all forms of analysis available to the command (e.g., combat simulations, wargames, and experimentation). It remains an open challenge to summarize and synthesize the rich qualitative and quantitative results from these ongoing analytic studies, events, and exercises. This presentation summarizes current progress and evolution of the Army Modernization Synthesis Framework - a funded research project at The Research and Analysis Center (TRAC) within Army Futures Command (AFC). This effort is designed to continuously integrate qualitative and quantitative data into a holistic picture of Army modernization. This presentation will provide an in-progress update on the Army Modernization Synthesis Framework as it matures through (1) review and		

codification of current and emerging best practices (2) design and review of reusable campaign-level assessment routines and (3) proof-of-concept mixed-method integration leveraging current and historical analytic results.

Classification: UNCLASSIFIED
Working Group: WG19 Readiness

60070 - Army Continuum of Analysis Meta-Analysis

Start Date: 6/14/2022	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: LTC John Ferguson; Mr. Brian A. Hodges

Abstract: The Analytic Continuum of Analysis (ACA) examines enduring questions that our analytic community must answer to support Army Senior Leader decisions, synchronizes and focuses analytic efforts around those questions, and identifies gaps in the analytic support to major decisions. In mid-June 2021, the ACA Analytic Board of Directors (ABoD) directed The Research and Analysis Center and the Center for Army Analysis to perform a quick-turn meta-analysis of the current modernization efforts supporting the Army in 2030 and supporting the Army beyond 2030 as a proof-of-principle. The Fiscal Year 2021 ACA meta-analysis used products from 10 Army analytical agencies to demonstrate how the ACA could leverage analytic and wargaming efforts to assess how our modernization efforts are supporting the Army.
This presentation will describe the process and tools used to obtain, integrate, and synthesize study results across a representative set of Army analytic agencies for a modernization assessment the Army in 2030 and the Army beyond 2030 and provide the lessons learned in conducting this type of assessment.

Classification: SECRET NOFORN
Working Group: WG19 Readiness

60006 - Mapping Materiel Modernization to the Regionally Aligned Readiness and Modernization Model (ReARMM) to Aid Army Planning Processes

Start Date: 6/14/2022	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Candice Farney

Abstract: The Army's recent adoption of the Regionally Aligned Readiness and Modernization Model (ReARMM) has generated new requirements on how the Army Modernization Enterprise looks at equipping the future force. This model defines each unit's calendar with three phases: Modernization Phase, Training Phase, and Mission Phase. During the modernization phase, units receive modernized equipment based on their requirements. This ensures the unit has the ability to train and become proficient on new equipment before deploying on a mission. There are multiple systems, such as the Decision Support Tool (DST) and the Army Synchronization Tool (AST), that can provide visualizations on equipping events that have been scheduled outside of a modernization phase. In June 2021, the Vice Chief of Staff of the Army and the Under Secretary of the Army asked for a visualization tool that could extend materiel resourcing decisions through the Future Years Defense Plan (FYDP) to the end of the Extended Planning Period (EPP) based on the ReARMM in order to see the impacts of decisions made in the near term on the future force. This led to the creation of the Modernization Synchronization Tool (MST) by a team in The Research Analysis Center (TRAC).
Members of the MST team had two areas of focus: the development of the tool itself and the data collection that would be used in the tool. The data collection team worked across the Army with Army Forces Command (FORSCOM), Army staff (including Personnel, Financial Management, and

Operations), Army Futures Command (AFC), the Assistant Secretary of the Army- Acquisition, Logistics, and Technology (ASA(ALT)), Army Materiel Command (AMC), and Army Sustainment Command (ASC), to track new technologies and programs from budget plans to unit prioritization down to a unit in a modernization phase. By understanding this process, we were able to create a computer simulation that could incorporate planning data from the FYDP to project future materiel modernizations decisions based on ReARMM as if they were being made now. This data and simulation were then used to create several different views that could answer specific questions of what units would receive what modernization programs and when, as well as a friction point view that could highlight current misalignments based on ReARMM or other resourcing errors. This presentation will highlight the process and methods of data collection as well as the challenges of data visualization for multi-faceted problems.

Classification: UNCLASSIFIED
Working Group: WG19 Readiness

60257 - Active-Reserve Compnent Mix Time Phased Force Deployment Data (TPFDD) Optimization

Start Date: 6/14/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Joseph F Adams; Mr. Nathaniel Cleaves; Dr. Cullen Alexander Roberts		

Abstract: We develop a model that optimizes force mix with respect to a TPFDD. A TPFDD is an operation plan (OPLAN) for moving forces to theater. It specifies the itineraries (lines) of parts of units through many intermediate destinations (legs). Historically, TPFDDs have been executed with much less advanced warning than they assume -- something our model takes into account by permitting the acceleration of TPFDD timetables. Our model simulates the arrival times of lines, giving special attention to two bottlenecks: the lines of a unit cannot not launch until after the unit has completed post-mobilization training; lines queue at ports if port capacity is exceeded. We infer port capacity from a "95% feasibility" assumption: in the best case scenario, ports reach (but do not exceed) port capacity at least once. Under this simulation, we apply a genetic algorithm, swapping the components of units, and thereby unit mobilization time and unit costs. This algorithm generates a unit-operating-cost/arrival-time efficient frontier.

Classification: SECRET NOFORN
Working Group: WG19 Readiness

60088 - Improving the Early Deployer Time-Phased Force and Deployment Data (TPFDD) Analysis Process

Start Date: 6/14/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Danford Smith; Mr. Christopher Lynn Hopkins		

Abstract: As part of the Total Army Analysis (TAA), the Army must determine an acceptable mix of Army Active Component and Reserve Component units. To help inform these decisions, the Early Deployer TPFDD Analysis identifies early deploying unit types required in combatant commanders' operation plans and translates these into the TAA baseline future force structure designs. These translated unit demands are portrayed both in terms of timing of demand and absolute quantity of demand by unit type. The Center for Army Analysis is examining methodologies to improve the Early Deployer TPFDD Analysis process to better analyze different combatant commander TPFDD formats and develop a user interface for the analysis conducted in the Microsoft database.

This presentation will describe the techniques and tools used to improve the Early Deployer TPFDD Analysis and provide lessons learned. We hope to inform and solicit feedback from those interested in TPFDD analysis.

Classification: UNCLASSIFIED
Working Group: WG19 Readiness

60187 - Using Simulation to Forecast the Impact of Events on Aircraft Availability

Start Date: 6/15/2022	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: Dr. Greg H. Gehret		

Abstract: At the onset of the Coronavirus pandemic, the previous Chief of Staff of the Air Force (CSAF) inquired about the potential impact of COVID-19 on AF readiness. We utilized several OR tools to create inputs, and then used simulation to estimate a cause-based, 6-month forecast of Aircraft Availability (AA) on 13 major AF fleets. Because the underlying inputs to the simulation were cause-based time elements, the simulation can be used to forecast AA for any time-based disruptions, including funding, manpower, and Chemical, Biological, Radiological, Nuclear, and high yield Explosives (CBRNE). Our presentation will discuss why we used simulation, how we established cause-based inputs, and possible use of the simulation for other "What If" scenarios, including CBRNE.

Classification: UNCLASSIFIED
Working Group: WG19 Readiness

60334 - Importance of Conducting Sound Provisioning Analysis and its Role in Ensuring Optimal Materiel Readiness

Start Date: 6/15/2022	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Ashley Brown		

Abstract: Initial provisioning analysis is an Army requirement based on Army Regulation 700-18 and Army Regulation 700-19 and is conducted to determine the range and quantity of spare and repair parts required to operate and maintain an End Item (EI) for an initial period of service while achieving desired readiness goals. A sound analysis plays an important role in helping to plan for EI sustainment and to ensure optimal materiel readiness. In order to perform a sound provisioning analysis, it is imperative to understand how provisioning fits within the acquisition process. An initial provisioning analysis needs to be performed multiple times throughout an EI's acquisition life cycle to reflect the state of its maturity and availability of better data. To accomplish this task, the Combat Capabilities Development Command DEVCOM Analysis Center (DAC) applies a rigorous analytical approach that involves the use of a readiness-based sparing model, the Selected Essential-Item Stock for Availability Method (SESAME) in order to support provisioning analyses conducted for various Army programs throughout the acquisition life-cycle. This approach also leverages a repository of logistics/maintenance data managed by DAC along with authoritative Army data sources to help inform provisioning analyses conducted for Army equipment to be deployed in both current and future combat operating environments.

Classification: UNCLASSIFIED
Working Group: WG19 Readiness

60261 - Holistic Assessment of Force Mix in support of National Defense Strategy Priorities and Problem Sets

Start Date: 6/15/2022	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Joseph F Adams; Nigel Mease; Neil Mithal; Mr. Jenns A. Robertson		
Abstract: The Department faces an increasingly complex and rapidly changing international situation. IDA was tasked with comparing the ability of the DoD to carry out a rapid movement of forces associated with TPFDDs to support OPLANs. Of particular importance to the DoD was the ability for TPFDDs to be rapidly mobilized with a truncated timeline. More specifically, the goal of the study was to determine how the Reserve Component would be utilized in the TPFDD force mix. IDA compiled current unit readiness data from the Defense Readiness Reporting System (DRRS) and cross-examined forces across different TPFDDs. IDA then identified units that may not be as ready for immediate operations as planned for in selected TPFDDS. Additionally, the study compared readiness of units not selected for deployment to determine the potential for substitutions. IDA synthesized force component data, substitution potential, and overall readiness to determine the feasibility of particular force mixes in specific TPFDDs. A presentation of this methodology to the MORS Readiness Working Group would illuminate to the community on the current state and feasibility of specified TPFDDs. Classification: SECRET NOFORN Working Group: WG19 Readiness		

60208 - Predicting Army Post-IET Attrition using Time-Varying Covariates

Start Date: 6/15/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Josephine Cammack		
Abstract: The Army is trying to reach a force of 500,000 by 2030. The Army needs to play a balancing act of figuring out how many soldiers will retire, attrit, or not reenlist; how many will leave for medical or other reasons; and determine how many soldiers need to be recruited every year. Military leaders need to know why and which factors cause soldiers to attrit before their first term is complete. This presentation uses multiple logistic regressions to determine if a soldier will attrit using data from the PED database. Soldiers who attrit have more variables in common by year in contract than by their contract duration. Thus, the models are by year in contract due to the changing nature of time-varying covariates. As the year in contract increases, the effects of demographic indicators generally decrease, and the effects of medical-related indicators largely increase. This model can help leaders determine how to prevent attrition and increase the likelihood of success for soldiers. Classification: UNCLASSIFIED Working Group: WG19 Readiness		

60247 - Topological Data Analysis and Flight Hour Prediction for Naval Aviation

Start Date: 6/15/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Mr. Dean Lee; Dr. Benjamin Michlin; Dr Jamal Tildon Rorie		
Abstract: In Naval aviation, squadrons are assigned flight hour targets which must be met. Therefore, flight hour execution is a crucial performance metric by which squadrons are judged. Prior work performed under the Digital Aviation Readiness Technology Engine (DARTE) effort demonstrated the viability for extracting actionable insights from manning, training, and equipment data to predict squadron readiness. We extend the DARTE framework to include topological data analysis (TDA) for flight hour execution prediction. Specifically, TDA is a set of methods that identify topological structures resident in the data. In turn, the summarizations of the topological information become		

features for machine learning algorithms. In this work, we demonstrate the feasibility of utilizing TDA on manning, training, and equipment data for flight hour execution prediction.

Classification: UNCLASSIFIED
Working Group: WG19 Readiness

60320 - (U) New Sustainment Analysis Capabilities for Next Generation Army Aircraft

Start Date: 6/15/2022	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Ms. Geetha Vallabhapurapu Chary

Abstract: (U) The U.S. Army is currently developing a new generation of aircraft to replace legacy rotary-wing aircraft fleets, specifically UH-60 Black Hawks, AH-64 Apaches and CH-47 Chinooks. This new generation of aircraft, ranging from light to heavy weights, includes new and improved capabilities affecting most combat functions. To ensure undisrupted flight operations during future Multi-Domain Operations, the Army is aligning some sustainment requirements to focus on a Maintenance Free Operation Period (MFOP). To help inform this MFOP requirement, the Combat Capabilities Development Command DEVCOM Analysis Center (DAC) performed an analysis that included estimating MFOP metrics for a currently fielded system and for the next generation aircraft. This analysis approach consisted of three steps. The first step was to process maintenance data collected on a legacy aircraft and develop downtime and time between visit distributions to estimate that legacy system's MFOP. The next step was to collaborate with Cross Functional Team (CFT), United States Military Academy (USMA), Army Aviation and Missile Command (AMCOM) and DEVCOM Aviation & Missile Center (AvMC) experts to determine expected MFOP improvements associated with the new generation aircraft technologies. The last step was to generate the probability to achieve different levels of MFOP. Based on resulting analysis curves, the probability to achieve MFOP for the new generation aircraft was extracted and contrasted with the requirement. This analysis has applicability to support trade studies, dynamic maintenance studies, cost benefit analyses and more.

Classification: UNCLASSIFIED
Working Group: WG19 Readiness

59835 - Armored Vehicle Gunnery Crew Dashboard and Performance Prediction Tool

Start Date: 6/16/2022	Start Time: 8:30 AM	End Time: 9:00 AM

Authors: James Starling; Mary Bell; Seth Benson; Kevin J Quigley; Benjamin Wettstein

Abstract: Tank and Bradley gunnery is the culminating event to ensure armored units are prepared to deploy and fight on our Nation's behalf. This research seeks to answer two current issues related to gunnery: 1) Can we provide an up-to-date crew gunnery status to commanders at echelon within an U.S. Army Armored Division? and 2) Can we provide a diagnostic/predictive model to assist commanders to prioritize their crew training effectively? In reference to the first issue, units devote a significant degree of man hours to tracking current crew status due to personnel-related challenges, to include Permanent Change of Station (PCS), Expiration Term of Service (ETS), injuries, promotions, and other disruptions lead to crew turnover and decertification. Our team presents a potential solution that incorporates readily available Microsoft products (PowerBI, SharePoint, Excel, etc.) integrated with the Army's Vantage personnel system of record to enable commanders at echelon within an Armored Division to have a snapshot of their crew statuses. To address the second issue, we provide various regression models consisting of salient explanatory variables based on crew and individual attributes. The solution consists of predicted gunnery scores prior to starting gunnery

training and affords the ability to perform sensitivity analyses to identify the effects of additional training on a predicted post-gunnery score. The commander dashboard and prediction models developed in this study stem from real-world data provided by the U.S. Army's Third Infantry Division; However, the results of this research can be expanded across the Army to other Armored Divisions and potentially to Stryker and Light Infantry Divisions for squad and platoon qualifications.

Classification: UNCLASSIFIED
Working Group: WG19 Readiness

60318 - Redefining Army Tactical Wheeled Vehicle Maintenance through Proper Diagnostics and Tools

Start Date: 6/16/2022	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Logan Rutherford

Abstract: Reliability-Centered Maintenance (RCM) data collected through the Combat Capabilities Development Command DEVCOM Analysis Center has highlighted current maintenance tactics that favor replacing major assemblies on tactical wheeled vehicles (TWVs) vice properly diagnosing and making precision repairs on this equipment at minimal cost and manpower. Maintenance data shows highly elevated no-evidence-of-failure (NEoF) rates on repair parts examined through the RCM process that are driving up maintenance costs and man-hours expended on TWVs to excessive levels. These maintenance practices ultimately result in an Army that is heavily dependent on a large logistics infrastructure and inadequately trained maintenance personnel, which is counter to the new Multi-Domain Operations (MDO) paradigm.

The DEVCOM Analysis Center categorized failure modes, root causes, and effects for the most frequent TWV failures and developed a preferred set of optimal diagnostic aides, techniques, and task lists that provide for maximum readiness at the least-cost to the unit. These diagnostic resources, referred to collectively as the Compact Diagnostics Package (CDP), will fit in several small kits or backpacks and will greatly reduce the Army's reliance on a large and cumbersome logistics infrastructure.

An analysis effort was initiated that provided electronic diagnostics equipment, commonly replaced parts lists, and advanced diagnostics training in order to assess the ability of maintenance units to properly diagnose and repair components and cease the practice of replacing major assemblies in order to alleviate equipment faults. It is expected that the small repair kits, improved diagnostic tools, and expanded diagnostic capabilities will lead to more cost effective maintenance actions and provide the ability to operate in austere conditions without the reliance on the delivery of major assemblies. Initial findings from the analysis effort highlight the emergence of new diagnostic processes resulting in unprecedented TWV fault repairs, saving hours of repair time and thousands of dollars in unit sustainment costs.

Classification: UNCLASSIFIED // NOFORN
Working Group: WG19 Readiness

59570 - Determining informative maintenance groupings from a large aircraft dataset using natural language processing

Start Date: 6/16/2022	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Emily F. Joback; Cynthia Engholm; Dr. Qinxian Chelsea Curran; Yan Glina; Erin Mitchell

Abstract: Title: Determining informative maintenance groupings from a large aircraft dataset using natural language processing

Authors: Emily Joback, Cynthia Engholm, Qinxian Chelsea Curran, Yan Glina, Erin Mitchell

MIT Lincoln Laboratory is working with the Air Mobility Command (AMC) to explore the application of machine learning techniques to derive insights from aircraft data and develop a predictive maintenance capability. The dataset used in this work consists of KC-135 maintenance activity logs over a one-year period between 2017-2018, which contain large quantities of free text describing aircraft system discrepancies and corrective actions. Previously, we presented several approaches for analyzing aircraft maintenance data that leverage natural language processing (NLP) techniques, demonstrating the potential of NLP techniques for determining groupings of related maintenance activities from the free text [1]. However, refinements to the process were required to achieve groupings specific enough to inform a predictive maintenance model.

For the follow-on analysis, multiple enhancements were made, but these changes increased the volume of data, compounding the complexity of the problem and making many of the standard steps within the NLP framework unfeasible without additional data processing. Data reduction methods were considered to address this issue, which enabled the application of new clustering techniques that were previously impractical due to computational tractability. In this presentation, we will provide a review of prior results as well as a deep dive into the recent enhancements. A comparison of the two result sets will reveal insights about the effectiveness of the NLP process for determining informative aircraft maintenance groupings. It is expected that the resulting NLP framework will play a key role toward building a predictive maintenance capability.

[1] E. Joback, C. Engholm, Q. C. Curran, Y. Glina, A. Chang. “Application of Natural Language Processing to Aircraft Maintenance Data.” The 88th MORS Symposium, Working Group 34 – Data Science and Analytics. June 19, 2020.

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Classification: UNCLASSIFIED
Working Group: WG19 Readiness

60332 - Using Discrete Event Simulation to Aid in Sustainment Analyses

Start Date: 6/16/2022	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Alexander Bertram		

Abstract: Aberdeen Proving Ground, MD 21005-5071Discrete Event Simulation is a powerful tool in any analyst’s toolbox because of the flexibility that it provides in modeling and evaluating process flows. Too often, sustainment analyses are completed using deterministic approaches that do not leverage this capability. Discrete event simulations provide the capability to explicitly model processes while not requiring the expansive costs and time that typical testing would require. There are many low cost and easy to obtain COTS software packages that enable the analyst to model in this

fashion. Over that past several years, the Combat Capabilities Development Command DEVCOM Analysis Center (DAC) has developed the capability to leverage the strength of a well-built discrete event simulation to model a wide array of sustainment related issues. Modeling of this type has been used to evaluate Sustainment KPP metrics (Operational and Materiel Availability), kill chain technologies and timelines, maintenance burdens placed on personnel within units, and spares optimization and placement, to name a few. This presentation will highlight major accomplishments as well a present a path forward on new and improved implementations of this modeling technique.

Classification: UNCLASSIFIED
Working Group: WG19 Readiness

WG20 Analytic Support to Training and Education

60117 - Application of Network Flow Optimization to Accession Planning Challenges at Submarine Learning Center

Start Date: 6/15/2022	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: LT Kevin Lutz		

Abstract: COVID-19 caused major delays in the accession of Non-Nuclear Submarine Sailors in the second trimester of fiscal year 2020 requiring increased accessions in the third trimester to meet the annual accession mission. The third trimester accession plan led to an increased flow of Sailors to Submarine Learning Center (SLC) in the first trimester of fiscal year 2021 creating a sustained backlog that required the stand up of a weekly operations planning team (OPT) to mitigate the impact of the backlog. The OPT has representatives from Naval Education and Training Command (NETC), SLC, Recruit Training Command (RTC), and Navy Recruiting Command (NRC) and has required sustained effort to this day.
The backlog problem has emphasized the need for better tools to inform supply chain stakeholders of capacity limitations. We have addressed this need by developing a network flow optimization model that represents courses as nodes and uses arcs to create the required training paths over time. The network flow model will:
1. Provide a forecast of the execution of the current plan to identify potential backlogs.
2. Identify a flow of Sailors that maximizes supply chain throughput without exceeding capacity limitations.
3. Recommend an optimized flow of Sailors that satisfies production orders and other supply chain constraints.
The NETC N3 team will use this model to navigate the uncertainty of future supply chain challenges in accessions, recruit training, and delivery.

Classification: UNCLASSIFIED
Working Group: WG20 Analytic Support to Training and Education

60008 - Forging the Future at the National Training Center

Start Date: 6/15/2022	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Sean Eskew; MAJ Colby Smithmeyer; Myles Durkin; Candice Farney; Matthew D Smith		

Abstract: The National Training Center (NTC) located at Fort Irwin, CA serves as the Army's premiere combat training center for Stryker and Armored Brigade Combat Teams. The NTC hosts ten rotational training units and trains over 35,000 troops annually. During each rotation, the brigades conduct large scale force-on-force and live-fire exercises in a fully instrumented training environment, which

produce massive volumes of data ranging from daily equipment status reports to GPS enabled battlefield data. To leverage this data, the NTC must expend significant amounts of manpower to capture, collect, process, and visualize the information.

On 1 October 2021, the Commanding General of the NTC visited Army Futures Command (AFC) to establish the foundations for collaboration with AFC's downtrace units. As part of this effort, The Research and Analysis Center (TRAC) has provided ongoing analytic support to the NTC Operations Group to advance their data practices. This initial project focuses on automating the Logistics and Fires Observer-Controller Teams (OCTs) pre-existing data processes and product development. To accomplish this, we applied machine learning techniques to collect, process, and display rotational information on an interactive RShiny dashboard. This dashboard, updated in near real time, displays combat slant, combat power, and critical equipment information based on G-Army data, as well as geospatial displays of fires information uploaded from the Fires OCTs. The application allows senior leaders at the NTC to provide better mentorship and training to rotational units, and more readily identify operational trends across training rotations.

This briefing provides an overview of the problem, methodology, relevant outcomes, and future applications of this analytic effort.

Classification: UNCLASSIFIED
Working Group: WG20 Analytic Support to Training and Education

59701 - Structured Analytic Techniques (SATs) improves Decision Making Capabilities for Intelligence, Surveillance, and Reconnaissance (ISR) Mission Environments

Start Date: 6/15/2022	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Dr Justin Nelson

Abstract: The future of intelligence, surveillance, and reconnaissance (ISR) missions will require enterprise collaboration to disseminate critical data across a multi-domain environment in order to provide our warfighters an edge in the battlefield. It is extremely difficult to determine if the collected data is useful and should be transitioned to strategic planners for future mission tactical moves. As a result, ISR operators are required to adapt to incomplete or vague information which may lead to questionable decision-making outcomes. The objective of this study was to evaluate the effectiveness of structured analytic techniques (SATs) when provided an obscured narrative to support and facilitate current ISR tool development and future technology innovations. Participants were provided with one of three analytic approaches: method for defining analytical questions (MDAQ) which was developed in-house by our ISR subject matter experts (SMEs), a scaffolding approach commonly used in education, and a control approach. Each group consisted of 25 participants (N=25). The findings showed that those who were provided with the scaffolding approach performed significantly better at decomposing the obscured narrative to determine the essential elements of information (EEI) resulting in improved performance compared to the MDAQ and control approach ($p<0.01$). These results provide initial evidence that SATs can be implemented to detect otherwise overlooked EEIs within obscured information. The next phase is to determine if this approach can be transitioned into unclassified ISR situations for tool advancements and training exercises.

Classification: UNCLASSIFIED
Working Group: WG20 Analytic Support to Training and Education

59800 - The Impact of Losing a Single Instructor on Undergraduate Pilot Training Production

Start Date: 6/15/2022	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Mr. Mark D Hatch		

Abstract: The US Air Force's Undergraduate Pilot Training (UPT) program produces a total of over 1200 pilots annually at three Air Force Bases (AFBs): Columbus, Laughlin, and Vance. Instructing the pilot trainees in the classroom, in simulations, and in the aircraft are two types of instructors: Instructor Pilots (IPs) and Civilian Simulation Instructors (CSIs). At the request of the 19th Air Force the Air Education and Training Command's (AETC) Studies and Analysis Squadron (SAS) conducted a study to determine how many fewer pilots would graduate annually due to the loss of a single IP and a single CSI from each UPT base.

AETC SAS conducted this study using a simulation tool, the Executive Decision Model (EDM). EDM models the Air Force's flying training pipeline, including UPT. EDM calculates the impacts that several variables (i.e. weather, number of available aircraft and simulators, number of IPs and CSIs, aircraft utilization rate, maintenance, etc.) have on the production and capacity of the flying training pipeline. AETC SAS, using data provided by 19AF, used EDM to provide graduate capacity calculations, and created two separate statistics from the analysis to calculate the contribution of a single IP and single CSI at each UPT base.

Classification: UNCLASSIFIED
Working Group: WG20 Analytic Support to Training and Education

60101 - Virtual Reality Enhancement of Geospatial Military Intelligence Training

Start Date: 6/15/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Myles Durkin; Charles Timm; Dr. Rudy Darken; Brian Wade		

Abstract: The Army Intelligence Center of Excellence (ICOE) seeks to explore how virtual reality (VR) and 3D game-based tactical identification training could enhance the training and test scores of military intelligence soldiers in selected modules of Advanced Individual Training (AIT).

Partnering with Naval Postgraduate School (NPS) faculty and graduate students, The Research and Analysis Center (TRAC) developed two proof-of-principle applications designed to address training challenges experienced by geospatial intelligence analysts using unclassified 3D models, the Unity game engine, and Oculus Quest 2 VR devices. The team designed an experiment to determine whether the injection of 3D models using VR and desktop platforms would increase the students' overall test scores on the vehicle identification test. Using a control group and two separate cohorts of AIT students, the team collected qualitative and quantitative data to determine the effectiveness of the supplemental training.
This briefing will provide an overview of the research, application and experiment design methodology, relevant outcomes, lessons learned, and future applications of this research.

Classification: UNCLASSIFIED // FOUO
Working Group: WG20 Analytic Support to Training and Education

WG21 Operational Energy

60587 - Improved Operational Energy Modeling Support to Analytic Wargaming, an Argument for Capability Consolidation

Start Date: 6/14/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Dr. Dominick' Wright		
Abstract: Since around 2010, joint operational energy – as analyzed by the services, office of the secretary of defense, and Joint Staff – has evolved considerably. Once relegated as an afterthought to system acquisition and deliberate plan assessments, those who embrace the importance of sustaining the force using fossil fuels and other means are considerable in number and include more than logisticians. Consider Air Force and its Title X wargaming as an illustrative example of change. Whereas in the Global Engagement (20)16 capstone, the Air Force minimally conditioned (according to munitions inventories) the generation of combat power, gameplay in Global Engagement (20)22 capstone conditionally constrained prosecution of the joint integrated prioritized target list (JIPTL) according to the availability of airfield infrastructure, airframes, munitions, and jet fuel. A modeling and simulation system of systems (M&S SoS) drove this enhanced, operations-integrated logistical realism in gameplay. Modelers, analysts, and game planners made the system work with difficulty. Disparate data sources and formats combined with ad hoc transfer processes and conflicting assumptions to require regular complementary injections of professional military judgment into the system. Knee jerk reactions to the outcome renewed the call for surveys of available operational energy modeling capabilities. Knowledge about existing tools and others under development is important but not just for curating an ever-growing, non-standard federation. Leveraging the information to support model reduction can be just as important. Focusing on transport modeling and the analysis of liquid bulk as a subset, the presenter argues that while the Defense Department should continue avoiding model unification efforts pursued during the Joint Warfare System (JWARS) program, it should support select cases of model and data consolidation. In this case, the presenter advocates for enhancing the Analysis of Mobility Platform's scenario data sets rather than building yet another operational energy network model separate from the rest of our analytical tools and processes. Doing so will simultaneously enhance analytic wargaming supportability analyses for deliberate planning. Classification: UNCLASSIFIED Working Group: WG21 Operational Energy		

59752 - Need, Function, and Requirements Analysis for Liquid Air Energy Storage Prototype on a Military Microgrid

Start Date: 6/14/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: LCDR Christofer J. Fackrell; LT Frank Smeeks; LT Denntrick Horton; LT Jasmine Sweet; LT Steven Arnold; Dr. Anthony Pollman		
Abstract: Islanded, renewable microgrids suffer from intrinsic, intermittent electric energy generation. Intelligently controlled energy storage can mitigate intermittent generation. Due to its gravimetric and volumetric energy density, as well as other favorable characteristics, liquid air energy storage is a promising storage solution for remote, islanded, military microgrids. Power in excess of immediate demand can be used to make and store liquid air. Later, when demand exceeds generation, the liquid air can be used to generate electric energy. This work employed a systems engineering approach to analyze and define the need, functions, and requirements for a liquid air energy storage and recovery system (LAESRS) for the 3-kW microgrid at the Naval Postgraduate School. Needs analysis uncovered stakeholders' desire for a tabletop LAESRS prototype employing		

automated and controlled liquid air production, storage for one week, and subsequent energy recovery to match energy generation with demand. Subsequent functional analysis yielded four primary functions and 19 sub-functions. Requirements analysis resulted in set of measures that trace through the functional hierarchy back to stakeholder need. A morphological box was used to outline combinations of possible components, sub-systems or technologies that could satisfy system requirements. Future work will include analysis of design alternatives, selection of a preferred design based on a value hierarchy, development and refinement of system measures of effectiveness and performance, construction of a tabletop prototype, and test and evaluation to verify and validate the degree to which the prototype addresses the desired system capability.

Classification: UNCLASSIFIED
Working Group: WG21 Operational Energy

59805 - Coupled Dispatch of Microgrids for Islanded Resilience and Grid-Connected Economics

Start Date: 6/14/2022	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Mackenzie Wodicker

Abstract: This talk develops and applies strategies for microgrid control and risk aversion to maintain resilience during islanded operations in the event of a grid outage and provide energy and demand cost-savings during grid-connection operation. Specifically, this work develops a model predictive control (MPC) approach to (1) operate in grid-connected mode to minimize the total operational cost and to consider preservation of DER assets, such as battery storage or fossil fuel generators, in the potential event of a grid outage. (2) to mitigate risk by applying statistical modeling techniques to calculate microgrid survivability (probability to serve 100% of critical load) for 7-14 days of operation during a grid outage. (3) to consider continuous microgrid operations for planned and unplanned maintenance schedules and quantify the impact on microgrid survivability. Optimal objectives for grid-connected operation use weighting factors to prioritize the consumption of energy from a utility interconnection, distributed generators, or battery storage. These weighting factors influence the control decisions employed to ensure local energy sources can serve local loads during utility outages. Asset outage modeling allows for analysis of planning maintenance schedules to minimize negatively affecting survivability and better understand the relationship of survivability and individual asset availability. Results will be presented for a Navy military installation. This work is sponsored in part by the DoD Environmental Security Technology Certification Program (ESTCP).

Classification: UNCLASSIFIED
Working Group: WG21 Operational Energy

61172 - Discussion Panel Part 1: Energizing Future Forces

Start Date: 6/15/2022	Start Time: 8:30 AM	End Time: 10:00 AM

Authors: Jason Bell

Abstract: What types of energy forms should power future U.S. military forces? The predominant Operational Energy (OE) sources for current and programmed military equipment are liquid petrochemical (e.g. JP8, JP5, F76, etc.) fuels. Looking forward we must assess which energy sources will: ensure our fighting forces maintain operational dominance; maintain the security of our country; enable us to be interoperable with our allies; and, align with climate adaptation and mitigation objectives. It is highly improbable that a single energy source will comprise the solution; rather, a combination of energy sources that are aligned to availability, the operational environment, and other similar factors will likely be required to achieve the aforementioned objectives. To inform this

transition new or more robust analytic modeling and simulation capabilities are needed to evaluate energy demand by source, understand future hybrid supply networks that will be used to convert and distribute multimodal forms of energy, and understand how the various energy alternatives and supply chains impact military operations from the tactical to the campaign level. This emergent analytical space includes questions regarding the end-to-end cost of a “multi-energy-source” military, total cost (including R&D, system investment, energy generation and distribution) of a modernized sustainment architecture, impact on military operations, and impact on the environment and climate. Diversification of energy sources could increase resiliency yet could management of more supply chains increase risk to operations? With all this in mind, analysts supporting the OE community must ask one another: how do we progress our tools and techniques and work together to assess each of these concerns individually while simultaneously finding the appropriate balance between these overlapping and competing priorities? No small challenge, for sure.

Classification: UNCLASSIFIED
Working Group: WG21 Operational Energy

60229 - Hyrbid Power Systems

Start Date: 6/15/2022	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Bjorn Kristoffer Oberg; David Pogue; Jonathan Michael Goebel; Tom Decker		

Abstract: Resilient energy systems are critical enablers for conducting multi-domain operations (MDO) in a highly contested environment. Advancements in technologies serve as combat multipliers for US forces, but continue to increase power requirements. Previous military operations reported a fully burdened fuel cost of 4:1, in that it cost 4 gallons of fuel to deliver 1 gallon of fuel to the operating environment. Current estimates for conducting operations in the continent of Africa and the Arctic place the fully burdened rate at 10:1. Ensuring overmatch will require the US forces to efficiently increase energy availability to the warfighter while reducing the logistics burden of resupply convoys. The current program of record generators, Advanced Medium Mobile Power Systems (AMMPS), are sized to meet the peak demands of a load. Current systems are often loaded at 30% capacity on average, which reduces the fuel efficiency of the system and increases the maintenance burden on a unit. This has led to the development of the US Army Engineer Research and Development Center (ERDC) Construction Engineering Research Laboratory (CERL) Hybrid Power System (HPS) concept. The HPS is composed of AMMPS generator(s), a high energy density (lithium-ion) energy storage system, and a ruggedized tactical inverter system. This allows generators to be more optimally loaded, supplying the energy requested by the load while discharging any remaining capacity into the energy storage system. This stored energy can then be used to cycle off the generator to save fuel or conduct silent operations, or provide peak-shaving capabilities, eliminating the requirement for spinning reserve. This presentation will outline lessons-learned from previous hybrid prototypes as well as discuss current systems and prototype developments.

Classification: UNCLASSIFIED
Working Group: WG21 Operational Energy

59865 - Atmospheric Impacts on Future Hybridized Tactical Power

Start Date: 6/15/2022	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Gail Vaucher; Mr. Morris Berman; Micheal 'Sean' D'Arcy; Dr Robert Scott Jane; Dr. Michael Lee; Prof Gordon Parker; Thomas Price; Jessica Whitaker		

Abstract: Integrating heterogeneous energy resources is one way to maintain uninterrupted battlefield power, ensuring a tactical advantage. Hybridized tactical power systems require model-based energy management strategies to harmonize diverse assets such as fossil fuels, photovoltaics (PV), and energy storage. Predicting an asset's power generation ensures that future power needs are met. Electrical loads and renewable generation depend on atmospheric conditions; thus, it is essential that atmospheric models are accurate and used by a hybrid power, energy management system. Artificial intelligence and machine learning techniques hold much potential in this area.

Solar radiation and panel temperature are two critical atmospheric elements needed to predict power from a PV panel. Ambient temperature is often used instead of panel temperature resulting in prediction errors. How does this convenient, yet approximate, approach impact PV power-generation model accuracy? Do these errors affect hybridized power energy management? This presentation will review diurnal and seasonal patterns in the two critical PV panel atmospheric parameters, compare panel-temperature acquisition methods, and describe their effects on energy management performance.

Classification: UNCLASSIFIED
Working Group: WG21 Operational Energy

59869 - Developing Photovoltaic Array and Panel Temperature Predictions Using LSTMs and Kth Nearest Neighbor Classifiers to Quantify Atmospheric Uncertainty

Start Date: 6/15/2022	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Dr Robert Scott Jane; Gail Vaucher; LTC Corey James; Mike Cook; Mr. Morris Berman; Micheal 'Sean' D'Arcy; Dr. Michael Lee; Thomas Price; Prof Gordon Parker		
Abstract: As the U.S. Army continues to modernize toward a fully connected multi-domain battlespace, technological advancements in energy and power (E&P) have lagged. E&P advancements require prohibitively large financial costs, and offer little operational improvements to the warfighter. The most effective and efficient option to further U.S. Army E&P capabilities is to develop and deploy tactical hybridized energy network-based solutions. Hybrid energy networks can improve survivability and lethality of operation by diversifying the way energy is effectively and efficiently managed, generated, and transmitted across the battlefield. In this presentation, we review the development of Artificial Intelligence (AI) and Machine Learning (ML) to predict future ambient temperature, a critical parameter in the power generation calculation. Using a set of Long Short-Term Memory Artificial Neural Networks (LSTMANNs) and Kth Nearest Neighbor (KNN) classifiers, ambient temperature predictions range from a few minutes to several hours. By combining the LSTMANN and the KNN, we not only develop predictions but provide a means to assess the AI/ML based algorithm applicability. This evaluation provides an understanding of atmospheric uncertainty, which in turn can be attributed to energy generation and consumption. Classification: UNCLASSIFIED Working Group: WG21 Operational Energy		

60382 - Educational Wargaming of Operational Energy

Start Date: 6/15/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Nick Ulmer		
Abstract: We developed and played an educational DND-style game with an ultimate goal of providing an enriching experience of how operational energy is a critical component of military force		

development. The purpose of the game was explained to players as a visceral sense of winning or losing based on the operational energy decisions made in two phases of gameplay. They achieve this through connecting procurement and technology investment decisions to operational consequences. The focus has been on education and provocation vice analysis. However, comments from students afterwards provide evidence of lasting impression, understanding, and appreciation for the complexity of operational energy in warfare.

Classification: UNCLASSIFIED
Working Group: WG21 Operational Energy

60325 - Automated Artificial Intelligence (AI) Global Terrain Classification

Start Date: 6/15/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Chongying Wang		

Abstract: This Artificial Intelligence (AI) / Machine Learning (ML) application transforms terrain type classification approaches and fundamentally revolutionizes military vehicle route planning, fuel/ energy consumption estimation, and virtual simulation of battlefield scenarios. This approach leverages existing test data and uses AI/ ML techniques to extend the application of information to areas of the world for which test data are unavailable, and enables sustainment-related predications for locations where adversaries are likely to operate. This AI/ ML enabled classification method can be used to support both future acquisition decisions, and sustainment-related operational decisions.

Terrain type is a key factor estimating military vehicle fuel/ energy consumption, and terrain classification will be a significant challenge as the Army considers multi-function and Multi-Domain Operations (MDO) across a diverse set of terrains. It will be even more challenging to plan operations in parts of the world unknown to our Forces. In contested environments during MDO, one of the most important questions is going to be how far can you go (operational reach), and how long can you stay there (operational duration)? The answer, in part, can be obtained by leveraging the Google Earth Pro database, with Digital Terrain Elevation Data level II (DTED II), in conjunction with the Google Earth Pro software which simulates driving over global terrains. This project's transformational contribution is creatively training a popular pre-trained deep machine learning AI system – GoogLeNet, which was created by Google with 22 layers deep convolutional neural network. To date, efforts have been verified against well-defined Aberdeen Proving Ground and Yuma test courses on Google Earth. By applying the re-trained GoogLeNet to classify terrains from simulated driving video anywhere across the world, terrains otherwise unfamiliar to our Forces, could be modeled appropriately within our vehicle fuel / energy consumption suite of models, to significantly improve the accuracy of operational range and duration estimates in contested environments.

Classification: UNCLASSIFIED
Working Group: WG21 Operational Energy

60004 - Modeling the Operational Feasibility of Synfuel from Seawater

Start Date: 6/16/2022	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: Stephanie Brown; Brant Horio; Michael Anderson; Simon Whittle; Lucas McCabe; Christopher Johnson; Stuart Funk		

Abstract: A critical factor for deterrence is the ability to resupply our forces to maintain extended physical presence and to support sustained military operations. Given continued National interest in the Pacific, future marine and aviation fuel generated from alternative sources such as seawater, is a

potential game changer for naval replenishment logistics. In addition to the engineering challenges for making this technology a reality, the impact on logistics and operations must be fully understood. In this talk, we discuss how modeling and simulation may be used to support feasibility studies of sustainable aviation fuel.

Classification: UNCLASSIFIED
Working Group: WG21 Operational Energy

61182 - Discussion Panel Part 2: Energizing Future Forces

Start Date: 6/16/2022	Start Time: 10:30 AM	End Time: 12:00 PM
Authors: Dr. John R. Hummel, FS		
Abstract: What types of energy forms should power future U.S. military forces? The predominant Operational Energy (OE) sources for current and programmed military equipment are liquid petrochemical (e.g. JP8, JP5, F76, etc.) fuels. Looking forward we must assess which energy sources will: ensure our fighting forces maintain operational dominance; maintain the security of our country; enable us to be interoperable with our allies; and, align with climate adaptation and mitigation objectives. It is highly improbable that a single energy source will comprise the solution; rather, a combination of energy sources that are aligned to availability, the operational environment, and other similar factors will likely be required to achieve the aforementioned objectives. To inform this transition new or more robust analytic modeling and simulation capabilities are needed to evaluate energy demand by source, understand future hybrid supply networks that will be used to convert and distribute multimodal forms of energy, and understand how the various energy alternatives and supply chains impact military operations from the tactical to the campaign level. This emergent analytical space includes questions regarding the end-to-end cost of a “multi-energy-source” military, total cost (including R&D, system investment, energy generation and distribution) of a modernized sustainment architecture, impact on military operations, and impact on the environment and climate. Diversification of energy sources could increase resiliency yet could management of more supply chains increase risk to operations? With all this in mind, analysts supporting the OE community must ask one another: how do we progress our tools and techniques and work together to assess each of these concerns individually while simultaneously finding the appropriate balance between these overlapping and competing priorities? No small challenge, for sure. Classification: UNCLASSIFIED Working Group: WG21 Operational Energy		

WG22 Military Assessments

59867 - Challenges in conceptualizing and modeling performance in the U. S. Army

Start Date: 6/14/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Dr. Joel Thurston; Nathaniel Ratcliff; Aritra Halder; Joshua Goldstein; Eric Oh; Joanna Schroeder; Aaron Schroeder; Stephanie Shipp; Dr. Sallie Keller		
Abstract: It is easy to find references to "performance" across Joint and U.S. Army doctrine. For example, JP 3-0 defines Measures of Performance and ADRP 7-0 describes the need to evaluate individual and organizational performance. These documents make it clear that assessing performance is crucial to military operations. Yet despite these many references, pinning down an overarching, operational definition of Soldier performance is no easy task. Instead, the focus on metrics inextricably links performance to accomplishing context specific tasks or achieving specific		

end states. Consequently, performance becomes a binary condition. You have 'performed,' for example, if you check an item off a Mission Essential Task list or achieve Qualified status with a weapons system. Even when not treated as binary, Soldier or unit performance is typically recorded in discrete categories (e.g., rated as Trained, Practiced, Untrained on an Objective Task Matrix).

While this view is useful in accomplishing goals set by doctrine or commander's intent, it is not easy to reconcile it with how other large-scale organizations, industries, and academia typically conceptualize performance as a multi-faceted concept, often measured on a continuous spectrum. In cases where engagement across these areas does occur, there is often a lack of sufficient granularity in DOD performance-related data to allow for the types of analysis that would be most useful – thus blunting the ability to leverage external perspectives.

Our research addresses this challenge by introducing conceptual and methodological profiling into a data science pipeline. By marrying data science practices with social science research techniques, we provide data users and researchers with qualitative tools to derive additional understanding. Using taxonomies to categorize variables and produce metadata, we capture how variables were created or recorded and the concepts they represent. We then show how (guided by theory) these concepts and their associated variables can be reassembled into a conceptual framework that is statistically representable.

These processes are demonstrated utilizing the vast stores of U.S. Army administrative and survey data contained within the Army Analytics Group's Person-Event Data Environment (PDE). Our conceptual and methodological profiling of these data sources, coupled with an extensive literature review of related topics, gives rise to a conceptual performance framework informed by multiple perspectives that is flexible enough to incorporate administrative military data. This framework can be used to guide descriptive and predictive analytics and inform policy decisions as they relate to individual and team performance.

Classification: UNCLASSIFIED
Working Group: WG22 Military Assessments

59760 - The Risk of Strategic Deterrence Failure (RoSDF) Assessment and the USSTRATCOM J73 Assessment Enterprise - Supporting a Continuum of Assessment

Start Date: 6/14/2022	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Martin Robert Apprich; Reginald Henry Rice

Abstract: The Risk of Strategic Deterrence Failure (RoSDF) Assessment and the USSTRATCOM J73 Assessment Enterprise - Supporting a Continuum of Assessment

The USSTRATCOM Assessments Division/J73 directs and employs a wide range of data-driven assessments across a Continuum of Assessment. These assessments inform strategy development, operational planning, resource prioritization, operations execution and advocacy across all of USSTRATCOM's assigned Unified Command Plan Mission Areas.

This Continuum of Assessment help the command better understand the strategic and operational impacts of USSTRATCOM's Operations, Activities, and Investments (OAI's) on the strategic and operational environments.

Our Continuum of Assessment is comprised of the Campaign Assessment, the RoSDF Assessment in the Current temporal domain (0-2 years/0-96 hours in crisis) and Future temporal domain (2-15 years). The Campaign Assessment Methodology employs the traditional elements of assessment structure (Objectives-based, Measures of Effectiveness (MOE) and Performance (MOP)). The Campaign Assessment is a data-driven, discussion-based process that involves a multi-level, Subject Matter Expertise-enabled vetting process. The RoSDF assessment process originated in 2020 as a Secretary of Defense directed focused assessment designed to inform Globally Integrated Deterrence Operations. The core venue for these processes is the Command Assessment Cell (CAC). The CAC convenes weekly or as needed during Steady-State, Crisis, or Contingency. Members consist of Action Officers from across the Headquarters Directorates as well as Components.

J73's assessments are supported with a suite of infrastructure and software to input (Microsoft Access), process (R, Python….) and visualize data (Tableau Desktop Professional, Server).

This assessment process has been lauded in the Exercise Global Thunder 2018 Joint Staff Hotwash Summary: "(U) USSTRATCOM produces a true Command Assessment; anchor point of the Commander's Decision Cycle."

We provide this overview of the USSTRATCOM J73 Assessment Enterprise (J73AE) and a deep dive into the USSTRATCOM Commander's Risk of Strategic Deterrence Failure (RoSDF) Assessment in an effort to share methods and encourage collaboration among the assessment community. [288 Words]

Presentation ID: 59760
Presentation Classification: SECRET//REL TO USA, FVEY
Presentation Venue: 90th MORS Symposium; Working Group 22 – Military Assessments
Presentation Distribution Statement C. Distribution authorized to U.S. Government Agencies and their contractors
Presentation Duration: 30 minutes (25+5 Minute Q&A)
Presentation Media: Microsoft PowerPoint

Classification: SECRET//REL TO FVEY
Working Group: WG22 Military Assessments

60035 - Connecting Outcomes to Indicators: A Multiservice Manual Spells Out How to Do It

Start Date: 6/14/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Dr. Adam Patrick Shilling		

Abstract: Although merely collecting metrics is not sufficient for conducting operation assessment, it is still necessary to collect empirical evidence on the operational environment, and our place in it, so that the assessment is as free of bias and as accurate as possible. This presupposes a method to determine what evidence should be gathered. The author posits "a way" to go about this critical task, and also to preserve hypothetical causal links and relationships between outcomes and indicators and between related indicators, that must be analyzed together in order to understand the dynamics of the operational environment and our effect upon it. This model is based on the approach described in Appendix A of the multi-service Operation Assessment manual referenced below. This model also helps with planning and design, in breaking down the changes in the environment joint forces desire, and how to specify those changes as orders to the organizations who will execute them. The model

has proven useful for a variety of organizations, and has inspired a derivative model published in JP 5-0 (2017).

Over the past several years, the author has found an update of the original model preferable to its JP 5-0 derivative. The original model and explanatory notes are found in Appendix A of the multiservice publication, Operation Assessment. Its publication numbers are ATP 5-0.3, MCRP 5-10.1, NTTP 5-01.3, and AFTTP 3-2.87 for the various services. A description of the model is also found in NATO Science and Technology Organization's publication, TR-SAS-110 Operations Assessment in Complex Environments: Theory and Practice.

This presentation will highlight how to use the model for assessment, and also explain its value in the design of operations and campaigns.
Keywords: assessment, operation assessment, effectiveness, indicators, metrics, measures, causality

Classification: UNCLASSIFIED
Working Group: WG22 Military Assessments

59775 - Operation Assessments at United States Cyber Command (USCYBERCOM)

Start Date: 6/14/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Mr. John Walsh; Dr. Francine Nelson; E. Thomas Powers; Christine Faulent		

Abstract: USCYBERCOM Operation Assessments Branch produces an operation assessment for the USCYBERCOM Annual Campaign Operation Order (ACO), as well as operation assessments for priority operations. This presentation will provide a summary of the USCYBERCOM operation assessment methodology and products used to present findings on achievement of ACO objectives and recommendations for improvement. This methodology includes a hierarchical approach using traditional assessment elements of Objectives, Effects, and Indicators. Additionally, the assessment also provides information on the mission posture of units conducting cyber and information operations. The process to produce assessments involves a substantial data collection effort through interactions with multi-level subject matter experts and stakeholders from across the Headquarters Directorates and Subordinate Headquarters. Finally, this presentation will conclude with discussion on how USCYBERCOM Operations Directorate (J3) is working to standardize metrics and automate data collection to provide assessment information at all levels of USCYBERCOM.

Classification: SECRET//REL TO FVEY
Working Group: WG22 Military Assessments

60069 - Army Continuum of Analysis Meta-Analysis

Start Date: 6/14/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: LTC John Ferguson; Mr. Brian A. Hodges; Raymond Sibaja		

Abstract: The Analytic Continuum of Analysis (ACA) examines enduring questions that our analytic community must answer to support Army Senior Leader decisions, synchronizes and focuses analytic efforts around those questions, and identifies gaps in the analytic support to major decisions. In mid-June 2021, the ACA Analytic Board of Directors (ABoD) directed The Research and Analysis Center and the Center for Army Analysis to perform a quick-turn meta-analysis of the current modernization efforts supporting the Army in 2030 and supporting the Army beyond 2030 as a proof-of-principle. The Fiscal Year 2021 ACA meta-analysis used products from 10 Army analytical agencies to

demonstrate how the ACA could leverage analytic and wargaming efforts to assess how our modernization efforts are supporting the Army.
This presentation will describe the process and tools used to obtain, integrate, and synthesize study results across a representative set of Army analytic agencies for a modernization assessment the Army in 2030 and the Army beyond 2030 and provide the lessons learned in conducting this type of assessment.

Classification: SECRET NOFORN
Working Group: WG22 Military Assessments

59968 - SPACECOM's mission command framework and transformation of warfighter tasks

Start Date: 6/14/2022	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Joseph Troy Morgan; Michael Teter

Abstract: The 2020 Department of Defense (DoD) Data Strategy highlighted the departments' shift to becoming a data-centric organization, which USSPACECOM has sought to exemplify. As part of the command's continual improvement, the Data Management Framework was created to capture a planned 3-year approach to implement a data-centric transformation, accelerating data management and analysis capabilities enabling advanced warfighter decisions. At the heart of the framework is the identification and transformation of warfighter tasks to free up human capital and achieve digital dominance. SPACECOM has leveraged a mission command framework to help identify and characterize these tasks, differentiating between real-time and non-real time as well as "back end" business processes versus operational tasks. In particular, the process seeks to uncover specific mission threads (warfighter tasks), identify/streamline common and similar missions and authorities while identifying the requirements, in particular C4I needs, to operationalize the transformation. This framework and process will be shared to help build best practices across the DoD and awareness of SPACECOM's mission.

Classification: UNCLASSIFIED // FOUO
Working Group: WG22 Military Assessments

60016 - Planning the Assessment Process: A Multiservice Manual Spells Out How to Do It

Start Date: 6/15/2022	Start Time: 8:30 AM	End Time: 9:00 AM

Authors: Dr. Adam Patrick Shilling

Abstract: A new multiservice publication, or more accurately, the 2020 update of a publication, spells out conceptually in just a few pages, how to plan an assessment process. The purpose of an assessment process is to enable more effective operations from any organization. It follows that any organization, large or small, even any decision-maker, can benefit from an assessment process. While the entire publication is a step forward in thinking about assessment processes, the section of Chapter 2 on planning the process conceptually is particularly valuable. It is also short, but dense. A single reading is not enough to understand all there is. This presentation will highlight the contents of this section to help a reader get the most out of reading it the first time. The text itself should bring someone designing or improving a process back for a re-read.

The manual is a multiservice publication, "Operation Assessment." Its publication numbers are ATP 5-0.3, MCRP 5-10.1, NTTP 5-01.3, and AFTTP 3-2.87 for the various services. This presentation will focus and expand on the assessment planning process described in Chapter 2, sections 6-16.

Keywords: assessment, operation assessment, effectiveness, indicators, metrics, measures, causality Classification: UNCLASSIFIED Working Group: WG22 Military Assessments

59944 - Developing a Standard Methodology for Assessing Multinational Interoperability

Start Date: 6/15/2022	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Ms. Sarah E Stewart		
Abstract: As a multinational alliance, the North Atlantic Treaty Organization (NATO) is most effective when its member nations can bring their forces together with confidence on short notice. As a result, it is critical for senior leaders to understand the degree to which their national forces are interoperable before operations begin. The Systems Analysis and Studies (SAS)-156 group was formed to develop a NATO standard for interoperability data measurement, collection, and assessment. The study group's research will help NATO move towards a standard for interoperability data definition, collection, and management. The resulting assessment framework will allow military planners to better understand the state of interoperability with their partners and discuss those assessments in a common manner. Additionally, these assessments will inform resourcing decisions of individual nations as they pursue their own interoperability objectives. The authors will present their work on synthesizing and extending existing assessment frameworks based on defined levels of interoperability for various domains. Classification: UNCLASSIFIED Working Group: WG22 Military Assessments		

60163 - Agile Combat Employment Assessment

Start Date: 6/15/2022	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Ms Susan Swink		
Abstract: Agile Combat Employment (ACE) is "a proactive and reactive operational scheme of maneuver executed within threat timelines to increase survivability while generating combat power throughout the integrated deterrence continuum." A critical component for the Pacific Air Forces (PACAF), the ACE concept enables Air Operations to project power across the Pacific theater with a lean and mobile force. ACE is an evolving concept which requires a flexible assessment methodology to inform key doctrinal and implementation decisions. To illustrate the ACE assessment process, this presentation will show attendees how PACAF has assessed the early stages of ACE from concept development to recommendations. Classification: SECRET NOFORN Working Group: WG22 Military Assessments		

59637 - C2IE: Facebook + Database = Global Linkage & Visibility of Data

Start Date: 6/15/2022	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Rebecca Porinsky		

Abstract: Command and Control of the Information Environment (C2IE) is an Office of the Secretary of Defense (OSD) Strategic Capabilities Office (SCO) sponsored web-based system accessible from NIPR and SIPR that is designed to enable commanders to sense, understand and respond to the information environment (IE) in near real time. C2IE enables global integration and collaboration supporting Department of Defense (DoD) shaping efforts from peacetime through armed conflict.

This demonstration, from a COCOM perspective, will describe uses of C2IE and demonstrate platform features including both vertical and horizontal linkage and global visibility of data between plans, activities and assessments at various levels from the Components to the COCOMs to the Joint Staff.

Classification: UNCLASSIFIED
Working Group: WG22 Military Assessments

60231 - Measuring Escalation through HQ Crowd Sourcing

Start Date: 6/15/2022	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Mr Richard Peter Hoyes; Maddy Taylor

Abstract: Defence has increasing been adjusting its position to focus efforts on deterrence below the threshold to class the situation as war. Typically the situation between two opposing states can easily escalate or deescalate in tension and actions, as we have seen with recent events. To understand how a planned operation may impact this tension or how it may progress, a standardisation is need to help the “measurement” or estimates of this into the future and across different Operational Headquarters. Without this, a description of the level of tension can be highly subjective to an individual and their perception.
We have developed a framework for understanding and tracking the tension and actions between two players: nations, factions or simply two people. This escalation framework builds on existing methodologies and allows an objective approach to encapsulate a range of opinions or judgements of a situation. This standardised framework allows different people to use the same tool to either measure the current state or progress and also able to explore how an operation may escalate or deescalate into the future.
This escalation framework approach for measuring progress and supporting planning was put into action on a multinational deterrence exercise using key subject matter experts. Furthermore, an alternative approach was run in parallel – to crowd source the measurement of escalation/de-escalation through the understanding of the whole HQ, thereby capturing the perceptions and situational awareness of all the staff involved. This allowed to open discussions into how future actions or operations designed to deter or de-escalate may play out on the world stage.

Classification: UNCLASSIFIED
Working Group: WG22 Military Assessments

60103 - Force Design Update (FDU) Prioritization Support for Total Army Analysis (TAA)

Start Date: 6/15/2022	Start Time: 11:30 AM	End Time: 12:00 PM

Authors: Dereck Kennedy; Regina Rauer; MAJ John Walter Barlow, Jr.

Abstract: The Army must continually evolve to best address the ever changing challenges of the current, highly dynamic global operating environment. How the Army will do this is being codified in Multi Domain Operations (MDO) doctrine and the necessary formations for the future are defined by the Army 2030 and 2040 concepts. Unfortunately, the transition from the Army that met the asymmetric challenges of the last two decades to the MDO capable force described by the Army 2030

concept is not instantaneous. Instead, it is an incremental transformation that spans the DOTMLPF-P spectrum. The Army's mechanism for developing and implementing this deliberate transformation is the Force Design Update (FDU) process. FDU prioritization prior to TAA has, in recent years, been guided by a clear set of Army-wide priority capability gaps. This is no longer the case; consequently, The Research and Analysis Center (TRAC) was asked to provide analytic support to the Total Army Analysis (TAA) prioritization effort.

At the direction of the Commanding General for Army Futures Command (AFC), TRAC and the Combined Arms Center-Force Design Directorate (CAC-FDD) partnered to provide analysis that prioritizes and supports Army 2030 FDUs considered for TAA 25-29. Initially, the TRAC study team identified key attributes and measures required to differentiate and quantify relative FDU value. Next, attributes and measures were incorporated into remote assessment tools that were distributed to Force Modernization Proponent and Operating Force commanders, commandants, and senior representatives. The study team then leveraged multiple analytic techniques to translate these inputs into a prioritized list of FDUs with supporting analysis.

The presentation will focus on two aspects of the study. First, it will describe how the study team used a combination of Intensity of Preference Adjusted Borda Count ranking, visual analogue scales (VAS), and dependency matrices to elicit the necessary data for follow-on analysis. Secondly, it will describe how different analytic techniques were used to determine a proposed FDU prioritization supported by analysis of FDU interdependencies and uncertainty. Techniques that will be discussed include simulation, Multi-Attribute Decision Analysis, network analysis, and optimization.

Classification: UNCLASSIFIED
Working Group: WG22 Military Assessments

60250 - Project Convergence: Joint Integrated Data Analytics Approach

Start Date: 6/15/2022	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Mr. Alfonso Pesqueira

Abstract: Principal Author: Mr. Alfonso Pesqueira
Co-author(s): Ms. Danielle Aldrich, Ms. Cathy Miller
Presenter: Mr. Alfonso Pesqueira
Classification of Presentation: Controlled Unclassified Information
Presentation Distribution Statement: Approved for public release, distribution unlimited.
Working Group(s): WG27 – Decision Analysis; WG22 – Military Assessments

Abstract Title: Project Convergence: Joint Integrated Data Analytics Approach
Abstract text (limit 3,000 characters including spaces):
Project Convergence (PC) provides a venue to demonstrate and understand capability requirements underpinning the Joint All Domain Command and Control (JADC2) construct and execution of Joint All Domain Operations. The concept for PC is to run a large-scale field integration/experiment event on an annual cycle. Each iteration of PC provides a venue to conduct an annual assessment of capabilities as an integrated system to further refine and/or inform technology and concept capability requirements.
As part of the PC year-over-year campaign of learning, the PC21 effort considerably expanded the scope and scale of PC20, which focused on enhancing the close fight in multi-domain operations, to driving Joint Integration as part of JADC2. The objective of PC21 was to inform, develop, and integrate

an interoperable Joint Force capable of decision multi-domain maneuver. The PC20 lessons learned enabled the Integrated Analysis Team from The Research and Analysis Center (TRAC), Army Test and Evaluation Command, Data and Analysis Center, and Joint Modernization Command to understand what needed to be shaped within the PC21 planning process. The execution of PC21 enabled the team to more clearly identify data required and necessary expertise to ensure the analytic community is poised to focus on the key measures to successfully plan and execute data collection and analysis for PC22.
This presentation will provide an overview of the multi-line of effort approach for PC21 data collection and accelerated in-stride analysis, lessons learned from PC21 and their application to PC22, and a description of the challenges and opportunities associated with informing the AFC's PC campaign of learning initiative.

Classification: UNCLASSIFIED // FOUO
Working Group: WG22 Military Assessments

60296 - Systems Thinking for National Defense and DoD Enterprise Systems Challenges

Start Date: 6/15/2022	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Mr. Carl J. Unis

Abstract: .Systems thinking tutorial orients on the future of our Military Operations Research profession: "Where do we need to be going?"; "What should we be doing?"; "How should we be thinking differently about these challenges?"; How can we address new and innovative ideas that need to be vocalized to address interconnected, interdisciplinary, multi-dimensional systems architecture challenges and the countless strategic enterprise systems challenges that currently plague our DoD systems? With the correct framework, these complicated challenges can be addressed and pursued.

The German philosopher Hegel noted "We learn from history that we don't learn from history." The revolving door of re-learning processes with every catastrophic event, that often cascade out-of-control, frequently results in systems with significant financial or operational damage. In the systems engineering world, interconnected complexity relates to the multitudes of complex systems and subsystems, both internally and externally, often termed as ecosystems of ecosystems. For example, a ground-based satellite communications system must be connected to a power grid and may have a backup generator to maintain operational capability during an outage. An unintended consequence of the COVID-19 pandemic is that it has forced organizations and enterprises to reconsider their business models, operational models, re-examine their supply chain's resilience to shock and strengthen their supply chain foundations. Unfortunately, this resiliency was not checked or re-examined in many instances, bottlenecking and stove piping many organizations' ability to provide critical services and distribute supplies as needed. This will be a continual evolutionary process and needs to be addressed as such.

We need to utilize systems thinking to visualize the current interconnected ecosystems landscape and the evolving complexities and risks. To enhance enterprise supply chain resilience, we must reimagine how to address the challenges in our current and future environmental settings. In DoD systems, we must consider the unique requirements of the enterprise subsystems such as infrastructure, systems, IT, and environment, in their entirety, to prepare and plan for the impact of policy interventions in sustainability, cyber security, supply chain and the need for enterprise growth.

Three recent applications of Systems Thinking to enterprise system challenges are described and explored: defense resource planning, global logistics supply chains for materiel readiness, and creating resiliency for the infrastructure that supports our operational missions to the warfighter. We must integrate our intellectual capacities, considerable strategic planning acumen, diverse analytical capabilities, and integrate them into national and international security challenges of our time.

Classification: UNCLASSIFIED
Working Group: WG22 Military Assessments

59964 - SPACECOM digital maturity assessment framework

Start Date: 6/15/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Joseph Troy Morgan; Michael Teter		
Abstract: As USSPACECOM continues it's efforts to be an interconnected, innovative, and digitally dominant warfighting command, the Chief Data Office and Data Council have undertaken efforts to fully leverage digital transformation into order to enhance senior leader decisions, ensure digital modernization via technology, and build and leverage dynamic data environments which robustly support the command and our mission partners. As part of that effort, an assessment of USSPACECOM's digital maturity is helping identify gaps and evaluate whether the application of our people's time, and command funding, on specific initiatives are providing the warranted value and improvement as well as inform future allocation of those limited resources. Fully intertwined with USSPACECOM's digital transformation lines of effort and aligned with DoD guidance and industry best practices, this assessment covers foundational elements (data, architecture, culture) as well as making the assessment focused on USSPACECOM's unique mission set. This discuss will uncover the techniques and procedures used as well as welcome discourse across the community facing similar digital transformation assessments. Classification: UNCLASSIFIED // FOUO Working Group: WG22 Military Assessments		

WG24 Test and Evaluation (T&E) and Experimentation

59897 - A framework for using priors in a continuum of testing

Start Date: 6/16/2022	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Victoria Rose Carrillo Sieck; Dr Steven N Thorsen		
Abstract: A strength of the Bayesian paradigm is that it allows for the explicit use of all available information—to include subject matter expert (SME) opinion and previous (possibly dissimilar) data. While frequentists are constrained to only including data in an analysis (that is to say, only including information that can be observed), Bayesians can easily consider both data and SME opinion, or any other related information that could be constructed. This can be accomplished through the development and use of priors. When prior development is done well, a Bayesian analysis will not only lead to more direct probabilistic statements about system performance, but can result in smaller standard errors around fitted values when compared to a frequentist approach. Furthermore, by quantifying the uncertainty surrounding a model parameter, through the construct of a prior, Bayesians are able to capture the uncertainty across a test space of consideration.		

This presentation develops a framework for thinking about how different priors can be used throughout the continuum of testing. In addition to types of priors, how priors can change or evolve across the continuum of testing—especially when a system changes (e.g., is modified or adjusted) during phases of testing—will be addressed. Priors that strive to provide no information (reference priors) will be discussed, and will build up to priors that contain available information (informative priors). Informative priors—both those based on institutional knowledge or summaries from databases, as well as those developed based on previous testing data—will be discussed, with a focus on how to consider previous data that is dissimilar in some way, relative to the current test event. What priors might be more common in various phases of testing, types of information that can be used in priors, and how priors evolve as information accumulates will all be discussed.

Classification: UNCLASSIFIED
Working Group: WG24 Test and Evaluation (T&E) and Experimentation

60061 - Digital Engineering Support to the Joint All Domain Command and Control (JADC2) Network

Start Date: 6/16/2022	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Mr. Charles D Burdick, CAP; Dr. Deepinder Sidhu

Abstract: To potentially support JADC2, we have introduced the concept of a Network Digital Design Twin (NDDT) that employs both the technology of virtually cloning a network and the emulation capabilities of the Network Digital Twin (NDT), which can predict its physical twin's responses to any changes in hardware, software, configurations, etc. and to malware attacks and destruction of components.
The JADC2 Network Digital Design (NDD) Clone would be built from regular design updates from all participating JADC2 developers and the NDDT would be built from the current NDD Clone using digital artifacts appropriate to the design stage, e.g., hardware, protocols, etc. that are based on requirements documents.
In addition to providing an interrogatable 3D visualization of the current design, the NDD Clone would maintain a complete record of design changes with their source and date.
As the NDT already does for existing networks, the NDDT would provide a predictive capability allowing for tests of the design, both end-to-end and in segments if not yet connected. Since much of JADC2 already exists or will be in prototype networks they would be represented as NDT emulations that can interface with the NDDT to test both without any risks to the actual physical networks.
This approach would both advance the use of Network Digital Engineering and meet the Testing Community's desire to "Shift Left" allowing much earlier testing in the development cycle.

Classification: UNCLASSIFIED
Working Group: WG24 Test and Evaluation (T&E) and Experimentation

59861 - Quantifying the Impact of Staged Rollout Policies on Software Process and Product Metrics

Start Date: 6/16/2022	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Kenan Chen; Zakaria Faddi; Vidhyashree Nagaraju; Dr. Lance Fiondella

Abstract: Software processes define specific sequences of activities performed to effectively produce software, whereas tools provide concrete computational artifacts by which these processes are carried out. Tool independent modeling of processes and related practices enables quantitative assessment of software and competing approaches. This talk presents a framework [1] to assess an approach employed in modern software development known as staged rollout, which releases new or updated software features to a fraction of the user base in order to accelerate defect discovery

without imposing the possibility of failure on all users. The framework quantifies process metrics such as delivery time and product metrics, including reliability, availability, security, and safety, enabling tradeoff analysis to objectively assess the quality of software produced by vendors, establish baselines, and guide process and product improvement. Failure data collected during software testing is employed to emulate the approach as if the project were ongoing. The underlying problem is to identify a policy that decides when to perform various stages of rollout based on the software's failure intensity. The illustrations demonstrate how alternative policies impose tradeoffs between two or more of the process and product metrics.

References

[1] K. Chen, Z. Faddi, V. Nagaraju, and L. Fiondella, Quantifying the Impact of Staged Rollout Policies on Software Process and Product Metrics, In Proc. 68th Annual Reliability and Maintainability Symposium (RAMS 2022), Tucson, AZ, Jan 2022.

Classification: UNCLASSIFIED
Working Group: WG24 Test and Evaluation (T&E) and Experimentation

60146 - AEGIS Combat System Optimization and Analysis using HLA Simulation

Start Date: 6/16/2022	Start Time: 11:30 AM	End Time: 12:00 PM

Authors: Shane N Hall, PhD; Dr. Benjamin G. Thengvall; Jeff Smith

Abstract: The US Navy has stated a need to develop modeling and analysis software to optimize software-only changes in the Anti-Air Warfare (AAW) system design to address Anti-Ship Cruise Missile (ASCM) threats. Tweaks in the AEGIS Combat System (ACS) design can provide quick software-only fixes that provide large gains in overall system performance. Current processes involve human-driven engineering analysis to determine the best options for inserting new upgrades or system improvements; and hence, this process is manual, labor intensive, and has inputs from disconnected sources slowing the timeline associated with analysis and decisions for software insertions. Therefore, the Navy seeks to automate current processes and make them more data-driven to field capability more quickly, make the most optimal improvements to AAW within the capabilities of current weapons, and provide integrated data analysis to better integrate and ensure performance of future weapons. More specifically, a software tool is desired that integrates outputs of current and future models and uses goal-seeking behaviors to improve recommendations for software-only optimization of the AAW capability within the ACS. OptDef is a simulation optimization and analysis software technology that integrates with existing simulations to quickly determine the system configurations that produce the best possible outcomes and improve analytic insights. Thus, it is ideal for modeling and simulation environments that are used for system design, trade space assessments, and test and evaluation. OptDef is integrated and verified with multiple DoD simulations, most recently with the Navy's AEGIS Combat System Test Bed (CSTB), which is a high-level architecture (HLA) federation of complex system simulations that are critical to the Navy's ability to effectively and efficiently perform developmental test and evaluation (DT&E) and operational test and evaluation (OT&E) for the ACS. Here we present the status of the OptDef software tool integration with the CSTB to enable effective investigation of the nearly unbounded set of scenarios in a limited timeframe. This optimization capability makes it possible to identify outcomes that will quantifiably improve key system metrics related to countering ASCM threats such as miss distance, probability of kill, and probability of raid annihilation. This OptDef software tool with its prototype integration with CSTB and with its embedded industry-leading simulation optimization algorithms will be delivered to Navy CSTB environments later this year.

Classification: UNCLASSIFIED
Working Group: WG24 Test and Evaluation (T&E) and Experimentation

60322 - Capability-Based Teamed-System Analysis (CAPTAN) Methodology

Start Date: 6/16/2022	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Mr Andrew W Drysdale

Abstract: The U.S. Army's Combat Capabilities Development Command DEVCOM Analysis Center (DAC) is developing a new survivability/vulnerability (S/V) modeling and assessment paradigm called CAPTAN. This technique is focused on discerning, and enumerating, the discrete remaining capabilities of the system(s) during a mission scenario; in this way more (and more relevant) information can be provided in DAC's S/V analysis products.

The CAPTAN analysis model consists of three major components: the capability map, the event script, and the mission state machine. Together these data structures define the system(s) under analysis and operate on the model to track how system capabilities change due to threat effects. The capability map is a logical linkage between basic components, the functions they enable, and the high-level capabilities those functions comprise. The event script is an editable list of time-based or situation-contingent changes to the availability of entities in the map, based on the requirements of the mission context. The mission state machine, in turn, defines how the statuses of various map entities affect how a mission is executed and thus how further capability evolution is expected to unfold. Each of these three components can act on the others as the analysis is executed.

CAPTAN is designed to address several of the inherent gaps in legacy strategies. First, it is oriented towards holistic consideration of a formation of teamed systems, rather than considering an ad hoc collection of individual systems "in a vacuum", so the synergistic and survivability advantages of teaming are foregrounded. Second, it provides S/V assessments closely attuned to relevant operational environments. CAPTAN models are inherently sensitive to the mission context, so its output contributes readily to mission-based test and evaluation. Third, because CAPTAN was designed to replace averaged or rolled-up system status metrics with an itemized array of capability availabilities, the big-picture importance of attaining a given damage level is immediately apparent. DAC is now able to link component damage or environmental degradation all the way through system S/V to metrics like mission completion. Finally, CAPTAN offers a considerable leap forward in transparency of assumptions, data traceability, ease of model customization, and documentation.

This presentation will discuss the basic premises of capability-based modeling; will present an example of how CAPTAN component structures interact to execute an analysis; will discuss the advantages of the CAPTAN paradigm; and will present summaries of current methodology development work and projected future efforts.

Classification: UNCLASSIFIED // FOUO
Working Group: WG24 Test and Evaluation (T&E) and Experimentation

60274 - Insights and Lessons Learned - Towards Small and Routine Experimentation across Communities

Start Date: 6/16/2022	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Mr. Jed Richards; Keith Athmer; Dr. Niki C. Goerger, FS; Dr. Simon R. Goerger; Mr. William Leonard; James Richards

Abstract: The US Army Engineer Research and Development Center (ERDC) and the Maneuver Support Battle Lab (MSBL) embarked on a limited scope proof of concept experiment to help

operationalize the Army Persistent Experimentation eNvironment (APEN) and bring together science and technology (S&T) labs with battle labs for routine and small experimentation. Marrying operationally focused objectives and perspectives with engineering-level modeling objectives and perspectives provides a fuller system understanding to both communities. Linking together differing model types enables more informed weapon system decisionmaking and, ultimately, improves capability for the warfighter. This set of proof of concept excursions included use of OneSAF simulation and S&T computational models pertaining to autonomous vehicles and countering unmanned aerial systems. This initial work was not intended to provide a definitive analysis but a means to explore methods, investigate opportunities, and acquire lessons learned. This presentation will describe the goals, approach, and initial findings as well as highlight insights, lessons learned, and recommendations geared towards incorporating experimentation across communities into more routine use.

Classification: UNCLASSIFIED // FOUO
Working Group: WG24 Test and Evaluation (T&E) and Experimentation

WG25 AoAs and Capability Development

60321 - (U) New Sustainment Analysis Capabilities for Next Generation Army Aircraft

Start Date: 6/14/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Ms. Geetha Vallabhapurapu Chary		

Abstract: (U) The U.S. Army is currently developing a new generation of aircraft to replace legacy rotary-wing aircraft fleets, specifically UH-60 Black Hawks, AH-64 Apaches and CH-47 Chinooks. This new generation of aircraft, ranging from light to heavy weights, includes new and improved capabilities affecting most combat functions. To ensure undisrupted flight operations during future Multi-Domain Operations, the Army is aligning some sustainment requirements to focus on a Maintenance Free Operation Period (MFOP). To help inform this MFOP requirement, the Combat Capabilities Development Command DEVCOM Analysis Center (DAC) performed an analysis that included estimating MFOP metrics for a currently fielded system and for the next generation aircraft. This analysis approach consisted of three steps. The first step was to process maintenance data collected on a legacy aircraft and develop downtime and time between visit distributions to estimate that legacy system's MFOP. The next step was to collaborate with Cross Functional Team (CFT), United States Military Academy (USMA), Army Aviation and Missile Command (AMCOM) and DEVCOM Aviation & Missile Center (AvMC) experts to determine expected MFOP improvements associated with the new generation aircraft technologies. The last step was to generate the probability to achieve different levels of MFOP. Based on resulting analysis curves, the probability to achieve MFOP for the new generation aircraft was extracted and contrasted with the requirement. This analysis has applicability to support trade studies, dynamic maintenance studies, cost benefit analyses and more.

Classification: UNCLASSIFIED
Working Group: WG25 AoAs and Capability Development

60082 - A Balanced Approach to Capability Analysis: Multi-domain Investment Trade-space Environment (MITE)

Start Date: 6/14/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Natalie W Van Osch		

Abstract: Multi-domain Investment Trade-space Environment (MITE) is an analytical approach to explore and quantify existing warfighting capabilities and recommend potential ways to better utilize current force structures or invest more judiciously in future capabilities over time. At the MORS symposium, only the MITE mindset will be discussed. The MITE mindset is to provide more informed data for the stakeholders illuminating the relationship in and amongst the following; operational combat capability, combat capacity, launch platforms, enabling technologies, technical weapon solutions, information and intelligence architectures, near-peer defensive and offensive capabilities, financial implications and operational risk exposure. This to be done while focusing on the ability to successfully execute current and future warfighting missions within the Departments' of Defense and Navy with respect to scarcity of resources and evolving near-peer objectives and capabilities.

Classification: UNCLASSIFIED
Working Group: WG25 AoAs and Capability Development

60060 - An Adaptive Kill Web Framework for Mission Engineering and Concept Exploration Analysis

Start Date: 6/15/2022	Start Time: 8:30 AM	End Time: 9:00 AM

Authors: Christopher Santos

Abstract: What is a Kill Chain? What is a Kill Path? What is a Mission Thread? How do these relate to a Kill Web? For that matter, what is a Kill Web? Depending on who you ask and what background they have—operational, engineering, or acquisition—these terms may be describing the same thing, or—in other cases—common terms may have very different definitions in different communities. Finally, what are the analytic implications of these terms and their underlying concepts?

What is common about these terms and concepts is the attempt by the Department of Defense to understand and grapple with an increasingly complex warfighting environment. Over the past several decades, the effective projection of military power has become increasingly dependent on complex combinations of capabilities resident in all domains in order to achieve combined effects not possible from individual platforms or services. The combination of effects created by systems across all domains, from seafloor to space, through cyber and the electromagnetic spectrum, dictates a different approach to concept development, exploration, and analysis.

While the Office of the Secretary of Defense and the services have incorporated Mission Engineering methodologies to into the investment decision process to begin to tackle this new warfighting paradigm, these approaches tend to focus on the applications of singular missions or analyses within the context of a particular mission area. They may not address the full complexity across domains and multiple mission areas across a theater. Furthermore, Mission Engineering focuses on engineered employment options, which may create biases for concept exploration in which potential solutions may not yet be detailed to the engineering level.

The Adaptive Kill Web Framework outlined in this presentation extends OSD's published mission engineering concepts to enable unbiased concept exploration analysis across multitudes of missions and across all domains. Furthermore, it provides a common lexicon to address conflicting or divergent definitions for concepts such as Kill Chains and Kill Webs as well as a consideration of the types of analyses appropriate for a given tier in the Framework.

The Adaptive Kill Web Framework also provides the foundational organizing concepts for the mathematical applications described in the related 90th MORSS presentation (IDs 60062 and 60063),

"A Mission Engineering Perspective for Integrating Analytical Methods for Design and Evaluation of Complex Systems," by Raz, et al.

Classification: UNCLASSIFIED
Working Group: WG25 AoAs and Capability Development

60063 - A Mission Engineering Perspective for Integrating Analytical Methods for Design and Evaluation of Complex Systems

Start Date: 6/15/2022	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Professor Ali Khalid Raz; Prof. Paulo C Costa, Ph.D.; Dr William Forrest Crain, FS; Steven Jones; Dr. Daniel Thomas Maxwell; Christopher Santos

Abstract: Mission Engineering requires integration of multiple complex systems that are designed and acquired independently to satisfy demands of one or more missions. The state of the practice for complex systems and system of systems design and evaluation relies on brittle and static architectures that once implemented are difficult to change. These architectures are typically pre-defined for a given mission need for which a suite of analytical methods is used to optimize performance. In these analyses the role, capabilities, and utilization of constituent systems is rigidly defined and cannot be flexibly adapted to address real-time needs of evolving mission conditions or priorities. Analytical methods (for example, graph theory, multi-utility attribute theory, statistical design of experiments, and deep learning methods, to name a few) that are used for such analysis and evaluation of complex systems take a static snapshot of a complex system which simplifies the problem space but at the same time overshadows evolution of interactions that are the source of emergent behavior in complex systems. From a Mission Engineering perspective, however, a suite of high value architecture solutions that balance timeliness, interoperability, risk, and performance given slight variations in composition are more desirable than a single optimal architecture solution that does not consider the above factors.

Inspired by the concept of a battlefield system-of-systems where the capabilities of individual systems can be flexibly exploited to create real-time adaptable system-of-systems architectures, in this presentation, we propose integration of multiple analytical methods that facilitate identification, design, and analysis of such dynamic architectures. It is important to note that analytical methods (such as the ones named in previous paragraph) are often deeply rooted in their own theoretical and mathematical formulation that does not easily transcend to other methods for cross-method integration, and therefore, impedes holistic analysis of complex systems. For example, how can outputs of graph theoretical metrics for architecture analysis help shape the formulation of a multi-utility attribute theory model to guide real time decision making and performance characterization of system-of-systems architecture?

In this presentation, we propose a set-based mathematical notation for complex system representation. Building on this mathematical notation, we will demonstrate a work follow for integrating multiple analytical methods for near real-time analysis of complex system architectures which is required to achieve mission engineering's goals.

Note:

a) Another submission by Santos :"A Kill Web Framework for Mission Engineering and Concept Exploration Analysis" (ID 60059 & 60060) can serve as a precursor as it presents a Kill Web formulation in a system of systems context.

b) This presentation is submitted DWG 1 and WG 25 as ID 60062 and 60063, respectively.

Classification: UNCLASSIFIED
Working Group: WG25 AoAs and Capability Development

60176 - Applying Experimental Design with M&S to Support Program Prioritization

Start Date: 6/15/2022	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Jacob Samuel Sherman; Ms. Ashley E Banister

Abstract: 90th MORSS
U.S. Army The Research and Analysis Center (TRAC)

Principal Author: Mr. Jacob Sherman
Briefer: Mr. Jacob Sherman
Classification of Presentation: Unclassified
Length of Presentation: 25 minutes
Suggested Working Group:WG 28 – Advances in Modeling and Simulation Techniques; WG 25 – Analysis of Alternatives (AoA) and Capability Development

Applying Experimental Design with M&S to Support Program Prioritization

Keywords: M&S, Deterministic, Experimental Design, Design of Experiments, DOE, Prioritization

It is impossible to perfectly predict the future, but planning and prioritizing for various alternative futures is critical to ensuring readiness for future competition and conflict. “We’re never going to be exactly right – and that’s okay, but we need a baseline to guide our thinking and decision-making.” – GEN John Murray in Foreword to AFC PAM 525-2 Future Operational Environment.

To prepare for potential futures, decision makers often leverage Models and Simulations (M&S) results to inform prioritization decisions. Accordingly, The Research and Analysis Center (TRAC) recently addressed an Army Futures Command (AFC) need for trades analysis relevant to multiple future operating environments to help inform prioritization decisions for a variety of next generation signature programs and enablers. To support this multi-center Army Modernization Analysis (AMA), TRAC employed design of experiments instantiations in multiple representative theaters using its Advanced Warfighting Simulation (AWARS). Each AWARS experiment utilized resolution V fractional factorial design to statistically analyze the marginal effects of future program acquisitions and their two-way interactions.

The FAMSD team thoroughly investigated friendly and threat force structure and basis of issue, performance data, requirements documentation, tactics, techniques, and procedures (TTP) and concepts of operations (CONOPS) to inform model representations of future programs and their current-day equivalents. To accommodate these representations using design of experiments, simulation analysts developed innovative tool suites not only to build the experimental designs and automate run configuration associated with various design points, but also to employ various forms of regression and machine learning algorithms to gain insights into the relationships between predictor and response variables.

This presentation will share the technical approach that guided the AWARS Support to AMA, as well as lessons learned during the process. Robust statistical analysis of M&S experiments will continue to

inform key decisions on a wide range of issues faced by Army senior leaders, including modernization, force sizing, POM resourcing, and more.

Classification: UNCLASSIFIED
Working Group: WG25 AoAs and Capability Development

61200 - Capability Development Panel

Start Date: 6/15/2022	Start Time: 10:30 AM	End Time: 12:00 PM

Authors: Charity Petrina

Abstract: All the Services and many industry partners have organizations responsible for capability development and early analysis activity. The WG 25 panel discussion will focus on the current status and future plans for Capability Development across DoD and industry and the ongoing efforts to adjust to the current environment, balancing speed and risk.

Panel members are subject matter experts in their capability development processes and are at the cutting edge of methods for validating and prioritizing operational capability requirements. They support early analysis such as Capabilities Based Assessments and Analysis of Alternatives, as well as more fluid methodologies in keeping with rapid innovation.

Candid discussion will be encouraged on implementing successful Capability Development that ensures effective validation of requirements to satisfy long-term military strategy in a rapidly changing world. The session aims to allow attendees to ask questions, share best practices, and hear/provide insights on lessons learned. The format includes peer-to-peer discussion among panel members and panel-to-audience Q&A and discussion.

Panel Members:

Mr. Ken Amster, Head Mission Interoperability and Cyber Test and Evaluation Branch, NAWCWD
Jerry Schlabach, Raytheon Engineering Fellow (OR and AI), Raytheon Missiles and Defense
Mr. Paul Works, Director, Analytic Data and Development Group (ADDG), The Research and Analysis Center (TRAC) - Fort Leavenworth.
Mr. Robert Tobasco, Manager - AF Operational Requirements Development Portfolio, Headquarters AF (AF/A5/7)

Classification: UNCLASSIFIED
Working Group: WG25 AoAs and Capability Development

60215 - Directed Energy Utility Concept Experiment

Start Date: 6/15/2022	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Dr Garrett Darl Lewis; Mr. Joseph Allen Aldrich

Abstract: There is an urgency to rapidly integrate and field viable Directed Energy (DE) weapons and advanced Kinetic Energy (KE) effectors to Areas of Responsibility (AORs) in response to unprecedented changes in adversary capabilities and intent. In 2020, the Air Force Research Laboratory Directed Energy Directorate's Wargaming and Simulation Branch (AFRL/RDMW) initiated a series of virtual wargames in support of this goal. These Directed Energy Utility Concept Experiments (DEUCEs) identify capability and joint integration gaps to be closed prior to Initial Operational Capability (IOC), introduce the warfighter to emerging technology, and inform senior AFRL leadership

about military utility of current DE and KE concepts while bringing together stakeholders across the Research and Development (R&D) and warfighter communities. We present the methodology and initial findings from three DEUCEs focused on evaluating the employment of game-changing High Energy Laser (HEL) and High Power Electromagnetic (HPEM) technology alongside current and future KE effectors.

During the inaugural HEL DEUCE in January 2021, RDMW brought together fighter pilots, Weapon Systems Officers (WSOs), and an Airborne Warning and Control System (AWACS) air battle manager (ABM) to evaluate the capabilities of two variants of airborne HEL in Airbase Air Defense (ABAD) and Platform Protect (PP) scenarios in the future battlespace. The warfighters provided excellent assessments through a series of vignettes exploiting virtual-reality capabilities to identify and characterize potential military utility of DE weapons. They further provided valuable operator inputs and engagement tactics to supplement ongoing technical analyses. Together, these provide critical information to the Air Force to evaluate new technologies, support investment decisions, and provide warfighters with insight into the capabilities of emerging technologies.

The second event focused on the employment of HPEM systems alongside current KE capabilities as part of an integrated Air Defense System (IADS). This event brought together over one dozen ABMs and Army Air Defense Artillery Fire Control Officers (ADAFCOs) in tabletop and simulated environments to explore synergies between DE and KE systems in a base defense role and to identify gaps HPEM systems are capable of filling.

RDMW most recently executed a DEKE DEUCE playing HEL alongside two KE concepts under development at AFRL's Munitions Directorate (RD) in a similar scenario to the HEL DEUCE. Multiple ABMs, pilots, and WSOs provided excellent inputs on the employment of the DE alongside next generation KE, with a special emphasis on the tactics and missions that the effectors are best suited for both individually and jointly.

Classification: SECRET NOFORN
Working Group: WG25 AoAs and Capability Development

60281 - Orbital Harmonics and Resiliency of Hybrid Constellations

Start Date: 6/15/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Christopher Wishon; Lt Col Ryan M McGuire; Dr. Jason Reiter; Rebecca Widrick		

Abstract: Hybrid constellations are naturally more resilient to losses in coverage as gaps in the multiple layers must synchronize in time and location for a complete loss of mission capability over a given region of interest. The resiliency of these architectures is further enhanced as these gaps are less likely to synchronize over the same or similar regions in the future due to the varied altitude, inclination, and other orbital parameters of the layers. Our research has shown that the synchronization between the layers, referred to by the authors as orbital harmonics, can be very sensitive to even small design changes. For example, as little as a 10 kilometer change in altitude between layers can drive the hybrid constellation out of sync. This implies that very careful consideration must be given when designing hybrid constellations. This presentation will demonstrate the sensitivity of a hybrid constellation's orbital harmonics to various design parameters such as altitude, inclination, plane count, sensor design, and satellite count.

Classification: SECRET NOFORN Working Group: WG25 AoAs and Capability Development

60220 - Combat Modeling in Support of Optionally Manned Fighting Vehicle (OMFV) Analysis

Start Date: 6/15/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Lloyd Waggoner		
Abstract: On behalf of the Next Generation Combat Vehicle (NGCV) Cross-Functional Team (CFT), The Research and Analysis Center (TRAC) executed analysis focused on identifying the operational effectiveness of technology trades for the Optionally Manned Fighting Vehicle (OMFV), to inform capability requirements specified in the abbreviated capabilities development document (A-CDD). TRAC analyzed operational impacts of trade options within seven trade areas. OMFV-equipped formations in three varied operational contexts using two different integrated modeling and simulations software suites. Important findings included analytic comparisons between the base capabilities associated with the M2A4 and options potentially offered by commercial vendor OMFV concepts; preliminary assessments of vendor concepts; and an assessment of vendor concepts' adherence to requirements defined in the A-CDD. This presentation will discuss the uniquely tailored post-processing techniques used to process data and analyze metrics. Classification: SECRET NOFORN Working Group: WG25 AoAs and Capability Development		

60214 - How Operational Research is Deciding the UK's Next Generation of Land Equipment

Start Date: 6/16/2022	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: Mr Samuel George Genge, BA (Hons) MA		
Abstract: The UK's Land Forces are currently undergoing significant equipment changes. This is predominately being driven by a requirement to meet the objectives laid out in the UK's Integrated Operating Procedure 2025 (IOpC25). IOpC25 specifies the need for the British Army to be persistently engaged worldwide, whilst also being able to generate the mass required to engage in 'War Fighting at Scale'. This has resulted in a renewed focus on identifying and adopting emerging land concepts that can provide the UK land force a competitive advantage. The Defence Science and Technology Laboratory's (Dstl) Land Environment Group (LEG) provides Operational Research in support of decision making by the British Army. It primarily supports force structure and procurement decision making. IOpC25 provides an opportunity for Operational Research (OR) to shape the direction Science and Technology (S&T) in support of Land Forces. LEG's Future Land Concepts Project is employing OR to understand which land concepts could have the greatest impact. This submission will illustrated the project's analytical processes, and provide examples of specific OR methods employed. The project takes a threat focused approach, measuring the performance of the UK land forces against a range of threats. By engaging with Dstl's network of subject matter experts, new land concepts have been identified which could fill capability gaps. Through Wargaming and capability analysis, concepts are down selected for further analysis and testing. In summary the project ensures that analytical decision making drives Land S&T in the UK. This submission will only use illustrative examples due to classification.		

Classification: UNCLASSIFIED // FOUO
Working Group: WG25 AoAs and Capability Development

59723 - Simulation and Value Modeling Air Station Closures

Start Date: 6/16/2022	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: David Kent; Mr. Joseph W Kidwell

Abstract: Coast Guard Air Stations provide valuable service to the boating community. The cost of these services comes in the form of operating budgets. Could the Coast Guard save money by eliminating one or more air stations from operation while still maintaining an effective SAR response posture? The Coast Guard has well defined and defended analysis for making changes to the system of Response Boat Stations around the country. But does not have similar analysis for Air Stations. The scope of this analysis is to introduce a framework and methodology for analyzing the performance of the SAR system when considering the closure of CG Air Stations. Analysis goals: establish a framework and methodology to conduct a comprehensive analysis that recommends the closures of air stations; build a simulation model that can produce metrics for alternative scenarios in which Air Stations are closed for a stream of historical helicopter Search and Rescue case data; and develop a value model that rank orders the resulting performance of the SAR system in each scenario.

Classification: UNCLASSIFIED // FOUO
Working Group: WG25 AoAs and Capability Development

60193 - Soldier Lethality and the Emergence of small Unmanned Aircraft Systems (sUAS) on the Modern Battlefield

Start Date: 6/16/2022	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Caleb Johnson; Ms. Sara K. Krondak

Abstract: The emergence of sUAS on the battlefield signifies a new and real problem for forces during all phases of multi-domain operations. Troops at all echelons are susceptible to enemy surveillance, and effects delivered by threat sUAS. Military senior leaders acknowledge the threat and have allocated research and development resources towards doctrine, organization, training, materiel, leadership and education, personnel, facilities, and policy (DOTmLPF-P) solutions, to give the force the capability to defeat threat sUAS. The Commanding General, Army Futures Command directed TRAC to study Counter-sUAS (C-sUAS) capability requirements to inform an abbreviated capabilities development document and C-sUAS portfolio investments in a Program Objective Memorandum. Effective C-sUAS capabilities differ depending on battlefield geometry, echelon, and available resources. Emerging C-sUAS technologies provide forces self-defense capabilities against threat sUAS during its mission cycle. Future systems integration is subject to available resources and platform limitations.

The study team incorporated maneuver scenarios operating in various terrains during large-scale combat operations. In order to answer what technologies are possible to develop, the study team gathered a list from the scientific community within the Army. Given the uncertainties associated with emerging and developing technology, the study team organized them into a technological trade space, based on the architectural choices across the detect, identify, and defeat tasks. These methods allowed the study team to elicit combatant command subject matter expert (SME) feedback on desired C-sUAS characteristics.

The technology trade space and SME feedback served as input data for the purpose-built abstract model to determine high payoff mixes, analyzing multiple C-sUAS technology pairings across the

echelons studied. Each pairing examined measures of operational effectiveness against a most likely threat scenario to determine the C-sUAS system's ability to deny threat's intent. The analysis is instrumental in providing senior leaders the necessary information to effectively plan and develop future C-sUAS systems.
This presentation will provide an overview of the study methodology.

Classification: UNCLASSIFIED // FOUO
Working Group: WG25 AoAs and Capability Development

60275 - US Ignite Concept of Operations for Non-tactical Installation Capabilities Development

Start Date: 6/16/2022	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Mr. Kyle Compton

Abstract: We at US Ignite would like to present our experience and approach to non-tactical installation management capabilities development, and seek input from the working group on our role in the mission space, our operating model, and best practices.

As a DC-based non-profit born out of the White House Office of Science and Technology Policy, US Ignite's mission is to accelerate the development and adoption of community smart city technologies that promote innovation, workforce development, and economic opportunity. Since 2019, US Ignite has managed multiple installation scale living laboratories meant to develop non-tactical installation capabilities by creating dual uses of existing commercial smart city technologies, known as our 'Smart Base Program'. As a contractor to the US Army Corps of Engineers Engineering Research & Development Center (USACE-ERDC), US Ignite has managed the AV Transportation Testbed at Fort Carson, which has continued into the ongoing Artificial Intelligence for Traffic & Weather project there as well. US Ignite is also managing the Smart Installation and Community Dashboard project at Fort Benning on behalf of USACE-ERDC as well as the 5G Living Laboratory at MCAS Miramar as a contractor to the Office of Naval Research NextSTEP program.

In all of these Smart Base projects, US Ignite's concept of operations for capabilities development starts by gathering a diverse set of project performers, including defense research groups, academic partners, and commercial solution providers to each fill their role in US Ignite's methodology. Adapted from the National Security Innovation Network's 'Hacking for Defense' (H4D) model, US Ignite takes a five-step approach to installation capability development. First, through stakeholder engagement US Ignite defines use cases that both meet the unique needs of their host installation, and meet the broad directional objectives of the DoD. Second, through our network of over 160 defense, federal, state & local, academic, and commercial partners, we source solutions that meet those needs. Third, we work with host installation leadership and commercial solution providers to develop the networking, power, facilities, and other infrastructure capabilities required to demonstrate and assess the technology's ability to meet the use case. Fourth, we then work with our defense research, academic and commercial partners to establish actionable measures of merit (MoMs) to understand success. Fifth and finally, if a technology is successful, we work with our defense research partner to identify pathways for sustaining the technology at the host installation, and transitioning the technology into operational use at installations across the DoD.

Classification: UNCLASSIFIED
Working Group: WG25 AoAs and Capability Development

60205 - Writing an Effective Problem Statement: Best Practices

Start Date: 6/16/2022	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Mr. Paul Works		

Abstract: Establishing a problem statement is one of the key analytic tasks when initiating a study. It is often the first analytic activity upon receipt of a tasker. A problem statement is critical to providing a definitive focus for the study. It ensures the study effort will respond to the decision maker's needs. It drives the study plan, methodology, study issues, essential elements of analysis, and measures of merit. It directly influences study results and solutions. It subtly influences every aspect of the effort.

The Research and Analysis Center (TRAC), as part of its commitment to continued enabling of the analytic profession, developed the Writing an Effective Problem Statement Best Practice Guide (BPG). The document provides best practices for operations research and systems analysts (ORSAs) when developing an analytic problem statement to effectively guide an effort and produce an effective analysis. It includes challenges and pitfalls frequently encountered when developing a problem statement and includes an exemplar use case.

The presentation provides an overview of the Writing an Effective Problem Statement BPG and details several recent examples.

Classification: UNCLASSIFIED
Working Group: WG25 AoAs and Capability Development

60182 - Parametric Analysis in Support of the Future Attack Reconnaissance Aircraft (FARA) Analysis of Alternatives (AoA)

Start Date: 6/16/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Stephen Gillespie		

Abstract: The Future Attack Reconnaissance Aircraft (FARA) is the Army's vision for its future aerial reconnaissance capability. It is envisioned to operate as a part of an ecosystem including long range missiles, unmanned aerial systems (UAS), other rotary wing aircraft, and the larger Army and joint force. To enable senior leaders to make informed acquisition decisions regarding the FARA, the Army initiated an Analysis of Alternatives (AoA) in March of 2021. This occurred in conjunction with competitive prototyping efforts led by the Future Vertical Lift (FVL) Cross Functional Team (CFT). The AoA study team needed a way to quickly assess the operational performance of a wide range of potential aircraft with varying capabilities while still using validated Army combat simulations and operational scenarios.

To address this problem, the study team employed the Advanced Warfighting Simulation (AWARS) to represent a US Corps conducting multi-domain operations in a defense planning scenario. It then identified key attributes of the aircraft such as speed, time of flight, vulnerability, detectability, sensor range, and varying load capacity and mixes of load. The study team employed a nearly orthogonal Latin hypercube experimental design to select 256 of the millions of possible combinations of aircraft attributes and then simulated those 256 combinations. The team measured key results such as aircraft losses and mission accomplishment and then performed statistical and machine learning on the results to develop models that predict the results of the simulation for any combination of traits in the bounds the team assessed. The team then used this to find the minimal requirements to achieve any given operational end-state (percent of threat dis-integrated).

This methodology enabled the study team to complete this parametric analysis without specific performance parameters from each particular alternative as those parameters were unavailable until the end of the study. As the study concluded, the team was able to assess each particular alternative's operational performance according to the results of the parametric analysis very quickly and provide insights into both the prescribed alternatives and the subsequent "what if" alternatives that arose through the course of the study.

This presentation will explain the methodology and tools to do this parametric analysis as described above. It will only present notional results as the actual results are not yet releasable. Additionally, it will cover key lessons learned and future work related to this problem set.

Classification: UNCLASSIFIED
Working Group: WG25 AoAs and Capability Development

59859 - Project INSIGHT: Assessing Tomorrow's Warfighting Capability Requirements Through An AI-enabled Analytic Architecture

Start Date: 6/16/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Paul L Hartman; Shweta D Kumar; Brian Heath; Ross Jackson		
Abstract: Modern analytical tools for the Intelligence Community must include enabling capabilities such as Advanced Artificial Intelligence, High-speed Algorithms, Machine Learning, Computer-aided Design and Engineering, and 3D-4D Mixed Reality Visual Reference Models. These enabling capabilities are becoming increasingly more critical tools for Intelligence Community analyst to 1) support near real-time identification, qualification and assimilation of structured and unstructured intelligence data and 2) meet operational requirements to turn intelligence data into cohesive and actionable sets of threat-based offensive or defensive system level responses or requirements. These enabling capabilities, along with proven analytic techniques such as Modeling, Simulation and Analysis (MS&A), Design Thinking, Risks/Uncertainty Quantification, and Trade Space Analysis, present Intelligence Community analyst with a range of time compressing capabilities to: 1. rapidly ingest and cross-correlate multisource threat content; 2. create engineering quality modeling representations of the perceived threats; and 3. examine threat-specific physical attributes via interactive augmented and virtual reality Classification: UNCLASSIFIED Working Group: WG25 AoAs and Capability Development		

WG26 Cost Analysis

59617 - Cost Estimate Kick-Starters

Start Date: 6/14/2022	Start Time: 1:30 PM	End Time: 2:30 PM
Authors: daniel j harper		
Abstract: I'd like to present several "Cost Estimate Kick-Starters" I created to "kick-start" your cost estimate, including: • LaRRGE [Labor Rate Reference Guide for Estimators] Labor Rates resources including newly added Cyber Labor Rates • GRIPS [GSA Robust Infrastructure Pricing Solutions] The GSA Enterprise Infrastructure Solutions Pricer, or "Turbotax" for Enterprise Infrastructure Solutions		

• SLiCE [Software License Cost Estimator] lookup tool containing over 4,000 prices (and growing) for software licenses, training, etc.
Expanded Session Description
LaRRGE [Labor Rate Reference Guide for Estimators] includes Labor Rates resources including newly added Cyber Labor Rates.

SLiCE [Software License Cost Estimator] lookup tool, pulling over 4,000 prices (and growing) for software licenses, training, etc. from the DoD Enterprise Software Initiative and translating and normalizing into a format useable within SLiCE. It culls thousands of labor rates from the GSA Highly Adaptive Cybersecurity Services (HACS) schedule, which includes 344 Vendors offering a wide range of cyber labor categories, i.e., information assurance, virus detection, network management, situational awareness and incident response, secure web hosting, and backup, security services and Security Operations Center (SOC) services.

The GSA Robust Infrastructure Pricing Solutions [GRIPS] is a tool he developed based on data from the GSA Enterprise Infrastructure Solutions Pricer "Turbotax"-like tool for pricing Enterprise Infrastructure Solutions Based on GSAs EIS telecommunications contract, which replaced GSA's Networx schedule for government telecommunications and infrastructure solutions.

Classification: UNCLASSIFIED
Working Group: WG26 Cost Analysis

60278 - Masters and Certificate Program in Cost Estimating and Analysis at NPS

Start Date: 6/14/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: LtCol Greg K. Mislick		
Abstract: This presentation provides an update to the Master's Degree offered at the Naval Postgraduate School. NPS is meeting the need for a distance learning master's program in the cost estimation field by offering a two-year, 16 course curriculum, with over 200 graduates so far. There is also a four-course certificate program that encompasses one course per quarter for one year leading to a Certificate in Cost Estimating and Analysis. Details of the relevant and current capstone projects will also be discussed. Further information is available at: https://my.nps.edu/web/dl/degProgs_MCEA. Classification: UNCLASSIFIED Working Group: WG26 Cost Analysis		

60531 - Estimating the Effects of Lifecycle O&S Spending on Ship Readiness

Start Date: 6/15/2022	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: Dr. Omer Alper		
Abstract: Lifecycle costs of weapons platforms depend partially on the readiness level at which the platforms are maintained. In this study, we estimated the lifecycle cost of different levels of readiness for Navy ship classes. Our methodology addressed the primary challenge of estimating this relationship using historical observations: namely, disentangling the two-way causality between spending and readiness reflected in the data. More spending drives higher readiness (the causal effect of interest), but at the same time, ships in need of more repairs (i.e., with lower material readiness) also tend to have higher spending.		

We estimated the effects of a 10-percent annual increase in spending on the annual time a ship spends in the top one or two equipment condition categories. The effects ranged from 10 to 17 percent more time (four to seven weeks per year) for manpower and parts spending. The effects ranged from 0 to 7 percent more time (zero to three weeks per year) for spending on depot and intermediate maintenance, sustaining support, and system improvements. For spending levels close to historical averages, the results suggest that increases in unit manpower and parts spending are likely to provide the largest gain in equipment readiness per dollar spent.
These findings can be used to develop evidence-based budget forecasts for O&S costs that allow for varying material readiness; specifically, how much additional spending might be required (saved) for current and future ship programs to achieve readiness levels above (below) historical averages. The cost forecasts can inform decisions and trade-offs between cost and material readiness both in the near term (e.g., during budget development for the current fleet) as well as in the longer term (e.g., during acquisition planning).

Classification: UNCLASSIFIED // FOUO
Working Group: WG26 Cost Analysis

60373 - CNA Aging and Flying Hour Factor

Start Date: 6/15/2022	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Mr. Frank Wallace		
Abstract: CNA developed a model of the relationship between the number of flying hours (FH), the average age of aircraft, and the number of AVDLRs that were beyond the capability of maintenance (BCM) for repair by the aviation intermediate maintenance departments (AIMDs). CNA developed this model to explain why the budgeted CPH was different from the realized CPH and to project expected costs more accurately so the Navy could better budget for AVDLRs. The Navy budget model for the FHP incorporates this relationship by adjusting to the most recent observed CPH, which is the basis for the next FHP budget. Classification: UNCLASSIFIED Working Group: WG26 Cost Analysis		

60156 - Weapon System Sustainment Cost Analysis Using Contract Documents

Start Date: 6/15/2022	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Dennis Robertson; Dr Brad Guthrie		
Abstract: Costs associated with sustainment of air force weapon systems have grown faster than inflation, resulting in a cost growth measured in billions of dollars. Weapons Systems Sustainment (WSS) funds depot maintenance as well as supporting Contractor Logistics Support (CLS) programs. Existing analysis focused on data sources such as funding spreadsheets, narrative spreadsheets, and brochure PDFs. The contracts themselves were not considered due to the unstructured nature of the contract documents. The contract text as well as contract artifacts (e.g., contract line item numbers, CLINs) have been extracted and structured in a searchable database. With this structured contract data, the analysis can be expanded and enriched. This analysis focuses on CLS specifically, as the data is exclusively contracts. The exploratory phase first established the contracts that were likely CLS-based based on a broad searching of the text of all ~4M contracts in the database. Additionally, over 7M CLINs were also queried for CLS terms to identify the set of CLINs that are likely CLS. The CLINs within this subset were further assessed to identify the CLS category to establish the total cost and cost over time for each category. These		

categories were identified both by text queries for keywords as well as via EEIC-based approach. The EEICs were extracted from the line of accounting using a named entity recognition (NER) model, which was fused to already extracted CLIN data based on the accounting classification reference number (ACRN).
This enriched dataset informed analyses that examined the impact of different CLS categories, both overall, as well as over time. CLIN-based costs over time for all CLS CLINs were evaluated to establish the cost growth. The use of CLIN data enables a deep dive into the root cause of the growth. Additional investigations were also performed, including identifying areas to focus cost reduction based on vendor, contract type, and the extent the contract was competed.

Classification: UNCLASSIFIED
Working Group: WG26 Cost Analysis

59849 - Equipping the Estimator: Providing Software Estimating Methods Tailored to Defense Program Characteristics

Start Date: 6/15/2022	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Nick Biancalana		
Abstract: Software is an integral component of modern warfighting and is the lynchpin in current military aircraft, vehicles, and support systems. The Department of Defense's ability to properly estimate the costs and size of these software programs is of equal importance. Currently, practitioners utilize Probability Density Functions (PDFs) to model plausible outcomes and implement risk within their cost estimates. This research intends to equip estimators with an arsenal of distributions that can be used in any situation. Given program characteristics known at the genesis of a project (service, commodity, system type, contractor, and contract type), there are circumstances where a closely tailored PDF could be used to provide a more representative distribution of outcomes that a more general PDF could not provide. Additionally, this research investigates how costs and effective sizes vary within particular program characteristics to expose which elements tend to result in larger or more expensive programs. Lastly, this research also analyzes the effects of employee experience and identifies certain team compositions that increase the likelihood of experiencing higher costs. Results from this research arm the practitioner with vital information that could aid in formulating better estimates as well as equipping decision-makers with critical knowledge to wield when analyzing projects and contractor proposals. Classification: UNCLASSIFIED Working Group: WG26 Cost Analysis		

60379 - Software Phasing and Schedule Growth Analysis

Start Date: 6/15/2022	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Daniel Long		
Abstract: Software development research, once a priority for the DoD, has received less focus in recent years. What research that has occurred has focused on size and cost prediction of software. Putnam (1978) showed that there were measurable effects between early program management and final schedule growth, but these relationships have not been explored using the DoD Software Resources Data Report (SRDR) database. Additionally, industry software development guidance provides rules of thumb for effort allocation, but a comparison of the rules to DoD software projects is nonexistent. We sought to understand how the development phases of software interact with each		

other and with final outcomes of schedule and effort, as well as provide guidance for the program manager and developer.

Using least square models and Hotelling's T2 test we evaluated conventional rules of thumb for effort allocation against projects in the SRDR database. Given the variation in the data, we find that multiple rules of thumb are applicable to DoD software development, though the mean values indicate a roughly even split among requirements/design, coding, and testing phases. We then compared through contingency analysis and t-tests how effort allocation varies between projects with either high or low schedule growth. Our analysis shows that increasing effort in early phases decreases the total schedule growth. These finding were significant across multiple categories such as developmental process type, Service, and project size.

Classification: UNCLASSIFIED
Working Group: WG26 Cost Analysis

61327 - MILCON Parametric Cost Estimating in R

Start Date: 6/15/2022	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: John H Woodcock, Jr		
Abstract: Military planners are often faced with basing and force posture decisions in support of service or Joint integrated deterrence requirements. These planners typically need to leverage the expertise of real property and installation subject matter experts to assess the various courses of action (CoAs) that they develop. However, DoD provides planning factors and a well-established methodology for conducting a rough order magnitude estimate that is suitable for the 'what-if' and sensitivity analysis military planners often need. This process can be largely automated to assist them with developing feasible, cost-effective CoAs. The aim of this presentation is to introduce some of the publicly available MILCON and sustainment data, the estimating methodology, then propose a concept for a questionnaire-based tool that can assist military planners with CoA or scenario development. Classification: UNCLASSIFIED Working Group: WG26 Cost Analysis		

60025 - Marine Corps Commanders Organizational Risk Estimate (CORE)

Start Date: 6/15/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Dr. Robert D. Clemence, Jr; Ms. Brittlea S. Brown; Chris Goodhart		
Abstract: The Marine Corps is reforming its Planning, Programming, Budget, Execution, and Assessment (PPBEA) process to modernize and optimize its corporate governance. Marine Corps Commanders Organizational Risk Estimate (CORE) reports provide organizations that have historically lacked a voice in Program Objective Memorandum (POM) development with an annual evidence-based process to articulate their fiscal plans and associated risks. The report reveals enterprise level impacts and investment/divestment opportunities so that Marine Corps senior leaders can make risk-informed decisions. The fundamentals of CORE are captured in four "R's": Requirements (What Must Be Done), Resources (What Is Needed and What Is Provided), Risks (With What Consequences) and Reporting (To What Extent and Standard). HQMC Program Analysis and Evaluation (PA&E) analysts guided the formulation and assisted with data collection for 37 selected Colonel, 1 Star, 2 Star and 3 Star commands throughout the Marine Corps. This presentation will describe the CORE process, the		

outcomes, how organizational and enterprise risks were compared and prioritized, and the lessons learned that will be incorporated for POM-25.

Classification: UNCLASSIFIED // FOUO
Working Group: WG26 Cost Analysis

59787 - INVESTIGATION INTO ENGINEERING CHANGE ORDER COSTS AND APPROPRIATE RULES-OF-THUMB

Start Date: 6/15/2022	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Kaiana Miller; Edward D. White, III; Jonathan Ritschel; Lt Col Scott Drylie; Dr. Robert David Fass

Abstract: Engineering Change Orders (ECO) are technical requirements changes to existing contracts. To account for the potential increase in contract costs stemming from ECOs, current acquisition practice is to estimate a dollar value to hold in management reserve (MR) in case of ECO occurrence. Estimators often rely on rules-of-thumb when developing these estimates. Specifically, estimators use a 10% rule-of-thumb for estimating MR contract costs in the Development life cycle phase and a 5% rule-of-thumb for contracts in the Production life cycle phase. However, no empirical data supports or validates these 10% and 5% figures. Using non-parametric statistical tests, 2,434 contracts with ECOs were analyzed to determine the accuracy of the 10% and 5% rules-of-thumb as well as to determine if more accurate rules-of-thumb could be developed. Results suggest that if a contract is likely to have a positive ECO percentage, then 13.25% and 5.5% general rules-of-thumb are more appropriate for contracts in the Development and Production life cycle phases respectively. Service, Contract Type, Commodity, Initial Program Size, and Schedule impact ECO percentages.

Classification: UNCLASSIFIED
Working Group: WG26 Cost Analysis

60113 - Marine Corps Force Design Affordability Analysis

Start Date: 6/15/2022	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Mr. JJ Bancroft; Stephanie Baynes; Davis Greenwood

Abstract: Marine Corps Force Design Affordability Analysis

The Marine Corps' concept for Force Design 2030 calls for major changes across the service both structurally and programmatically. These changes created significant shifts in resource programming and re-prioritized future funding in an already fiscally-constrained environment. The Marine Corps' Programs and Resources (P&R), Program Analysis and Evaluation Division (PA&E) has developed a repeatable process to assess affordability of USMC programs with respect to the USMC topline, Force Design, and relevant portfolios within the current and potential future budgetary environments. Through this process, PA&E created a framework for assessing current and future programs that drive or constrain FD implementation. This assessment included a 15 year look beyond the current base year of the Program Objective Memorandum (POM) cycle, and included Force Design, the Aviation Plan (AVPLAN), the Ground Combat Tactical Vehicle (GCTV) Plan, and the Network Modernization (NETMOD) Plan. PA&E developed a Tableau-based tool to facilitate capital planning and strategic risk analysis. It is envisioned that P&R's FD affordability study will provide a centerpiece for the detailed costing of all of the Commandant of the Marine Corp's Force Design transformation initiatives for the Supporting Establishment and Organizational Commands.

Classification: UNCLASSIFIED // FOUO Working Group: WG26 Cost Analysis

61074 - A little knowledge is a dangerous thing

Start Date: 6/16/2022	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: Mr. Kenneth A. Amster		
Abstract: This presentation focused on analysts at the beginning of their career. It consists of a presentation on providing a program office data on probably the most important elements necessary for decision making: effectiveness, risk, cost and schedule. Classification: UNCLASSIFIED Working Group: WG26 Cost Analysis		

61075 - Techniques to make Rapid, Portable, and Interactive HTML-Based Dashboards using R Markdown (without Shiny)

Start Date: 6/16/2022	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: David Azari, Ph.D.		
Abstract: This presentation demonstrates how commonly accessible techniques can be used to create rapid, interactive, and network-agnostic dashboards. Derived from an analytic effort at The Research and Analysis Center (TRAC) of Army Futures Command to integrate future modernization decisions across concepts, formations, cost, and operational analysis, this session focuses on how R Markdown (without Shiny) can create stand-alone and exportable interactive visualizations - without a virtual or cloud host - that comport with local security requirements. The resulting dashboard enabled a user to compare approximately 500 programs in the Equipping Program Evaluation Group (EE PEG) along various measures (e.g., program health, total cost and unfunded requests, priority, operational benefit, etc.) Classification: UNCLASSIFIED Working Group: WG26 Cost Analysis		

60119 - Intelligent Automation for Pricing: Natural Language Processing Supported Labor Category Matching

Start Date: 6/16/2022	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Dennis Robertson; Elizabeth Chirico		
Abstract: A key element in executing a successful acquisition process requires an effective assessment of proposal pricing, including labor costs. The current labor price evaluation process involves manually mapping the contractor provided labor category to several different reference data sources. This process is time intensive, which reduces the capacity of the acquisition specialist. Instead, an efficient aggregation of multiple data sources enables a more effective negotiation process. The primary challenge to improving this process is the varied, inconsistent, and limited data that serves as the starting point for the acquisition specialist: the labor category title. Often only a word or two, labor category titles may not have sufficient context to fully extract meaning. Therefore, mapping titles between a single contractor's proposal and a standardized dataset of titles can prove difficult. Natural language processing (NLP) is used to aid in the automation in these mappings. NLP is a branch of artificial intelligence that aims to provide computers with the ability to interpret human language and consists of various specific techniques. In this work, named entity recognition (NER) and sentence bi-directional encoder representations from transformers (SBERT) models are leveraged to		

extract labor category descriptions from unstructured sources to enrich the input data. This enriched data can more easily be mapped between various data sources and the input contractor data, using a sentence transformer model.
As no ground-truth dataset exists for the appropriate mapping between various data sources, a modest test set was built by the authors in collaboration with subject matter experts. The baseline results are achieved with fuzzy matching. These results do not include the meaning associated with the labor category title--it is simply a string comparison. The baseline tests indicated that only 22% of labor category titles were matched appropriately to their corresponding match in the Bureau of Labor Statistics (BLS) Occupational Employment and Wage Statistics (OEWS). A further 34% of this baseline test were similar, resulting in a poor match rate of 44%. After the application of NLP, the number of appropriately matched labor category titles more than doubled to 50%, with the poor match rate dropping to 13%. The NLP-based analysis requires no additional user input compared to the baseline, and therefore represents potentially significant time saved in the acquisition process.

Classification: UNCLASSIFIED
Working Group: WG26 Cost Analysis

59965 - Cost Comparison Analysis Tool for Stationing (CCATS)

Start Date: 6/16/2022	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Mr. Micheal Vincent Pannell		

Abstract: The Cost Comparison Analysis Tool for Stationing (CCATS) is an updated version of the Cost of Base Realignment Actions (COBRA) model used in the 2005 Base Realignment and Closure (BRAC) and more recently in the European Infrastructure Consolidation study. In 2016, the Office of the Secretary of Defense (OSD) initiated a three-phase effort co-led by CAA and OSD to update COBRA utilizing a Joint Process Action Team with representatives from all Services. The resulting CCATS is designed to leverage current technology, incorporate more analytic capabilities, and provide more functionality than its predecessors. These upgrades allow CCATS the ability to analyze small day-to-day stationing actions as well as large BRAC-like actions. Available through the Amazon Web Services U.S. GovCloud hosting environment, CCATS provides a DoD-wide enterprise tool to conduct cost comparisons of stationing decisions.
This presentation will provide an overview of CCATS operability, highlighting its utility and key functionalities for comparing cost of stationing scenarios.

Classification: UNCLASSIFIED
Working Group: WG26 Cost Analysis

60034 - Palestinian Authority Security Forces Personnel Cost Model

Start Date: 6/16/2022	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: LTC John Ferguson		

Abstract: The U.S. Security Coordinator (USSC) Jerusalem works with the Palestinian Ministry of the Interior and the Organizations and Administrative Commission to develop and implement human resource policies that fully support all the Palestinian security sector services, commissions, and directories as they relate to pay, careers, recruitment, retirement, promotion, and information sharing. USSC Jerusalem asked the Center for Army Analysis (CAA) to develop a costing model that informs on the sustainability of the Palestinian Authority Security Force (PASF) inventory and current pension system, and help planning teams explore options to create a right sized PASF with a sustainable cost structure.

This presentation will report on CAA's efforts to understand the PASF's human resource management issues dealing with promotion selectivity, benefits, pension system, and accessions. The presentation will also include the challenges in developing a forecasting model with limited personnel data and the efforts in developing a costing model including levers used to inform on solutions addressing projected PASF shortfalls. CAA will inform and solicit feedback from those interested in manpower and personnel analysis.

Classification: UNCLASSIFIED
Working Group: WG26 Cost Analysis

59855 - Develop and Analysis of a Cost Imposing Strategy

Start Date: 6/16/2022	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: 2d Lt Kevin Cruz; 1st Lt Glen Drumm; 1st Lt Norma Ghanem; Dr. Mark A. Gallagher, FS		
Abstract: We present a systematic approach to identify potential military cost-imposing actions and possible adversary responses. The cost imposition is in terms of budgets and resources over an extended period of time. Hence, the decisions of actions and responses are force mixes and strategies that affect a potential future conflict. The cost imposer takes an initial action, such as deploying an advanced system with new technology, intended to cause the targeted opponent to expend more resources in countering this initiative. We determine the extent of the adversary's response to maintain their overall effectiveness in the projected military campaign. We evaluate the ratio of costs for the adversary response that is sufficient to achieve the original effectiveness over the cost of military actions of imposition; these ratio are the relative cost incurred. Ratios greater than one represent viable cost-imposing actions with higher ratios being better for the cost imposer. Classification: UNCLASSIFIED Working Group: WG26 Cost Analysis		

WG27 Decision Analysis

60591 - Dynamic Airlift Planning in a Contested Environment

Start Date: 6/14/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Dr. Robert Franklin Dell; W. Matthew Carlyle, PhD; Dr Brad Davis; James D. Whitlow		
Abstract: The United States Air Force Air Mobility Command (AMC) requires the ability to rapidly design new route structures that optimize airlift in contested environments. The emerging future state of potential conflict with peer adversaries will require AMC to rapidly identify and evaluate alternative basing, route, and aircraft utilization strategies in order to mitigate adversary threat while still delivering vital cargo and personnel. This talk presents an Integer Linear Program (ILP) that daily prescribes what airfields to employ, the level of MOG (Maximum on Ground) capacity to establish at each airfield to include movement of capacity between airfields, and the use of aircraft to move materiel. The ILP permits analysis of the tradeoff between risk to force (expected attrition) and risk to mission (cargo and personnel not delivered). We present computational experience for up to 30 days, 100s of potential airfield locations, and multiple aircraft types. Classification: UNCLASSIFIED Working Group: WG27 Decision Analysis		

60109 - Optimizing Supply Blocks for Expeditionary Units

Start Date: 6/14/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Dr. Jefferson Huang; Capt Nikolas Anthony; LTC Peter Nesbitt, PhD		
Abstract: Marine expeditionary units (MEUs) are compact Marine air-ground task forces within the United States Fleet Marine Force that are capable of rapidly responding to crisis situations. Each operates according to a fifteen-month cycle, which includes a six-month deployment period. These deployments often include periods of time (e.g., weeks) during which external resupply is infeasible; for example, the MEU may be operating in a highly contested environment. As such, blocks of materiel are typically deployed with the MEU, for the purpose of being the MEU's sole source of resupply during these periods. Due to the enormous number of potentially combat-essential parts and practical (e.g., space and volume) constraints on the size of a deployable block, care must be taken in selecting which parts to include. We propose a tractable formulation of this part-selection problem as a multidimensional knapsack problem with a nonlinear Newsvendor-type objective function. Both the objective and constraints account for factors that existing methods do not, such as left-over costs and multiple space/budget constraints. We show empirically that a Pyomo implementation of the formulation can produce blocks that outperform those recommended by existing methods (e.g., in terms of the number of shortages), using significantly less computational time. Classification: UNCLASSIFIED Working Group: WG27 Decision Analysis		

59825 - Improved Acceptance Testing Procedures for Army Ammunition

Start Date: 6/14/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Daniel Paul Baller; LTC Blake Schwartz		
Abstract: Every year, Lake City Army Ammunition Plant (LCAAP) in Independence, MO, manufactures 1.6 billion rounds of small arms ammunition for the US military. In 2020 the Center for Data Analysis and Statistics (CDAS) was asked by the Assistant Secretary of the Army for Acquisition, Logistics, and Technology to conduct an analysis of the sampling and testing procedures of 0.50 caliber ammunition. Current sampling procedures are conducted by hand and sample sizes are determined using tables originally constructed as far back as the 1960s. We propose updates to both the sampling procedures and sample size calculations for the 0.50 caliber production line to improve efficiency and statistical confidence in test results. While this research focuses on the Army's acceptance testing procedures for .50 caliber ammunition, some of the findings may be usefully extended to other calibers of small arms ammunition as well. Classification: UNCLASSIFIED Working Group: WG27 Decision Analysis		

60071 - Army Continuum of Analysis Meta-Analysis

Start Date: 6/15/2022	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: LTC John Ferguson; Mr. Brian A. Hodges; Raymond Sibaja		
Abstract: The Analytic Continuum of Analysis (ACA) examines enduring questions that our analytic community must answer to support Army Senior Leader decisions, synchronizes and focuses analytic efforts around those questions, and identifies gaps in the analytic support to major decisions. In mid-June 2021, the ACA Analytic Board of Directors (ABoD) directed The Research and Analysis Center and the Center for Army Analysis to perform a quick-turn meta-analysis of the current modernization efforts supporting the Army in 2030 and supporting the Army beyond 2030 as a proof-of-principle.		

The Fiscal Year 2021 ACA meta-analysis used products from 10 Army analytical agencies to demonstrate how the ACA could leverage analytic and wargaming efforts to assess how our modernization efforts are supporting the Army.
This presentation will describe the process and tools used to obtain, integrate, and synthesize study results across a representative set of Army analytic agencies for a modernization assessment the Army in 2030 and the Army beyond 2030 and provide the lessons learned in conducting this type of assessment.

Classification: SECRET NOFORN
Working Group: WG27 Decision Analysis

60105 - Anti-Submarine Warfare (ASW) Weapon Procurement Mix Study - Methodology Overview

Start Date: 6/15/2022	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Mr. Craig Andrew Preston, Jr.; Thomas Karnezos; Jonathan Celaya; Deanne McPherson; Andrew Kosiba; Matthew D. Vonada

Abstract: As the U.S. Navy develops new weapon capabilities for Anti-Submarine Warfare (ASW), resourcing and investment decisions must consider current and future expected operational and logistical needs. Procurement numbers should account for the proper mix of legacy and new weapon loads, the total numbers required per variety, and for maintenance and storage considerations. This study examined Theater ASW weapon demands for potential areas of future conflict utilizing likely Tactical Situations (TACSITS) to determine the required MK 54 Lightweight Torpedo (LWT) inventory (as primary weapon), considerations for alternatives to the MK 54, and proposed mixed load requirements for ships and aircraft employing all variations of LWTs. The objective was to provide clarity towards future resourcing decisions based on legacy LWT inventory as well as the impacts from fielding viable alternatives. The technical approach selected for this study used a custom built Discrete Event Simulation (DES) model with Monte Carlo Analysis to determine the required loads for ASW surface ships and aircraft engaging submarine threats. The model was sensitive to geographic / physical constraints, operational timelines, platform utilization, and platform survivability. The DES model was applied to several geographical diverse scenarios. Within each scenario, a sensitivity analysis explored how variations in a number of key input parameters impacted the overall metrics and results. The study further quantified a metric of risk as the likelihood that a platform does not have enough weapons for a given TACSIT, and explored how LWT inventory requirements were impacted as a function of varying levels of risk. The overall number of LWTs recommended by the study was a summation of combat requirements, homeland defense requirements, and maintenance requirements. Results were compared to projected LWT inventory levels currently planned for procurement to inform future resourcing. This presentation focuses on the methodology and analytic challenges in the approach.

Classification: SECRET NOFORN
Working Group: WG27 Decision Analysis

60256 - Bayesian Networks to Analyze Electronic Warfare Capability

Start Date: 6/15/2022	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Mr. John Stephens; Jason Baker; Mr. David Fullmer; Mr. Daniel C Browne

Abstract: The Department of Defense needs new mission engineering methods and analysis tools that enable them to traceably and rapidly explore 'what if' questions in a form that is flexible to future modification and provides an explicit understanding of assumptions (as opposed to Excel,

PowerPoint). Model-based approaches in digital engineering offer ways to provide entirely new insights not discoverable using previous methods. The Electromagnetic Warfare (EW) domain offers a unique use case to explore the value of these methods to inform capability gaps and provide senior leaders and decision makers with the necessary tools to support recapitalization and modernization decisions.

As the complexity of concepts of employment continues to increase with the advancement of multi-role and distributed systems, tools that can plan and forecast how best to implement new and future systems become ever more important. In order to be credible to operational experts and technical SMEs, these analysis tools need to consider how they incorporate: 1. Confident assessments of effectiveness, 2. Varying levels of abstraction, 3. Ability to incorporate elements of time and capacity, and 4. The ability to incorporate and assess the role Command, Control and Communications (C3) plays. Traditional approaches that aim to assess capability for the purposes of gap identification and investment planning fail in many of the above factors by being document-centric, static artifacts that generally assume C3 is operational or consider it too abstractly. This presentation will show the utility of Bayesian Networks as a modeling structure to enable these necessary tools and explore the functionality required to make them a reality.

This presentation will build on previous efforts to utilize Bayesian Networks (BN) to model military kill-chains and/or kill-webs for mission analysis and concept of employment (CONEMP) studies by exploring threat system kill chains vs friendly EW system capabilities. BNs do experience implementation challenges due to the potential scale and complexity of interactions. Additionally, the traditional roadblocks for BN utilization of conditional probability table (CPT) data collection and the volume of models to be developed, can be time consuming. This presentation will address these challenges by demonstrating a model development environment that makes PGM construction, population and analysis simple and intuitive. Additionally, a novel technique that eases subject matter expert (SME) burden for populating CPTs will be presented. Finally, the presentation will discuss the exploration of utilizing EW system flight and laboratory test data to populate the appropriate CPTs that inform EW system effectiveness vs. threats; ultimately allowing exploration of EW system capability gaps relative to platform survivability that can inform procurement and divestment decision.

Classification: SECRET NOFORN
Working Group: WG27 Decision Analysis

60026 - Marine Corps Commanders Organizational Risk Estimate (CORE)

Start Date: 6/15/2022	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Dr. Robert D. Clemence, Jr; Ms. Brittlea S. Brown; Chris Goodhart		

Abstract: The Marine Corps is reforming its Planning, Programming, Budget, Execution, and Assessment (PPBEA) process to modernize and optimize its corporate governance. Marine Corps Commanders Organizational Risk Estimate (CORE) reports provide organizations that have historically lacked a voice in Program Objective Memorandum (POM) development with an annual evidence-based process to articulate their fiscal plans and associated risks. The report reveals enterprise level impacts and investment/divestment opportunities so that Marine Corps senior leaders can make risk-informed decisions. The fundamentals of CORE are captured in four “R’s”: Requirements (What Must Be Done), Resources (What Is Needed and What Is Provided), Risks (With What Consequences) and Reporting (To What Extent and Standard). HQMC Program Analysis and Evaluation (PA&E) analysts

guided the formulation and assisted with data collection for 37 selected Colonel, 1 Star, 2 Star and 3 Star commands throughout the Marine Corps. This presentation will describe the CORE process, the outcomes, how organizational and enterprise risks were compared and prioritized, and the lessons learned that will be incorporated for POM-25.

Classification: UNCLASSIFIED // FOUO
Working Group: WG27 Decision Analysis

60467 - Unmanned Systems Gap Analysis

Start Date: 6/15/2022	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Mr. Robert P. Trost; CAPT Kory Fierstine		
Abstract: The United States Naval Forces Southern Command (USNAVSO)/Fourth Fleet (FOURTHFLT), working with the Office of Naval Research (ONR) SCOUT Experimentation Campaign and the Joint Interagency Task Force – South (JIATF-S), are developing and testing unmanned systems (UxS), as well as artificial intelligence (AI)/machine learning (ML) techniques, to solve operational problems in the JIATF-S area of responsibility (AOR). This paper uses past and ongoing efforts by the USNAVSO/FOURTHFLT to identify potential gaps in UxS capability that could lead to future mission failure if conflict with a near peer competitor were to occur today. Classification: UNCLASSIFIED Working Group: WG27 Decision Analysis		

60154 - Using "complexity" as an attack surface

Start Date: 6/15/2022	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Hambisa A Keno; Jessica Peggy Dorismond; Patrick Fisher; Mr. Michael Miller; Dr Dan Zwillinger		
Abstract: Overwhelming an adversary with complexity may effectively limit their responsiveness. AFRL's Marionette program is metricizing complexity via a "decision calculus." BAE Systems' COMMAND (Complexity Modeling in Multiple Domains) program created a capability to capture data for complexity analysis. COMMAND created an extensible, multi-domain (air, space, cyber), multi-component (e.g., radars, missiles, command and control nodes), multi-function (HW, SW, power, communications), multi-connected (RF, fiber, and satellite) Red IADS (Integrated Air Defense Systems) that responds to Blue COAs (Courses of Action). Subject Matter Expert created COAs containing kinetic, cyber, and EW effects provided a demonstration set for a commander's intent. A genetic algorithm leveraged these COAs to create many more COAs. As an example of complexity through cognitive overload, COMMAND implemented a multi-class priority queuing model for message entities awaiting operator review. Classification: UNCLASSIFIED // FOUO Working Group: WG27 Decision Analysis		

60017 - Assessing the Perception and Comprehension of Adversarial Cyber Activity in Operational Technology Environments Using Bayesian Networks

Start Date: 6/15/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Dr. Lee T Maccarone; Dr. Dennis M. Buede; Mr. Scott T. Bowman; Mr. MacLeod C. Bracken; Dr. Gabriel A. Weaver; Mr. Charles D Burdick, CAP; Mr. Brian K. Castle		

Abstract: Critical infrastructure and other operational technology (OT) environments face increasing cybersecurity risks from adversarial behavior. The Cybersecurity for the Operational Technology Environment (CyOTE) program seeks to enable asset owners and operators (AOOs) to secure their OT environments. The cornerstones of the CyOTE methodology are the perception of observable cyber-events and the comprehension of these observables in broad context including people, processes, and technologies. This cycle of perception and comprehension enables business decisions on whether the observables suggest malicious cyber activity or a benign reliability failure. By applying the cycle of perception and comprehension to anomalous observables in the OT environment, AOOs can better identify adversary behavior and reduce the likelihood of impact.

This research defines a risk-based approach to enhance comprehension of observables. The approach leverages the MITRE ATT&CK® for Industrial Control Systems (ICS) framework as a common lexicon for describing potential adversary behavior in the OT environment. MITRE ATT&CK® for ICS is a taxonomy of adversary actions that categorizes techniques into groups of tactics based upon their intended malicious purpose within the victim's environment. The risk approach draws connections between the MITRE ATT&CK® for ICS techniques and their observables to enable improved attack comprehension.

A Bayesian network was developed to quantify the risk associated with combinations of observables and artifacts. Observables are reported in open-source reporting whereas artifacts are potentially observable events that were not reported, but likely occurred based upon digital forensic expertise. Stages of an attack are specified as nodes in the network. Each attack stage includes tactics that an attacker might employ during that stage. The tactics are mapped to techniques that are in turn mapped to the observables and artifacts that they might generate. The likelihood of perceiving and comprehending the malicious behavior is calculated as each piece of new evidence is introduced through discovery of more observables.

This approach is demonstrated using multiple historical case studies of cyber-attacks affecting OT systems. As the adversary utilizes techniques and generates observables, the Bayesian network is used to calculate the likelihood of perception and comprehension of the on-going behavior. Opportunities for improved perception and comprehension are identified through sensitivity analysis of each observable and artifact of the attack.

Classification: UNCLASSIFIED
Working Group: WG27 Decision Analysis

60241 - Strategies for containing a biological crisis

Start Date: 6/15/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Dr. Eva K. Lee		

Abstract: Purpose and Design: We describe the development of a biological-behavior-intervention computational informatics framework that combines disease modelling for infectious virus with stratifications for social behavior and employment, and resource logistics. The framework incorporates heterogeneous human and group behavior and interaction dynamics, and optimizes intervention and resources for effective containment. We link these insights to a web-based tool to provide quick and intuitive observations for decision making and investigation of the disease outbreak situation.

We demonstrate its usage for four types of viruses and its implementation for responses: (a) the 2014-2016 West Africa Ebola outbreak; (b) the 2016 Zika outbreak; (c) the 2020 COVID-19 pandemic in the United States; and (d) a potential scenario of global bird influenza outbreak.

Results: Our analysis shows that timely action within 1.5 months from the onset of confirmed cases can cut down 90% of overall infections and bring rapid containment within 6-8 months. The additional medical resources required are minor and would ensure proper treatment and quarantine of patients while reducing the risk of infections among healthcare workers. The benefit (in infection / death control) would be reduced by 10 to over 100-fold and time to containment would increase by 2-4 fold when intervention and medical resources are injected within 5 months. In contrast, the additional resources needed to bring down the overall infection in a delayed intervention are significant, with inferior results.

Subsequent use of the system to determine the optimal timing and effectiveness and tradeoffs analysis of various non-pharmaceutical intervention strategies for COVID-19 provide a foundation for policy makers to execute the first-step response. These results have been implemented on the ground since March 2020. The web-based tool pinpoints accurately the import of disease from global travels and associated disease spread and health burdens. This prospectively affirms the importance of such a real-time computational system, and its availability before onset of a pandemic.

Discussion: The disease module can be tailored for different pathogens. It expands the well-used SEIR model to include social and intervention activities, asymptomatic and post-recovery transmission, hospitalization, outcome of recovery, and funeral events. The model also examines the transmission rate of health care workers and allows for heterogenous infection factors among different groups. It also captures time-variant human behavior during the horizon of the outbreak.

The framework optimizes the intervention timeline and resource allocation under constraints and offers insights on how human behavior and resource availability in time and quantity can affect the disease trends and containment significantly. It showcases the needs for look-ahead rapid and dynamic decisions, and the importance of personal protection.

Classification: UNCLASSIFIED
Working Group: WG27 Decision Analysis

59666 - Decision Support Systems for Path Planning: Influence on Workload Perception and Performance

Start Date: 6/15/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Dr. Mary Frame; Dr. John Kegley; Jacob Kaiser; Dr. Jessica Armstrong; Erica Curtis		

Abstract: Decision Support Systems (DSS) are tools designed to help operators make effective choices in workplace environments where discernment and critical thinking are required for effective performance. Path planning in military operations and general logistics both require individuals to make the complex and time-sensitive decisions. However, these decisions can be complex, involving the synthesis of numerous tradeoffs for various paths with dynamically changing conditions. Intelligence collection can vary in difficulty, specifically in terms of the disparity between locations of interest and timing restrictions for when information can be collected. Furthermore, plans may need to be changed adaptively mid-operation, as new collection requirements appear, increasing task difficulty. We tested participants in a path planning decision-making exercise with scenarios of varying

difficulty in a series of two experiments. In the first experiment, each map displayed two paths simultaneously, relating to two possible routes for the two available trucks. Participants selected the optimal map, representing the best solution across both routes. In the second experiment, each map displayed a single path, and participants selected the best two paths. Perceived workload and overall task performance in both experiments for participants who utilized only geospatial information using a map. These measures, along with metrics for trust in the DSS, were collected from a separate, independent group that performed the decision task using a map and a companion summary from a DSS. In the first experiment, the DSS increased adoption of a more heuristic decision strategy, which yielded performance improvements. In the second experiment, the DSS decreased perceived workload and improved performance, particularly on difficult scenarios.

Classification: UNCLASSIFIED
Working Group: WG27 Decision Analysis

59765 - Large-scale Parallelized Simulation on Heterogenous Clusters

Start Date: 6/15/2022	Start Time: 2:00 PM	End Time: 3:00 PM

Authors: Robert Reaney

Abstract: MS&A simulation tasks often require an application, or workflow of multiple applications, to be run over many different parameter realizations following some experimental design. As design spaces become larger and more complex, the need for parallelization of individual simulations becomes obvious; moreover, distributing these simulations across heterogenous nodes on a cluster or network of workstations presents unique technical challenges including dependency management, resource collision, file/artifact collection, and cleanup.

This talk will overview SOFA (Simulation of Federated Applications), an Enterprise MS&A software developed by Anyar, Inc., which leverages containerization technology to deploy, manage, and retrieve information from simulations across a cluster of nodes. SOFA architecture and use will be exemplified using ongoing analysis efforts at Anyar and AFRL which require hundreds of thousands of computationally expensive simulations to be executed for each development cycle.

Classification: UNCLASSIFIED
Working Group: WG27 Decision Analysis

59635 - Wildlife Strike Hazards for United States Air Force Flight Operations

Start Date: 6/15/2022	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Maj Brian Morrison

Abstract: Wildlife-aircraft collisions can pose a substantial risk to United States Air Force (USAF) personnel, equipment and operational missions. The Air Force Safety Center, Bird/Wildlife Aircraft Strike Hazard Team's mission statement includes the preservation of war fighting capabilities (personnel and equipment) through the reduction of wildlife hazard to aircraft operations. Fully utilizing the power of data analytics and operations research techniques is one approach to offer new insights into this safety mission. Base-specific wildlife management plans often overemphasize the count of wildlife strikes by species, not recognizing the importance of ranking species by the hazard they pose to aircraft, personnel, and the mission. Giving these considerations, we produced a first of its kind tool to provide base-specific rankings of species by relative hazard score. This tool can be used by airfield wildlife managers to prioritize species of concern. Furthermore, we conducted a unique deep-dive into the hazards posed by bats for military flight operations. Bat collisions with military

flight operations have the potential to cause damage, substantial damage, or negative effect-on-flight procedures to the aircraft. Between October 1992 and October 2019 within the contiguous United States, Alaska, and Hawaii, 3,383 bat collisions were reported to the USAF Safety Center. We investigated intrinsic (e.g., body mass and roosting behavior) and extrinsic (e.g., geographical location, time of day, season, altitude, and airframe) factors associated with bat strikes. We hypothesized that bat strikes would increase during the summer months and at night. Separately, we hypothesized that bat strikes with aircraft damage would be associated with bat factors such as species richness, roosting behavior (solitary versus colony), and body mass, as well as airframe factors, with fighter, stealth, and rotorcraft airframes being particularly susceptible due to sensitive exposed components. To investigate these hypotheses, we: (i) conducted descriptive statistics assessment for species richness, season, time of day, and altitude of bat strikes; (ii) determined relative hazard scores for various bat species/groupings; and (iii) developed a model for predicting damaging strikes relative to airframe, bat species richness, roosting behavior, and body mass. We found that: (i) bat strikes increased during summer months and at night, peaking at 2100 hours; (ii) Brazilian free-tailed bats consistently ranked in the top eight of the most hazardous bat species across different airframe categories; (iii) fighter and rotorcraft had a positive association with damaging bat strikes; and (iv) species richness, airframe, colony roosting behavior, and body mass were important for predicting damaging bat strikes. Results from this study can be used to prioritize bat species management and suggest modifications in flying operation locations or times, within the needs of the USAF.

Classification: UNCLASSIFIED
Working Group: WG27 Decision Analysis

59802 - Integration of Weather and Traffic Data Analytics for Installation Decision Dashboards

Start Date: 6/16/2022	Start Time: 8:30 AM	End Time: 9:00 AM

Authors: Dr. John Richards

Abstract: The Smart Base Artificial Intelligence (AI) for Traffic and Weather project aims to support modernization of installation decision-making processes by applying complex computational analytics and high performance computing assets to inform installation decision makers for making holistic weather related decisions. Current decision processes are manual and require extensive human interactions in order to inform inclement weather-related decisions such as base closure. This research seeks to integrate weather and traffic data with real-time analytics in order to develop a decision dashboard that can more effectively communicate the impact of risk on weather and traffic safety advisories and closures. This approach identifies, captures, processes, analyzes and leverages various data streams to inform decision-making process in a methodology not currently implemented by military installations. Project deliverables will enable informed decisions for the management of weather-related operations on installations, reducing risk to the installation population and increase decision-making efficiency.
This presentation examines the socio-technical aspects that underpin weather and traffic decisions at installations, and presents the systems engineering methodology currently used to support installation modernization and readiness with automated systems, data fusion, and data analytics. Researchers also present the impacts to smart installation projects at Fort Carson, CO and Fort Benning, GA.

Classification: UNCLASSIFIED
Working Group: WG27 Decision Analysis

60223 - Informing Army Modernization Resourcing Decisions

Start Date: 6/16/2022	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Dr Xander Console		

Abstract: 90th MORSS
U.S. Army The Research and Analysis Center (TRAC)

Principal Author: Dr. Xander Console
Briefer: Dr. Xander Console
Classification of Presentation: Unclassified
Presentation Distribution Statement: Unclassified and Approved for Public Release; Distribution Unlimited
Length of Presentation: 30 minutes
Suggested Working Groups: WG 27 Decision Analysis, WG 34 Data Science and Analytics

Informing Army Modernization Resourcing Decisions

Keywords: Multiple-criteria decision analysis, Army Senior Leader, Modernization, Decision Analysis, Clustering

Army Senior Leaders (ASLs), facing an uncertain fiscal environment with rising costs and flat topline budget, must make difficult resourcing decisions to meet modernization needs while maintaining a balanced budget. As part of an effort to support these decisions, The Research and Analysis Center (TRAC) of the Army Futures Command supported Headquarters, Department of the Army staff with modernization program assessments.

To distinguish programs' operational benefit, the TRAC team developed a data elicitation tool in R Shiny to gather several key operational metrics for modernization programs: relevance to warfighting tasks in either of two theaters (European Command and Indo-Pacific Command) and operational benefit in each theater. To gain an understanding of the relevance to the warfighting tasks, the team solicited input from Army General Officer Commanders across the generating and operating Army communities. Additionally the study team solicited input from capability analysts whose operational benefit assessments were underpinned by capability studies such as Analyses of Alternatives and combat simulations.

The team used the TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution) method to transform the metrics into a single score for each program. These scores determined theater-specific sorted lists with uncertainty estimates for programs' operational benefit. To complement these lists, the team pursued a binning approach. K-means clustering provided program bins. The team ultimately delivered information papers and an R Shiny Dashboard to communicate the results.

The presentation details the decision space, the techniques used and why they were chosen, and how the team communicated results.

Classification: UNCLASSIFIED
Working Group: WG27 Decision Analysis

60300 - Techniques to make Rapid, Portable, and Interactive HTML-Based Dashboards using R Markdown (without Shiny)

Start Date: 6/16/2022	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: David Azari, Ph.D.		
Abstract: This presentation demonstrates how commonly accessible techniques can be used to create rapid, interactive, and network-agnostic dashboards. Derived from an analytic effort at The Research and Analysis Center (TRAC) of Army Futures Command to integrate future modernization decisions across concepts, formations, cost, and operational analysis, this session focuses on how R Markdown (without Shiny) can create stand-alone and exportable interactive visualizations - without a virtual or cloud host - that comport with local security requirements. The resulting dashboard enabled a user to compare approximately 500 programs in the Equipping Program Evaluation Group (EE PEG) along various measures (e.g., program health, total cost and unfunded requests, priority, operational benefit, etc.) Classification: UNCLASSIFIED Working Group: WG27 Decision Analysis		

59702 - Smarter Fleet Sustainment: Applying Game Theory for Support System Operations

Start Date: 6/16/2022	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Dr Dushy Tissa; Mr Michael Turner		
Abstract: The sustainment phase alone accounts for about 75% of the lifecycle costs during the life of major defense systems. Yet, the establishment and management of sustainment capabilities do not always receive the same attention as much as the mission systems they support. Consequently, the impact on the operational availability of a fleet of aircraft, for example, can be significant. The recent retirement by the Australian Defence Force (ADF) of its fleet of 47 MRH-90 Taipan helicopters, 16 years ahead of schedule and just 4 years in service, due to chronic sustainment issues is a case in point. Using a game theoretic framework, we explain why measures that aim to drive up the performance of support systems could undermine the very objectives that are being sought. We illustrate the principle by considering the key elements of a support system that is required to sustain a rotorcraft fleet and estimating that system's performance over time using discrete event simulations. The implications for the formulation of Key Performance Indicators (KPIs) for fleet sustainment are then drawn out. Using the rotorcraft fleet sustainment example, we demonstrate how the same game theoretic principles can also be applied to test the effectiveness of sustainment solutions and make observations on the particular degrees of freedom that different support system operators can exercise in achieving fleet sustainment goals. Classification: UNCLASSIFIED Working Group: WG27 Decision Analysis		

59762 - Impact of Reliability in Conceptual Design – An Integrated Trade-off Analysis

Start Date: 6/16/2022	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Tevari James Barker; Dr. Gregory S. Parnell, FS; Dr. Edward A. Pohl		
Abstract: Reliability is often a stand-alone requirement and not fully included in performance and life cycle cost models in conceptual design. Traditional reliability approaches often require detailed knowledge of a system and are used in later design stages, operational test and evaluation, and		

operations. We develop models to estimate the system reliability of an Unmanned Ground Vehicle early in the design life cycle using knowledge and data from similar systems. The critical role of reliability and its impact on acquisition program performance, cost, and schedule motivates the need for improved system reliability models in the early design stages. Our research integrates reliability, performance, and cost models in a trade-off analysis framework for early acquisition stages. We use functional analysis methods to estimate reliability Pre-Milestone A and assess the impact of reliability on performance and cost models of early system concepts. We use the technology readiness level (TRL), which is indexed, to select different levels of reliability for design. Our integrated cost and performance model assesses the impact of reliability to inform decision-makers before choosing a system concept for further development.

Classification: UNCLASSIFIED
Working Group: WG27 Decision Analysis

60249 - Project Convergence: Joint Integrated Data Analytics Approach

Start Date: 6/16/2022	Start Time: 11:30 AM	End Time: 12:00 PM

Authors: Mr. Alfonso Pesqueira; Danielle Monique Aldrich; Ms. Catherine Leigh Miller

Abstract: Principal Author: Mr. Alfonso Pesqueira
Co-author(s): Ms. Danielle Aldrich, Ms. Cathy Miller
Presenter: Mr. Alfonso Pesqueira
Classification of Presentation: Controlled Unclassified Information
Presentation Distribution Statement: Approved for public release, distribution unlimited.
Working Group(s): WG27 – Decision Analysis; WG22 – Military Assessments

Abstract Title: Project Convergence: Joint Integrated Data Analytics Approach
Abstract text (limit 3,000 characters including spaces):
Project Convergence (PC) provides a venue to demonstrate and understand capability requirements underpinning the Joint All Domain Command and Control (JADC2) construct and execution of Joint All Domain Operations. The concept for PC is to run a large-scale field integration/experiment event on an annual cycle. Each iteration of PC provides a venue to conduct an annual assessment of capabilities as an integrated system to further refine and/or inform technology and concept capability requirements.
As part of the PC year-over-year campaign of learning, the PC21 effort considerably expanded the scope and scale of PC20, which focused on enhancing the close fight in multi-domain operations, to driving Joint Integration as part of JADC2. The objective of PC21 was to inform, develop, and integrate an interoperable Joint Force capable of decision multi-domain maneuver. The PC20 lessons learned enabled the Integrated Analysis Team from The Research and Analysis Center (TRAC), Army Test and Evaluation Command, Data and Analysis Center, and Joint Modernization Command to understand what needed to be shaped within the PC21 planning process. The execution of PC21 enabled the team to more clearly identify data required and necessary expertise to ensure the analytic community is poised to focus on the key measures to successfully plan and execute data collection and analysis for PC22.
This presentation will provide an overview of the multi-line of effort approach for PC21 data collection and accelerated in-stride analysis, lessons learned from PC21 and their application to PC22, and a description of the challenges and opportunities associated with informing the AFC's PC campaign of learning initiative.

Classification: UNCLASSIFIED // FOUO Working Group: WG27 Decision Analysis

60190 - Writing an Effective Problem Statement: Best Practices

Start Date: 6/16/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Mr. Paul Works		
Abstract: Establishing a problem statement is one of the key analytic tasks when initiating a study. It is often the first analytic activity upon receipt of a tasker. A problem statement is critical to providing a definitive focus for the study. It ensures the study effort will respond to the decision maker's needs. It drives the study plan, methodology, study issues, essential elements of analysis, and measures of merit. It directly influences study results and solutions. It subtly influences every aspect of the effort. The Research and Analysis Center (TRAC), as part of its commitment to continued enabling of the analytic profession, developed the Writing an Effective Problem Statement Best Practice Guide (BPG). The document provides best practices for operations research and systems analysts (ORSAs) when developing an analytic problem statement to effectively guide an effort and produce an effective analysis. It includes challenges and pitfalls frequently encountered when developing a problem statement and includes an exemplar use case. The presentation provides an overview of the Writing an Effective Problem Statement BPG and details several recent examples. Classification: UNCLASSIFIED Working Group: WG27 Decision Analysis		

60202 - Practical Session: Tableau for the Data Scientist

Start Date: 6/16/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Joshua Gillmore		
Abstract: Learn how to setup Tableau's Python or R services, connect to Tableau Prep and Desktop, and allow business users to interact with machine learning and artificial intelligence in consumable interactive dashboards. At the end of this session, you will more insight in how to: • Understand the art of the possible with advanced analytics • Install TabPy using a series of basic commands • Understand the art of the possible and connect to Tableau Desktop and Tableau Prep • Apply deep learning-based natural language processing to any text field Classification: UNCLASSIFIED Working Group: WG27 Decision Analysis		

WG28 Advances in Modeling and Simulation Techniques

60237 - A reinforcement learning and optimization scheme for development of novel artificial neural network-based guidance

Start Date: 6/14/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Mr. Andrew Lawrence Kaminsky; Mr. Jonathan E Leonhardt; Mr. Isaac Wolf		

Abstract: Technologies improving onboard guidance, navigation and control (GNC) system components are needed to support a variety of guided weapon technologies including air-to-air engagement, hypersonic intercept, and hypersonic strike. State-of-practice guidance laws are optimal in the context of deterministic target motion, but in cases where the target motion is less predictable, the maneuverability advantage required of the interceptor to ensure intercept can grow significantly. For fast, agile targets, designing an interceptor which achieves this level of maneuver overmatch may be impractical. Thus, improved guidance laws are needed.

Computational modeling is key to addressing guided weapon design challenges particularly at the concept stage. Fortunately, engagement-level and mission-level modeling and simulation tools can be employed to consider and evaluate the missile defense architecture. Thus, the critical challenge is to utilize these modeling and simulation tools to identify and develop technologies that improve performance.

To meet this challenge, CFD Research is developing an optimization approach for training artificial neural networks (ANN) through reinforcement learning (RL) to enhance GNC of guided weapons. ANNs are universal approximators able to approximate complex functions using a set of tunable hyperparameters. In this effort, RL, a machine learning training method that seeks to train these networks by selecting desired behaviors and filtering undesired ones, is employed to train these ANNs to approximate a controller. Evolutionary algorithms, can be used to perform this selection and filtering. Through repeated trial and error of candidate ANN tunings, employed as the guidance scheme in 6DOF missile flyouts, improved guidance schemes can be learned. Evolutionary algorithms are well-suited to the challenges of guided weapon design. Their sole drawbacks are that they typically require significantly more evaluations than their gradient-based counterparts to identify optimal design(s), and it is hard to know which evolutionary algorithm heuristic will work best for a given problem. We have sought to address these issues, by developing surrogate models to map the relationship between the design variables and objectives from data as it is collected. These surrogate models are then employed to provide insight to tune the evolution heuristics and reduce the number of evaluations. This coupling of surrogate models and evolutionary algorithms creates surrogate-assisted evolutionary algorithms that significantly accelerate optimization.

In the presentation we will outline the implementation of an ANN-based guidance module within a 6DOF simulation tool and the use of surrogate-assisted evolutionary algorithms coupled to guided weapon performance evaluation tools for training ANN-based guidance laws using an RL approach with our Multi-disciplinary Engineering Analysis and Design Optimization of Weapons (MEADOW) framework.

Classification: UNCLASSIFIED
Working Group: WG28 Advances in Modeling and Simulation Techniques

59781 - Advanced Analytic Tools for Space Modeling & Simulation

Start Date: 6/14/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Shane N Hall, PhD; Lt Col Adam Messer; Capt Jeff Williams; Jon Vigil; Lt Michelle McGee		
Abstract: Modeling and simulation (M&S) tools are used to analyze Space Force (SF) and Air Force (AF) systems and operations. M&S is critical to developing Space capabilities and requirements in three primary ways: 1) designing Space systems; 2) evaluating the performance and effectiveness of systems; and 3) simulating Space operations to perform descriptive, diagnostic, predictive and		

prescriptive analyses. Here we present a multi-year effort to integrate optimization, experimentation, and post-run analytics with the Synthetic Theater Operations Research Model (STORM), Advanced Framework for Simulation, Integration, and Modeling (AFSIM), and System Effectiveness Analysis Simulation (SEAS) tools using an automated software suite that allows analysts to: 1) rapidly perform complex optimization analyses that identify the decisions that provide the best outcomes for a given objective or set of objectives, 2) manage and automate studies that require thousands of computationally expensive simulation runs saving analysts hours to weeks of study time, 3) exploit multi-core parallelization and high performance computing resources, 4) generate and execute robust design of experiments to assess the operational performance and effectiveness of Space systems, and 5) use advanced analytic and machine learning techniques to identify influential decision criteria and visualize the decision trade space across a broad set of goals and objectives. The advanced analytic methods are discussed, and specific simulation scenarios coupled with optimization are presented. Finally, results and insights from the simulation optimization are provided to show the parameter configurations that optimize the study objective(s).

Classification: UNCLASSIFIED
Working Group: WG28 Advances in Modeling and Simulation Techniques

59822 - Airbase Damage-Assessment and Resiliency Modeling Suite (AD-ARMS)

Start Date: 6/15/2022	Start Time: 8:30 AM	End Time: 9:00 AM

Authors: Andrew Langland

Abstract: What does the war look like from the airbase's perspective? For the Air Force, combat modeling often revolves around the aircraft's fight against the enemy. However, when considering potential future conflicts against peer or near-peer adversaries, understanding the airbase's fight becomes increasingly important. After all, our greatest aircraft are quite useless without fuel, weapons, maintenance, and a place to take-off and land. SAF/SA developed AD-ARMS to help better understand this piece of the fight.
AD-ARMS is a mission level, discrete event simulation to model an airbase as a power projection platform while under attack, with a focus on the support elements of sortie production. Enemy attacks are assessed for damage to aircraft, equipment, surfaces, and other resources. Resulting damage can be repaired, given sufficient resources and time. With fuel, munitions, maintenance, and a viable runway available, sorties can be produced. All combined, AD-ARMS provides the user with a modular and powerful analytical tool to examine airbase operations in a contested environment.

Classification: UNCLASSIFIED
Working Group: WG28 Advances in Modeling and Simulation Techniques

60175 - Applying Experimental Design with M&S to Support Program Prioritization

Start Date: 6/15/2022	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Jacob Samuel Sherman; Ms. Ashley E Banister

Abstract: 90th MORSS
U.S. Army The Research and Analysis Center (TRAC)

Principal Author: Mr. Jacob Sherman
Briefer: Mr. Jacob Sherman
Classification of Presentation: Unclassified
Length of Presentation: 25 minutes

Suggested Working Group: WG 28 – Advances in Modeling and Simulation Techniques; WG 25 – Analysis of Alternatives (AoA) and Capability Development

Applying Experimental Design with M&S to Support Program Prioritization

Keywords: M&S, Deterministic, Experimental Design, Design of Experiments, DOE, Prioritization

It is impossible to perfectly predict the future, but planning and prioritizing for various alternative futures is critical to ensuring readiness for future competition and conflict. “We’re never going to be exactly right – and that’s okay, but we need a baseline to guide our thinking and decision-making.” – GEN John Murray in Foreword to AFC PAM 525-2 Future Operational Environment.

To prepare for potential futures, decision makers often leverage Models and Simulations (M&S) results to inform prioritization decisions. Accordingly, The Research and Analysis Center (TRAC) recently addressed an Army Futures Command (AFC) need for trades analysis relevant to multiple future operating environments to help inform prioritization decisions for a variety of next generation signature programs and enablers. To support this multi-center Army Modernization Analysis (AMA), TRAC employed design of experiments instantiations in multiple representative theaters using its Advanced Warfighting Simulation (AWARS). Each AWARS experiment utilized resolution V fractional factorial design to statistically analyze the marginal effects of future program acquisitions and their two-way interactions.

The FAMSD team thoroughly investigated friendly and threat force structure and basis of issue, performance data, requirements documentation, tactics, techniques, and procedures (TTP) and concepts of operations (CONOPS) to inform model representations of future programs and their current-day equivalents. To accommodate these representations using design of experiments, simulation analysts developed innovative tool suites not only to build the experimental designs and automate run configuration associated with various design points, but also to employ various forms of regression and machine learning algorithms to gain insights into the relationships between predictor and response variables.

This presentation will share the technical approach that guided the AWARS Support to AMA, as well as lessons learned during the process. Robust statistical analysis of M&S experiments will continue to inform key decisions on a wide range of issues faced by Army senior leaders, including modernization, force sizing, POM resourcing, and more.

Classification: UNCLASSIFIED
Working Group: WG28 Advances in Modeling and Simulation Techniques

59721 - Ballistic Missile Discrimination Simulation and Analysis

Start Date: 6/15/2022	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Mr. Richard K. Null		

Abstract: Ballistic Missile Discrimination Simulation and Analysis

A key problem in ballistic missile defense is being able to discriminate the actual warhead from other debris or decoys traveling along with the “real” warhead. This presentation will discuss a high-level simulation and analysis capability designed to conduct rapid assessments of ballistic missile

discrimination given differing object discrimination logic, probability of discrimination and number of Kill Vehicles (KV's) employed. The presentation includes a description of the ballistic missile discrimination simulation and sample parametric analysis.

Classification: UNCLASSIFIED
Working Group: WG28 Advances in Modeling and Simulation Techniques

60283 - Bayesian Networks to Analyze Electronic Warfare Capability

Start Date: 6/15/2022	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Mr. John Stephens; Jason Baker; Mr. David Fullmer; Mr. Daniel C Browne

Abstract: The Department of Defense needs new mission engineering methods and analysis tools that enable them to traceably and rapidly explore 'what if' questions in a form that is flexible to future modification and provides an explicit understanding of assumptions (as opposed to Excel, PowerPoint). Model-based approaches in digital engineering offer ways to provide entirely new insights not discoverable using previous methods. The Electromagnetic Warfare (EW) domain offers a unique use case to explore the value of these methods to inform capability gaps and provide senior leaders and decision makers with the necessary tools to support recapitalization and modernization decisions.

As the complexity of concepts of employment continues to increase with the advancement of multi-role and distributed systems, tools that can plan and forecast how best to implement new and future systems become ever more important. In order to be credible to operational experts and technical SMEs, these analysis tools need to consider how they incorporate: 1. Confident assessments of effectiveness, 2. Varying levels of abstraction, 3. Ability to incorporate elements of time and capacity, and 4. The ability to incorporate and assess the role Command, Control and Communications (C3) plays. Traditional approaches that aim to assess capability for the purposes of gap identification and investment planning fail in many of the above factors by being document-centric, static artifacts that generally assume C3 is operational or consider it too abstractly. This presentation will show the utility of Bayesian Networks as a modeling structure to enable these necessary tools and explore the functionality required to make them a reality.

This presentation will build on previous efforts to utilize Bayesian Networks (BN) to model military kill-chains and/or kill-webs for mission analysis and concept of employment (CONEMP) studies by exploring threat system kill chains vs friendly EW system capabilities. BNs do experience implementation challenges due to the potential scale and complexity of interactions. Additionally, the traditional roadblocks for BN utilization of conditional probability table (CPT) data collection and the volume of models to be developed, can be time consuming. This presentation will address these challenges by demonstrating a model development environment that makes PGM construction, population and analysis simple and intuitive. Additionally, a novel technique that eases subject matter expert (SME) burden for populating CPTs will be presented. Finally, the presentation will discuss the exploration of utilizing EW system flight and laboratory test data to populate the appropriate CPTs that inform EW system effectiveness vs. threats; ultimately allowing exploration of EW system capability gaps relative to platform survivability that can inform procurement and divestment decision.

Classification: SECRET NOFORN
Working Group: WG28 Advances in Modeling and Simulation Techniques

60323 - Capability-Based Teamed-System Analysis (CAPTAN) Methodology

Start Date: 6/15/2022	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Mr Andrew W Drysdale

Abstract: The U.S. Army's Combat Capabilities Development Command DEVCOM Analysis Center (DAC) is developing a new survivability/vulnerability (S/V) modeling and assessment paradigm called CAPTAN. This technique is focused on discerning, and enumerating, the discrete remaining capabilities of the system(s) during a mission scenario; in this way more (and more relevant) information can be provided in DAC's S/V analysis products.

The CAPTAN analysis model consists of three major components: the capability map, the event script, and the mission state machine. Together these data structures define the system(s) under analysis and operate on the model to track how system capabilities change due to threat effects. The capability map is a logical linkage between basic components, the functions they enable, and the high-level capabilities those functions comprise. The event script is an editable list of time-based or situation-contingent changes to the availability of entities in the map, based on the requirements of the mission context. The mission state machine, in turn, defines how the statuses of various map entities affect how a mission is executed and thus how further capability evolution is expected to unfold. Each of these three components can act on the others as the analysis is executed.

CAPTAN is designed to address several of the inherent gaps in legacy strategies. First, it is oriented towards holistic consideration of a formation of teamed systems, rather than considering an ad hoc collection of individual systems "in a vacuum", so the synergistic and survivability advantages of teaming are foregrounded. Second, it provides S/V assessments closely attuned to relevant operational environments. CAPTAN models are inherently sensitive to the mission context, so its output contributes readily to mission-based test and evaluation. Third, because CAPTAN was designed to replace averaged or rolled-up system status metrics with an itemized array of capability availabilities, the big-picture importance of attaining a given damage level is immediately apparent. DAC is now able to link component damage or environmental degradation all the way through system S/V to metrics like mission completion. Finally, CAPTAN offers a considerable leap forward in transparency of assumptions, data traceability, ease of model customization, and documentation.

This presentation will discuss the basic premises of capability-based modeling; will present an example of how CAPTAN component structures interact to execute an analysis; will discuss the advantages of the CAPTAN paradigm; and will present summaries of current methodology development work and projected future efforts.

Classification: UNCLASSIFIED
Working Group: WG28 Advances in Modeling and Simulation Techniques

60106 - Anti-Submarine Warfare (ASW) Weapon Procurement Mix Study - Methodology Overview

Start Date: 6/15/2022	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Mr. Craig Andrew Preston, Jr.; Thomas Karnezos; Jonathan Celaya; Deanne McPherson; Andrew Kosiba; Matthew D. Vonada

Abstract: As the U.S. Navy develops new weapon capabilities for Anti-Submarine Warfare (ASW), resourcing and investment decisions must consider current and future expected operational and logistical needs. Procurement numbers should account for the proper mix of legacy and new weapon loads, the total numbers required per variety, and for maintenance and storage considerations. This

study examined Theater ASW weapon demands for potential areas of future conflict utilizing likely Tactical Situations (TACSITS) to determine the required MK 54 Lightweight Torpedo (LWT) inventory (as primary weapon), considerations for alternatives to the MK 54, and proposed mixed load requirements for ships and aircraft employing all variations of LWTs. The objective was to provide clarity towards future resourcing decisions based on legacy LWT inventory as well as the impacts from fielding viable alternatives. The technical approach selected for this study used a custom built Discrete Event Simulation (DES) model with Monte Carlo Analysis to determine the required loads for ASW surface ships and aircraft engaging submarine threats. The model was sensitive to geographic / physical constraints, operational timelines, platform utilization, and platform survivability. The DES model was applied to several geographical diverse scenarios. Within each scenario, a sensitivity analysis explored how variations in a number of key input parameters impacted the overall metrics and results. The study further quantified a metric of risk as the likelihood that a platform does not have enough weapons for a given TACSIT, and explored how LWT inventory requirements were impacted as a function of varying levels of risk. The overall number of LWTs recommended by the study was a summation of combat requirements, homeland defense requirements, and maintenance requirements. Results were compared to projected LWT inventory levels currently planned for procurement to inform future resourcing. This presentation focuses on the methodology and analytic challenges in the approach.

Classification: SECRET NOFORN
Working Group: WG28 Advances in Modeling and Simulation Techniques

60014 - Combat Model Experimentation on DoD HPCs

Start Date: 6/15/2022	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Charles Timm; Mr. Nemecio R Chavez, JR; Dr. Bob Donnelly; James Greene		
Abstract: As part of the broader cloud efforts within the Army, The Research and Analysis Center (TRAC), is investigating methods to efficiently and economically run their combat simulations in cloud architectures. Additionally, increasing TRAC mission requirements are pushing TRAC to seek larger and more capable classified computing resources to meet demand for increasing study scope and decreasing time available for execution. One promising architecture are the DoD High Performance Computing (HPC) assets. The DoD HPCs are multi-core supercomputers available to all DoD organizations. This presentation will provide an overview of an effort to efficiently conduct experimentation using two combat models, the Combined Arms Analysis Tool for the 21st Century (COMBATXXI) and One Semi-Automated Forces (OneSAF), on DoD HPC assets by a team of TRAC and Army Research Laboratory (ARL) analysts. The results of the testing showed a significant time and resource savings over traditional on-premises servers through dynamic load balancing across the HPC's more numerous computer cores. These results will have implications for how TRAC will potentially conduct studies in the future. Classification: UNCLASSIFIED Working Group: WG28 Advances in Modeling and Simulation Techniques		

60317 - Development of an Interactive Personnel Vulnerability Tool

Start Date: 6/15/2022	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Carolyn Stancoff		
Abstract: The DEVCOM Analysis Center (DAC) uses their Advanced Joint Effectiveness Model (AJEM) to perform modeling and simulation (M&S) of indirect fire munitions against dismounted Soldiers in		

various postures and body armor configurations. These analyses result in a large number of static plots showing the Soldier's vulnerability for each pairing of threat and personnel target. To improve our customer's access and use of these results, DAC developed an interactive tool in R Shiny that allows the user to view the standard plot as well as allowing the user to create a scenario, with a series of threat interactions against a squad. The user can select from a provided list of squad formations, body armor systems, postures, and threats and then create the scenario by selecting threat locations varying the threat, height of burst, and personnel posture as needed. The application reports each squad member's probability of receiving an injury after each threat detonation. The presentation will include the development of the underlying personnel vulnerability data, how that data is used to generate the visualizations in the application and will include a demonstration of the application.

Classification: UNCLASSIFIED
Working Group: WG28 Advances in Modeling and Simulation Techniques

60064 - Digital Engineering Support to the Joint All Domain Command and Control (JADC2) Network

Start Date: 6/15/2022	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Mr. Charles D Burdick, CAP; Dr. Deepinder Sidhu

Abstract: To potentially support JADC2, we have introduced the concept of a Network Digital Design Twin (NDDT) that employs both the technology of virtually cloning a network and the emulation capabilities of the Network Digital Twin (NDT), which can predict its physical twin's responses to any changes in hardware, software, configurations, etc. and to malware attacks and destruction of components.
The JADC2 Network Digital Design (NDD) Clone would be built from regular design updates from all participating JADC2 developers and the NDDT would be built from the current NDD Clone using digital artifacts appropriate to the design stage, e.g., hardware, protocols, etc. that are based on requirements documents.
In addition to providing an interrogatable 3D visualization of the current design, the NDD Clone would maintain a complete record of design changes with their source and date.
As the NDT already does for existing networks, the NDDT would provide a predictive capability allowing for tests of the design, both end-to-end and in segments if not yet connected. Since much of JADC2 already exists or will be in prototype networks they would be represented as NDT emulations that can interface with the NDDT to test both without any risks to the actual physical networks.
This approach would both advance the use of Network Digital Engineering and meet the Testing Community's desire to "Shift Left" allowing much earlier testing in the development cycle.

Classification: UNCLASSIFIED
Working Group: WG28 Advances in Modeling and Simulation Techniques

60099 - Enhancing Information System Integration in DoD Simulation-Based Training Environments through Robotic Process Automation

Start Date: 6/15/2022	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Matthew M Morse

Abstract: The stalled Russian advance, just days into their invasion of Ukraine, illustrates the vital importance of timely, responsive logistics on the modern battlefield. It also illustrates the importance of decision-makers maintaining a clear-eyed understanding of the capabilities and limitations of their supply chain management processes on the battlefield. While some advances have been made in the

representation of logistics considerations in DoD staff training and wargaming simulations, logistics information systems remain underrepresented. Unlike many command and control (C2) systems, which can be integrated with simulations through common protocols (e.g., OTH-Gold) and Sim-C2 research efforts, many logistics ISs require manpower-intensive human-in-the-loop (HitL) processes for integration with simulations. Where automated Sim-IS integration has been achieved (e.g., Joint Deployment Logistics Model [JDLM] and Battle Command Sustainment Support System [BCS3]) the information exchange does not simulate important sociotechnical system (STS) dynamics, such as information latency and simple human error, presenting decision-makers with an unrealistic representation of their logistics C2 capabilities in context.

This research seeks to overcome the limitations of conventional simulation-information system (Sim-IS) interoperability approaches by developing and validating a new approach for Sim-IS information exchange through robotic process automation (RPA) technology. RPA technology, commonly found in commercial off the shelf software from companies such as UiPath, Automation Anywhere, and Blue Prism, supports the automation of integrated business processes by replicating human operator interactions with information systems through graphical user interfaces. This “outside-in” approach to information system integration mitigates the need for engineering changes in operational information systems (or simulations) to support integration of information system. Instead, existing HitL processes are modeled and automated through a combination of tools such as screen scraping and virtual keyboard/mouse actions.

In addition to discussing technical opportunities and challenges associated with an RPA-based approach to Sim-IS integration, this research also addresses conceptual modeling considerations for designing Sim-IS environments to simulate complex integrated business processes and associated STS dynamics. Discussion of RPA-based Sim-IS environment design and development presents recommendations for an envisioned Sim-IS overlay for the Distributed Simulation Engineering and Execution Process (DSEEP). This discussion will include initial results in validation of an RPA-based Sim-IS information exchange prototype and the degree to which such an outside-in approach can simulate the way information delay and degradation manifests in sociotechnical systems.

Classification: UNCLASSIFIED
Working Group: WG28 Advances in Modeling and Simulation Techniques

59997 - High-Value Target (HVT) Tracking in a Mixed Urban-Rural Environment

Start Date: 6/15/2022	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Isaac Hampton

Abstract: High-Value Target (HVT) Tracking in a Mixed Urban-Rural Environment

Target tracking and asset cueing are an integral part of informing operations throughout every phase of an event.
Tracking HVTs through a mix of rural and urban environments poses a unique challenge due to uncertain terrain (e.g. limited target travel) in both regions as well as potential occlusion from buildings and confusion from non-targets, particularly in urban regions.

This mixed environment has been modeled in an AFSIM simulation containing a realistic road network running through urban and rural regions. A realistic skyline is modeled in the downtown to occlude sensing. Land-based HVTs are constrained to the network among a significant amount of unaffiliated traffic.

In this study, aerial visual sensors attempt to track the land-based HVTs through this complex environment, in order to establish terminal positions of the HVTs for further asset cueing.

Classification: UNCLASSIFIED
Working Group: WG28 Advances in Modeling and Simulation Techniques

59719 - Missile Defense Saturated Raid Simulation and Analysis

Start Date: 6/16/2022	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: Mr. Richard K. Null		

Abstract: Missile Defense Saturated Raid Simulation and Analysis

Adversaries are becoming more capable in mounting mass missile attacks on US forces to overwhelm defenses. This presentation will discuss a high-level simulation and analysis capability designed to conduct rapid assessments of raid size and missile defenses. Using a simple discrete event simulation representing a layered Integrated Air and Missile Defense (IAMD) system, contributions of airborne and terrestrial defenses are examined against raid size and raid synchronization. The presentation includes a description of the missile defense simulation and sample parametric analysis.

Classification: UNCLASSIFIED
Working Group: WG28 Advances in Modeling and Simulation Techniques

60079 - Multiagent Routing via the Multiple Shortest Path Problem with Spatiotemporal Dispersion

Start Date: 6/16/2022	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Michael Hughes; Dr. Kenneth Hopkinson; Dr Brian Joseph Lunday, Ph.D.; Dr. Jeffery D Weir		

Abstract: When routing multiple agents across a directed network, it is of interest to ensure they take efficient paths and are spatially dispersed, with the latter objective seeking to decrease risk due to, e.g., an adversary observing, detecting, and interdicting them. Two models respectively consider centralized agent routing and agent-based routing decisions for conditions when coordination is limited to visual range communication. Within the latter model, agents make myopically-optimal routing decisions at each time epoch, informed by the currently observed positions of proximal agents and rational assumptions about said agents' priorities. Illustrative testing demonstrates the efficacy of centralized agent routing and selected conditions under which decentralization can impair agent dispersion. A variety of symmetry defeat mechanisms are developed to improve the computational tractability of the underlying mathematical program within both modeling frameworks. Empirical testing examines combinations of these mechanisms, identifying the superlative symmetry defeat mechanisms and limits on practical instance sizes.

Classification: UNCLASSIFIED
Working Group: WG28 Advances in Modeling and Simulation Techniques

60472 - OneSAF Position, Navigation, & Timing (PNT) Model Enhancements

Start Date: 6/16/2022	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Mr. Joshua Taylor Lenig; Mr. Zachary Steelman		

Abstract: The Army needed to enhance the capability to conduct analysis and experimentation that considers Positioning, Navigation and Timing (PNT) and the impact of Assured Positioning, Navigation

and Timing (APNT) systems in the broader context of other systems/technologies, particularly in the ground fight. To fill this void, the Combat Capabilities Development Command DEVCOM Analysis Center (DAC) worked in conjunction with PNT subject matter experts to develop and implement methodologies to increase the fidelity of the representation of GPS technologies within One Semi-Automated Forces (OneSAF). Further improvements were made by adding behavioral models for a Call for Fires (CFF) mission thread in order to represent the crucial mission impacts of operating within a degraded or denied GPS environment. By adding these capabilities to OneSAF, mission effectiveness analysis support can be provided for upcoming PNT technology testing events.

Classification: UNCLASSIFIED
Working Group: WG28 Advances in Modeling and Simulation Techniques

59830 - Assessing Counter-UAS Detection and Defeat Capabilities in Arctic Environments

Start Date: 6/16/2022	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Mr. William Leonard; Mr. Jed Richards; Christina Rinaudo; Dr. Simon R. Goerger; Dr. David K Wilson

Abstract: The threat of intrusions by small Unmanned Aerial Systems (UAS) challenges the Department of Defense to evolve its Counter-UAS protection capabilities across all operating environments with particular relevance to the Arctic region. This work applies a systems-engineering methodology to integrate Counter-UAS detection and defeat analysis into a geospecific scenario environment (Arctic region), informing the development and employment of Counter-UAS capabilities to detect and interdict UAS intrusions in extreme conditions. This research extends previous capabilities to incorporate additional modalities and attributes (e.g., weather) as a part of the overall model's sensor and defeater selection and placement optimization approach. Furthermore, the model considers both fixed-site and moving targets subject to encroachment by threat UAS. The modeling implementation could facilitate higher-fidelity analysis to inform the design and employment of Counter-UAS systems against a myriad of threat capabilities present in geospecific scenarios. This presentation provides an overview of the overall modeling framework, including recent enhancements and an example use case, to evaluate and interdict threat UAS.

Classification: UNCLASSIFIED // FOUO
Working Group: WG28 Advances in Modeling and Simulation Techniques

60265 - Parametric Analysis in Support of the Future Attack Reconnaissance Aircraft (FARA) Analysis of Alternatives (AoA)

Start Date: 6/16/2022	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Stephen Gillespie

Abstract: The Future Attack Reconnaissance Aircraft (FARA) is the Army's vision for its future aerial reconnaissance capability. It is envisioned to operate as a part of an ecosystem including long range missiles, unmanned aerial systems (UAS), other rotary wing aircraft, and the larger Army and joint force. To enable senior leaders to make informed acquisition decisions regarding the FARA, the Army initiated an Analysis of Alternatives (AoA) in March of 2021. This occurred in conjunction with competitive prototyping efforts led by the Future Vertical Lift (FVL) Cross Functional Team (CFT). The AoA study team needed a way to quickly assess the operational performance of a wide range of potential aircraft with varying capabilities while still using validated Army combat simulations and operational scenarios.

To address this problem, the study team employed the Advanced Warfighting Simulation (AWARS) to represent a US Corps conducting multi-domain operations in a defense planning scenario. It then identified key attributes of the aircraft such as speed, time of flight, vulnerability, detectability, sensor range, and varying load capacity and mixes of load. The study team employed a nearly orthogonal Latin hypercube experimental design to select 256 of the millions of possible combinations of aircraft attributes and then simulated those 256 combinations. The team measured key results such as aircraft losses and mission accomplishment and then performed statistical and machine learning on the results to develop models that predict the results of the simulation for any combination of traits in the bounds the team assessed. The team then used this to find the minimal requirements to achieve any given operational end-state (percent of threat dis-integrated).

This methodology enabled the study team to complete this parametric analysis without specific performance parameters from each particular alternative as those parameters were unavailable until the end of the study. As the study concluded, the team was able to assess each particular alternative's operational performance according to the results of the parametric analysis very quickly and provide insights into both the prescribed alternatives and the subsequent "what if" alternatives that arose through the course of the study.

This presentation will explain the methodology and tools to do this parametric analysis as described above. It will only present notional results as the actual results are not yet releasable. Additionally, it will cover key lessons learned and future work related to this problem set.

Classification: UNCLASSIFIED
Working Group: WG28 Advances in Modeling and Simulation Techniques

60221 - Counter-small Unmanned Aircraft Systems Analytic Model

Start Date: 6/16/2022	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Dr. Michael Yereniuk; Shelby Lardner; Kenneth Wheeler

Abstract: The recent acceleration in the roles and numbers of small Unmanned Aircraft Systems (sUAS) used in combat operations pose a new threat to Army maneuver formations. Accordingly, Army Futures Command (AFC) and Futures and Concept Center (FCC) sponsored a 6-month C-sUAS study to inform Program Objective Memorandum 24-28 and C-sUAS Abbreviated Capabilities Development Document (A-CDD). The purpose of the study was to assess operational effectiveness and requirements of future C-sUAS technologies by echelon and battlespace geometry in the future.

The study team determined there was insufficient time to integrate scenarios into established combat models due to the effort required to develop Threat representations, behaviors, and acquiring data for those models. As a result, the team developed the C-sUAS Analytic Model that represented Friendly and Threat intent, simulated sUAS behaviors and capabilities, as well as C-sUAS detection and engagements. The C-sUAS Analytic Model had the capability to quickly assess over 250 scenario situations and gave the study team insights into the effectiveness of Threat sUAS and opportunities for future investment in Friendly C-sUAS technologies.

The C-sUAS study team utilized the Visual Application with Data-Collection in R (VADR) model framework as a main interface and environment to show interactions found in the newly developed Counter Information Seeker Computational Research (CISCR) model. The CISCR model is a stochastic, highly-abstracted, time-stepped adjudication model to analyze measures of operational effectiveness.

CISCR is set up similar to a two-player information acquisition game: Friendly forces try to understand and destroy enemy sUAS while the enemy forces try to evade and destroy Friendly forces. The study team adapted VADR to provide an interactive vignette map layout with both Friendly and Threat force components at specific coordinates to develop the correct starting placement of the battlespace. The simulation environment is a Voronoi partition placed over the Friendly entities within the area of operation. The model incorporates future Threat sUAS mission roles through assigned behaviors, such as intelligence, surveillance, and one-way attack. It represented emergent swarm-like behavior through the establishment of global communications that allowed one sUAS to provide information to the larger group, enabling other sUAS to act upon that information. With every run, CISCR tracked the sUAS detections, identifications, engagements, and defeats. This allowed the study team to complete quantitative analysis on key operational effectiveness statistics.

This presentation will provide an overview of the study, details of the model development and function, and lessons learned.

Classification: UNCLASSIFIED // FOUO
Working Group: WG28 Advances in Modeling and Simulation Techniques

60164 - Reduced Order Non-INtrusive (RONIN) Modeling Methodology Formulation for Military Operations Analysis Applications

Start Date: 6/16/2022	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Major Mark Bateman

Abstract: With the Department of Defense (DoD) shifting focus to prepare for peer and near-peer adversaries, there is a big push to out-innovate these adversaries through many different approaches. A specific area of interest is the use of Modeling, Simulation, and Analysis (MS&A) to provide analytical support for strategic decisions related to capability development. While extensive experimental and empirical data from past system development activities exists, there is a lack of similar data for proposed advanced concepts that are still in the early stages of research and development, which makes it difficult for military operations analysts to evaluate the military utility of a new concept in a cost-efficient manner. Operations research analysts are working toward using advanced MS&A techniques such as discrete-event or agent-based approaches to capture complex system and system-of-system behaviors in greater detail, however these advanced methods come at a high computational cost, especially when the scope of the analysis grows to the strategic level. To address the computationally prohibitive nature of some of these highly accurate methods, an approach of model abstraction through the use of surrogate models or meta-models which work to emulate the behavior of the computationally expense model but with a reduced computational cost. A promising class of surrogate modeling methods that could be potentially leveraged to enable these types of analyses is a non-intrusive parametric field surrogate approach that utilizes reduced order modeling techniques to create computationally efficient models. These field-based approaches that seek to leverage vector approximations of model responses have emerged as an alternative to more traditional approaches that rely on scalar-based approximations. This research works to formalize a methodology which leverages these Reduced Ordered Non-Intrusive (RONIN) modeling methods for military operations analysis, specifically focused at the mission and campaign level modeling.

Classification: UNCLASSIFIED
Working Group: WG28 Advances in Modeling and Simulation Techniques

60272 - Insights and Lessons Learned - Towards Small and Routine Experimentation across Communities

Start Date: 6/16/2022	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Mr. Jed Richards; Keith Athmer; Dr. Niki C. Goerger, FS; Dr. Simon R. Goerger; Mr. William Leonard		
Abstract: The US Army Engineer Research and Development Center (ERDC) and the Maneuver Support Battle Lab (MSBL) embarked on a limited scope proof of concept experiment to help operationalize the Army Persistent Experimentation eNvironment (APEN) and bring together science and technology (S&T) labs with battle labs for routine and small experimentation. Marrying operationally focused objectives and perspectives with engineering-level modeling objectives and perspectives provides a fuller system understanding to both communities. Linking together differing model types enables more informed weapon system decisionmaking and, ultimately, improves capability for the warfighter. This set of proof of concept excursions included use of OneSAF simulation and S&T computational models pertaining to autonomous vehicles and countering unmanned aerial systems. This initial work was not intended to provide a definitive analysis but a means to explore methods, investigate opportunities, and acquire lessons learned. This presentation will describe the goals, approach, and initial findings as well as highlight insights, lessons learned, and recommendations geared towards incorporating experimentation across communities into more routine use. Classification: UNCLASSIFIED // FOUO Working Group: WG28 Advances in Modeling and Simulation Techniques		

60327 - Standard System Performance Data for Test and Training

Start Date: 6/16/2022	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Ryan Barker		
Abstract: Live, virtual, and constructive instrumentation systems, models, and simulations within the U.S. Army Modeling and Simulation (M&S) Enterprise and Army Modernization Enterprise (AME) communities (Analysis, Test& Evaluation, Training, Acquisition, Experimentation, and Intelligence) depend on standard imbedded methodology and data to accurately represent battlefield effects. The Combat Capabilities Development DEVCOM Analysis Center (DAC) is working with these communities to apply the discipline of systems analysis throughout the acquisition life cycle of future test and training systems. This discipline ensures that the results of events are produced using standard performance data and physics-based methodology. The performance data has been developed through requirements analysis, methodology research and development, and system sustainment. This dataset is a key part of the Army M&S Enterprise/ AME's Data as a Service (DaaS) force structure efforts which houses force structure data linked to system performance data to create an easily accessible and ingestible dataset for the greater community. Innovative DOD policies, advances in technologies, along with the establishment of cloud infrastructures will continue to drive the implementation of DaaS, M&S as a Service (MSaaS), and Digital Engineering (DE) to adequately model the effects of multi-domain operations and beyond. Classification: UNCLASSIFIED Working Group: WG28 Advances in Modeling and Simulation Techniques		

60266 - Simulating Expeditionary Advanced Base Operations (EABO) in the Combined Arms Analysis Tool for the 21st Century (COMBATXXI)

Start Date: 6/16/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Dr. Curtis L. Blais; Dr. Imre Balogh; Christian Fitzpatrick; David Reeves; Capt Matthew Robinson; Kirk A Stork		
Abstract: The United States Marine Corps (USMC) is undergoing organizational and operational changes to adapt to new warfighting requirements in today's world. The USMC Force Design 2030 describes new concepts, such as Expeditionary Advanced Base Operations (EABO), with a focus on reconnaissance/counter-reconnaissance and maritime interdiction. To examine and evaluate such new concepts of operation, to include new force structures, new weapon systems, and other adaptations, the USMC requires models and simulations that can represent the full range of variations representing these expected changes. The Combined Arms Analysis Tool for the 21st Century (COMBATXXI) is a combat simulation jointly developed by the USMC and the US Army to support modeling and analysis. Developed over the past 20 years, COMBATXXI possesses many of the fundamental representations needed to study these new concepts but is lacking realistic representation in some key areas. This presentation reports on work performed in COMBATXXI to address some of these shortcomings. The presentation describes a modeling approach, initial implementation in COMBATXXI, and preliminary evaluation of the utility of the model for supporting scenarios and studies relating to the new USMC concepts of operation. The study concludes with recommendations for follow-on work to further improve or employ the developed capability. Classification: UNCLASSIFIED Working Group: WG28 Advances in Modeling and Simulation Techniques		

60263 - Representing Swarming Technologies in Aggregate Operational Modeling and Simulation

Start Date: 6/16/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Mrs Cara L Lance		
Abstract: Over the last several decades, there has been a proliferation of autonomous systems on the battlefield. A unique feature of these systems is their ability to inter-operate in a manner such that they present an emergent behavior that is not easily understood through an understanding of the constituent systems. This behavior is often termed "swarming" and is increasingly being looked to as a means to gain an advantage on the battlefield. Much modeling and simulation (M&S) research has focused on understanding the nature and capabilities of swarms by representing individual systems and their interactions. This is highly useful and important work; however, the methods used to do this do not immediately translate into M&S that attempt to understand how swarms integrate into larger, operational fights. This is because it is not feasible to represent each individual constituent system of a swarm that may number in the hundreds in a model that is also representing all of the other aspects of a corps operation. As such, there is a need to represent swarms in an aggregate nature to understand how they interact and affect larger operations. This presentation reviews how a team did this by employing the Advanced Warfighting Simulation (AWARS) in support of the Future Vertical Lift (FVL) Cross Functional Team (CFT). The presentation further suggests areas for continued swarm M&S development and needed areas of research. Classification: UNCLASSIFIED Working Group: WG28 Advances in Modeling and Simulation Techniques		

WG29 Computational Advances in OR

60206 - Achieving Multi-Resolution Campaign Modeling in AFSIM

Start Date: 6/14/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Alexander Braafladt; Dr. Alicia Sudol; Professor Dimitri Mavris		
Abstract: This work is a continuation of the efforts presented previously at MORS Symposiums evolving a 'Campaign-Lite' methodology for aggregating information across fidelity levels in simulation. This aggregation supports effective analysis of means and ways options in a design context for large-scale military operations. The aggregation of information is used to provide analysis scope at the decision-level of interest (e.g., campaign-level), while maintaining technical credibility and transparency through traceable connection to the other levels (e.g., physics, engagement, and mission). Ongoing research efforts are working to better support analysis by tailoring fidelity – resolution, scope, and abstraction – to the specifics of the case, while working within runtime constraints and providing improved re-usability and re-configurability of simulation. The Advanced Framework for Simulation, Integration, and Modeling (AFSIM) provides an open architecture for these efforts and is successfully in use supporting simulation and analysis focused on the engagement and mission levels. The work presented here continues the evolution of an approach to supporting campaign-level analysis using AFSIM – the Campaign-Lite approach. The advances presented here involve extending the object-oriented, higher-level operational information framework to include intelligence management and involves planning, collection, and processing of campaign-level intel information dynamically in the AFSIM agent-based structure. This provides a set of modular interfaces for managing and using intel information in the loop to support analysis looking at larger-scale operational activities – in addition to classic AFSIM interfaces for mission, engagement, and physics-level modeling. The scenario considered in this work builds on a multi-domain, large-scale operation to specifically follow an analytic path through the intel collected and utilized during the initial stages of a large-scale operation. The analysis considerations are based in a data-driven dashboard enabled by surrogate models that is directed at supporting or integrating data with other simulations at the campaign level. Classification: UNCLASSIFIED Working Group: WG29 Computational Advances in OR		

61072 - A new way to look at multi-resolution modeling

Start Date: 6/14/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: J. Scott Thompson		
Abstract: Military operations researchers decompose systems and define simulation requirements based on the analytic questions at hand. Often, the need to answer multiple questions drives a need to represent systems at multiple levels of detail. This presentation leverages an apparently abandoned line of research in multi-resolution modeling, expands on existing definitions, and proposes a method to assist analysts with selecting the appropriate level of detail. Classification: UNCLASSIFIED Working Group: WG29 Computational Advances in OR		

59655 - "One Stop Shop Leadership Dashboard in R Shiny"

Start Date: 6/14/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Summer Padilla		

Abstract: The Air Combat Command (ACC) Inspector General's mission is to inspect over 80 ACC and Air National Guard (ANG) wings. The goal of the inspections is to assess readiness of each wing and ensure all are on track to complete their missions. With so many Wings being inspected with limited resources within a short cycle, a "One Stop Shop" product was required to decrease preparation time for the inspectors and trip planners. The dashboard allows for historical trend analysis to better assess the risk level of each wing and to determine the amount of resources required for each inspection to minimize waste. A spare "Wing Only" dashboard was also created to ensure Wings were prepared for what the focus of the inspection would be. This product condenses five different data sources into one multi-input app that is hosted on the R Shiny Server. This presentation communicates the impact of this tool, along with the process and lessons learned of making an R Shiny Dashboard within the Chief Data Office (CDO) Software Vault.

Classification: UNCLASSIFIED // FOUO
Working Group: WG29 Computational Advances in OR

60271 - Safe Machine Learning Prediction and Optimization via Extrapolation Control

Start Date: 6/15/2022	Start Time: 8:30 AM	End Time: 9:00 AM

Authors: Dr. Thomas A. Donnelly; Christopher Gotwalt

Abstract: Uncontrolled model extrapolation leads to two serious kinds of errors: (1) the model may be completely invalid far from the data, and (2) the combinations of variable values may not be physically realizable. Optimizing models that are fit to observational data can lead to extrapolated solutions that are of no practical use without any warning. In this presentation we introduce a general approach to identifying extrapolation based on a regularized Hotelling T-squared metric. The metric is robust to certain kinds of messy data and can handle models with both continuous and categorical inputs. The extrapolation model is intended to be used in parallel with a machine learning model to identify when the machine learning model is being applied to data that are not close to that model training set or as a non-extrapolation constraint when optimizing the model.

Classification: UNCLASSIFIED
Working Group: WG29 Computational Advances in OR

60380 - Software Phasing and Schedule Growth Analysis

Start Date: 6/15/2022	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Daniel Long

Abstract: Software development research, once a priority for the DoD, has received less focus in recent years. What research that has occurred has focused on size and cost prediction of software. Putnam (1978) showed that there were measurable effects between early program management and final schedule growth, but these relationships have not been explored using the DoD Software Resources Data Report (SRDR) database. Additionally, industry software development guidance provides rules of thumb for effort allocation, but a comparison of the rules to DoD software projects is nonexistent. We sought to understand how the development phases of software interact with each other and with final outcomes of schedule and effort, as well as provide guidance for the program manager and developer.

Using least square models and Hotelling's T2 test we evaluated conventional rules of thumb for effort allocation against projects in the SRDR database. Given the variation in the data, we find that multiple rules of thumb are applicable to DoD software development, though the mean values indicate a

roughly even split among requirements/design, coding, and testing phases. We then compared through contingency analysis and t-tests how effort allocation varies between projects with either high or low schedule growth. Our analysis shows that increasing effort in early phases decreases the total schedule growth. These finding were significant across multiple categories such as developmental process type, Service, and project size.

Classification: UNCLASSIFIED
Working Group: WG29 Computational Advances in OR

60170 - A reinforcement learning and optimization scheme for development of novel artificial neural network-based guidance

Start Date: 6/15/2022	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Mr. Andrew Lawrence Kaminsky; Mr. Jonathan E Leonhardt; Mr. Isaac Wolf

Abstract: Technologies improving onboard guidance, navigation and control (GNC) system components are needed to support a variety of guided weapon technologies including air-to-air engagement, hypersonic intercept, and hypersonic strike. State-of-practice guidance laws are optimal in the context of deterministic target motion, but in cases where the target motion is less predictable, the maneuverability advantage required of the interceptor to ensure intercept can grow significantly. For fast, agile targets, designing an interceptor which achieves this level of maneuver overmatch may be impractical. Thus, improved guidance laws are needed.

Computational modeling is key to addressing guided weapon design challenges particularly at the concept stage. Fortunately, engagement-level and mission-level modeling and simulation tools can be employed to consider and evaluate the missile defense architecture. Thus, the critical challenge is to utilize these modeling and simulation tools to identify and develop technologies that improve performance.

To meet this challenge, CFD Research is developing an optimization approach for training artificial neural networks (ANN) through reinforcement learning (RL) to enhance GNC of guided weapons. ANNs are universal approximators able to approximate complex functions using a set of tunable hyperparameters. In this effort, RL, a machine learning training method that seeks to train these networks by selecting desired behaviors and filtering undesired ones, is employed to train these ANNs to approximate a controller. Evolutionary algorithms, can be used to perform this selection and filtering. Through repeated trial and error of candidate ANN tunings, employed as the guidance scheme in 6DOF missile flyouts, improved guidance schemes can be learned. Evolutionary algorithms are well-suited to the challenges of guided weapon design. Their sole drawbacks are that they typically require significantly more evaluations than their gradient-based counterparts to identify optimal design(s), and it is hard to know which evolutionary algorithm heuristic will work best for a given problem. We have sought to address these issues, by developing surrogate models to map the relationship between the design variables and objectives from data as it is collected. These surrogate models are then employed to provide insight to tune the evolution heuristics and reduce the number of evaluations. This coupling of surrogate models and evolutionary algorithms creates surrogate-assisted evolutionary algorithms that significantly accelerate optimization.

In the presentation we will outline the implementation of an ANN-based guidance module within a 6DOF simulation tool and the use of surrogate-assisted evolutionary algorithms coupled to guided weapon performance evaluation tools for training ANN-based guidance laws using an RL approach

with our Multi-disciplinary Engineering Analysis and Design Optimization of Weapons (MEADOW) framework.

Classification: UNCLASSIFIED
Working Group: WG29 Computational Advances in OR

61097 - Leveraging Emerging Technologies to Create Innovative Solutions

Start Date: 6/15/2022	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Ms. Lana E. McGlynn, FS; Scott Gallant; Mr. Christopher J McGroarty; Mr. Christopher J. Metevier

Abstract: Being an innovative analyst requires us to employ both existing and emerging technologies in new and creative ways. Often current technological advancements challenge us to look beyond their intended and adapt them for use in Modeling and Simulation (M&S). Our job as M&S practitioners is to be smart in evaluating how to best adopt these advances to the benefit our stakeholders, while considering interoperability with existing tools, data reuse, and standardization.

In order to increase your level of awareness, we invite you to learn more and get involved in the Simulation Interoperability Standards Organization (SISO) Exploration of Next Generation Technology Applications to Modeling and Simulation (ENGTAM) Standing Study Group (SSG). The SSG focuses on technology adoption, technology application metrics, interoperability, and technology areas, such as data analytics, Artificial Intelligence, mixed reality, game development technology, and technology forecasting techniques. Members from the US DoD, many North Atlantic Treaty Organization (NATO) nations, industry, and academia, meet online monthly to discuss emerging technologies with the goal of understanding how they can be adopted and adapted to support a diverse body of M&S stakeholders.

This presentation will discuss relevant findings from the ENGTAM SSG and how they can be applied in the use of cutting-edge tools, techniques, and best practices. It will also provide an opportunity to discuss these emerging technologies and how they can be employed to address all challenges, anticipated and unanticipated.

Classification: UNCLASSIFIED
Working Group: WG29 Computational Advances in OR

59829 - Enabling Course-of-Action Analysis in Wargames with Reinforcement Learning

Start Date: 6/15/2022	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Mr. William Leonard; Christina Rinaudo; Dr. Jonathan Alt; Dr. Christopher Morey; Dr. Simon R. Goerger

Abstract: Recent advances with artificial intelligence (AI) in industry and academia provide an opportunity to develop intelligent system agents capable of reliably competing against human experts in course-of-action (COA) analysis. The team trained agents using deep reinforcement learning in a prototype wargaming framework in ground-based and naval scenarios. Team members conducted experiments to evaluate the performance of AI threat agents trained using multiple algorithms and parameter configurations in each scenario; through benchmarking, researchers identified configurations providing superior COA results. Trained agents competed in a desktop wargaming framework that enabled the team to examine current agent capabilities and identify areas for improvement. This presentation provides an overview of the wargaming framework, results of

experimentation, and next steps, including the potential to train new agents versus previously trained agents for COA development.

Classification: UNCLASSIFIED
Working Group: WG29 Computational Advances in OR

59813 - Reduced Order Non-INtrusive (RONIN) Modeling Methodology Formulation for Military Operations Analysis Applications

Start Date: 6/15/2022	Start Time: 11:30 AM	End Time: 12:00 PM

Authors: Major Mark Bateman

Abstract: With the Department of Defense (DoD) shifting focus to prepare for peer and near-peer adversaries, there is a big push to out-innovate these adversaries through many different approaches. A specific area of interest is the use of Modeling, Simulation, and Analysis (MS&A) to provide analytical support for strategic decisions related to capability development. While extensive experimental and empirical data from past system development activities exists, there is a lack of similar data for proposed advanced concepts that are still in the early stages of research and development, which makes it difficult for military operations analysts to evaluate the military utility of a new concept in a cost-efficient manner. Operations research analysts are working toward using advanced MS&A techniques such as discrete-event or agent-based approaches to capture complex system and system-of-system behaviors in greater detail, however these advanced methods come at a high computational cost, especially when the scope of the analysis grows to the strategic level. To address the computationally prohibitive nature of some of these highly accurate methods, an approach of model abstraction through the use of surrogate models or meta-models which work to emulate the behavior of the computationally expense model but with a reduced computational cost. A promising class of surrogate modeling methods that could be potentially leveraged to enable these types of analyses is a non-intrusive parametric field surrogate approach that utilizes reduced order modeling techniques to create computationally efficient models. These field-based approaches that seek to leverage vector approximations of model responses have emerged as an alternative to more traditional approaches that rely on scalar-based approximations. This research works to formalize a methodology which leverages these Reduced Ordered Non-Intrusive (RONIN) modeling methods for military operations analysis, specifically focused at the mission and campaign level modeling.

Classification: UNCLASSIFIED
Working Group: WG29 Computational Advances in OR

59177 - Identifying Failure Modes of Intrusion Detection Systems

Start Date: 6/15/2022	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Capt Marc Winczer Chale; Dr. Nathaniel D. Bastian

Abstract: Network Security Monitoring requires intensive human capital, but modern Intrusion Detection Systems use machine learning (ML) to automatically classify cyber traffic as either normal or malicious. Techniques to defeat ML classifiers have been identified in the field of cyber vision. This research draws analogy between ML vulnerabilities in the computer vision domain and cyber domain. We present a theoretical rationale of ML failure modes and how they differ in the cyber domain. The worst case vulnerability for ML classifiers is formulated as a convex transshipment optimization problem with constraints specific to the cyber domain. By exposing these vulnerabilities, the cyber community is better prepared to defend against them.

Classification: UNCLASSIFIED
Working Group: WG29 Computational Advances in OR

60046 - Efficient Response Surface Estimation through Adaptive Sampling

Start Date: 6/15/2022	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Dr. Benjamin G. Thengvall; Dr. Michael Deskevich

Abstract: The Missile Defense Agency (MDA) is creating a new high-fidelity, high-accuracy digital simulation capability to model the Missile Defense System (MDS). This accuracy, however, comes with high computational expense. There are many more simulation trials desired to perform different types of analysis than there are computing resources available to execute them. OptTek Systems is providing tools to use the high-fidelity digital simulation capability to generate heat maps to measure the effectiveness of different MDS system configurations while executing a minimal number of simulation runs. Traditional approaches to response surface estimation have relied on parametric enumeration or static sampling approaches with a fixed number of Monte Carlo replications at each design point. In this effort a custom, adaptive sampling optimization algorithm has been created to generate accurate heat maps with orders of magnitude fewer simulation runs. Efficiently generating heat maps can be more generally described as efficient response surface estimation. The techniques and software developed in this effort can be used for more generally applicable response surface estimation problems. The approach combines optimized adaptive sampling of the operational space with geospatially accurate regression and interpolation techniques derived from Kriging. This approach can take any number of sample points and both estimate the response surface and measure the uncertainty in that estimate. Furthermore, computational expense is minimized with dynamic Monte Carlo run management to determine how many replications should be executed at any sample point. In recent work, the sampling approach has been augmented to generate heat maps that minimize the uncertainty across multiple metrics at once making this a multi-objective optimization approach. This presentation will provide updates on this effort and include a methodological overview and sample results.

Classification: UNCLASSIFIED
Working Group: WG29 Computational Advances in OR

60246 - Transportation Routing and Group Theory

Start Date: 6/15/2022	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Dr. Bruce W Colletti

Abstract: Here we use the Wolfram Language to treat transportation routes.

Group Theory returns the true population variance of all 2.4 quadrillion uncomputed routelengths in a certain 1-agent m-load Pickup and Delivery Problem (PDP). We swiftly compute the true variance rather than a theoretically hi-quality large sample estimate whose actual unknown quality is doubtful. This talk illustrates a practical use of Algebra in a combinatorial optimization problem that appears in the classroom, DoD, and the transportation industry.

Within the PDP hides a group action that yields the population variance via a quadratic form whose vector depends upon distances and whose matrix M depends only upon m. The matrix is stored in a library for on-demand use by any m-load PDP and its peculiar distances. The true variance is swiftly computed.

This use of Group Theory has not been found in the Operations Research and Applied Mathematics literature, and is distantly rooted in work done by a 2000-2010 AFOSR-funded DoD-University Research Consortium that supported Headquarters, Air Mobility Command. Consortium members had been AMC/XPY (Studies and Analysis Flight), USMA (Systems Engineering), AFIT (Operational Sciences) and The University of Texas at Austin (Graduate Program in Operations Research).

Classification: UNCLASSIFIED
Working Group: WG29 Computational Advances in OR

60288 - Poisoning Hidden-Markov-Model Inferences on Batch Data

Start Date: 6/16/2022	Start Time: 8:30 AM	End Time: 9:00 AM

Authors: Tahir Ekin; Capt William Nicholas Caballero; Roi Naveiro; Jose Manuel Camacho Rodriguez

Abstract: Time-series models typically assume untainted and legitimate streams of data. However, a self-interested adversary may have incentive to poison this data, thereby altering a decision maker's inference. This research focuses on poisoned hidden Markov models, an understudied area in the adversarial machine learning literature. We provision a suite of poisoning problems for filtering, smoothing, and decoding inferences leveraging an adversarial risk analysis approach. Multiple stochastic programming models are provisioned that incorporate realistic uncertainties and varied attacker objectives. A collection of general solution methods is developed by alternatively viewing the problem from frequentist and Bayesian perspectives. The efficacy of each method is illustrated via extensive, empirical testing. The developed methods are characterized by their solution quality and computational effort, resulting in a stratification of techniques across varying problem-instance architectures. This research highlights the weaknesses of Hidden Markov Models under adversarial activity, thereby motivating the need for robustification techniques to ensure their security. These computational advances related to use of stochastic programming in novel ways will enable solve the problems of adversarial forecasting.

Classification: UNCLASSIFIED
Working Group: WG29 Computational Advances in OR

59770 - Large-scale Parallelized Simulation on Heterogenous Clusters

Start Date: 6/16/2022	Start Time: 9:00 AM	End Time: 10:00 AM

Authors: Robert Reaney; Mr. Trever Knie

Abstract: MS&A simulation tasks often require an application, or workflow of multiple applications, to be run over many different parameter realizations following some experimental design. As design spaces become larger and more complex, the need for parallelization of individual simulations becomes obvious; moreover, distributing these simulations across heterogenous nodes on a cluster or network of workstations presents unique technical challenges including dependency management, resource collision, file/artifact collection, and cleanup.

This talk will overview SOFA (Simulation of Federated Applications), an Enterprise MS&A software developed by Anyar, Inc., which leverages containerization technology to deploy, manage, and retrieve information from simulations across a cluster of nodes. SOFA architecture and use will be exemplified using ongoing analysis efforts at Anyar and AFRL which require hundreds of thousands of computationally expensive simulations to be executed for each development cycle.

Classification: UNCLASSIFIED
Working Group: WG29 Computational Advances in OR

WG30 Wargaming

60172 - Starting Conditions

Start Date: 6/14/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Mr. Kenneth Hartman		

Abstract: Keywords: starting conditions; wargaming; modeling; scenario

Professional, analytic scenarios outline potential future events. They contain the history, key events, region, and key players concerned with these future events and serve as the bedrock for professional wargaming and plans development.

While the scenario serves as the foundation of a wargame it can also be validated and advanced through the wargaming process with the refined scenario being the product of a wargame. Effective wargames require sophisticated scenarios with a great deal of detailed information so that players can provide defensible decisions and courses of action. For example, the scenario and wargame must have a defined time setting, terrain (the gamebox), event history leading up to the situation, as well as force capabilities for all players (including technical capacity and capabilities of physical assets, networks, and integrated systems). This foundational information establishes the credibility of any scenario and is summarily described as setting the starting conditions.

TRAC has developed a methodology for establishing starting conditions for scenario building and wargaming through collaborative workshops involving multiple agencies and organizations to ensure high quality analysis and accurate information is fed into these scenarios that will later provide the basis for numerous high visibility analytic efforts and acquisition decisions. This presentation will walk through an example of one of these workshops and provide an actionable outline of key considerations for developing your own starting conditions for scenario building and/or wargaming efforts.

Classification: UNCLASSIFIED
Working Group: WG30 Wargaming

60207 - Writing an Effective Problem Statement: Best Practices

Start Date: 6/14/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Mr. Paul Works		

Abstract: Establishing a problem statement is one of the key analytic tasks when initiating a study. It is often the first analytic activity upon receipt of a tasker. A problem statement is critical to providing a definitive focus for the study. It ensures the study effort will respond to the decision maker's needs. It drives the study plan, methodology, study issues, essential elements of analysis, and measures of merit. It directly influences study results and solutions. It subtly influences every aspect of the effort.

The Research and Analysis Center (TRAC), as part of its commitment to continued enabling of the analytic profession, developed the Writing an Effective Problem Statement Best Practice Guide (BPG). The document provides best practices for operations research and systems analysts (ORSAs) when

developing an analytic problem statement to effectively guide an effort and produce an effective analysis. It includes challenges and pitfalls frequently encountered when developing a problem statement and includes an exemplar use case.

The presentation provides an overview of the Writing an Effective Problem Statement BPG and details several recent examples.

Classification: UNCLASSIFIED
Working Group: WG30 Wargaming

60404 - Divided by a Common Method: Understanding the Wargaming Community

Start Date: 6/14/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Dr. Ruby Booth		

Abstract: As members of the Wargaming community, we all share a method of accomplishing our aims. However, within the community the aims differ widely. In our number, we have those who build games for varied purposes: training future commanders vs. experimentation vs. gaining strategic insight. Yet, we don't always make explicit our goals, nor openly discuss the effect that these goals have on our implementation of our chosen method. In fact, divergent goals are best served with differing implementations. The wargame designed to train future commanders has a materially different look, function, and mechanics set from one designed for gaining strategic insight, and both are materially different from a game designed to experimentally test a specific research question. We will highlight key differences, address measures of effectiveness, and discuss areas of overlap where collaboration might be beneficial.

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Classification: UNCLASSIFIED
Working Group: WG30 Wargaming

60038 - Opportunities, Challenges, and Risks of Implementing AI Opponents in Wargames

Start Date: 6/15/2022	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: Dr. Cristin Chall		

Abstract: In 2018, the Department of Defense (DoD) published its Artificial Intelligence (AI) Strategy document in order to “harness the potential of AI to transform all functions of the Department positively, thereby supporting and protecting U.S. servicemembers, safeguarding U.S. citizens, defending allies and partners, and improving the affordability, effectiveness, and speed of our operations.” The Army’s Annex to this AI Strategy outlines “how the Army will apply AI as an enabler for critical functions in training, equipping, and fighting wars.” One promising avenue for employing AI within the scope of these documents is to implement AI in analytic wargaming. This unclassified presentation will discuss the potential opportunities, challenges, and risks involved with implementing AI opponent players in Army wargames. Some wargames have features that are amenable to machine learning training regimens to train AI opponents. AI players offer opportunities for consistent opposition over repeated executions, the removal of human player biases, exploration of novel strategies, and a chance for Army personnel to gain familiarity with, and trust in, the application of AI in a low-stakes environment. Even if these opportunities do not fully materialize, the benefits of the research investment in attempting to implement wargaming AI likely outweigh the challenges and risks.

Classification: UNCLASSIFIED
Working Group: WG30 Wargaming

60160 - Simulation-Supported Wargaming at the Campaign Level

Start Date: 6/15/2022	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Mr. Charles D Burdick, CAP

Abstract: This paper addresses Wargaming at the Campaign Level capable of gaming the Russian Invasion of Ukraine.

In his 2015 article, former DepSecDef Bob Work stated in that "…players should be able to observe and live with the consequences of their actions in the face of a thinking and reacting competitor... Actions must have tangible consequences that are determined by the actual performance of weapons and sensors in the real world, backed by a rigorous adjudication process..."

The wargaming community has for years sought computer-supported "in stride adjudication." This has met with some success in air and maritime operations. But land operations in both the STORM and JICM models use aggregate brigade-level attrition over hours-long periods with scripted maneuver providing a general outline of the ground battle. For STORM, its associated wargame is played out in the SWIFT model where additional detail is added.

But meeting Work's other 2015 dictum is harder, "The best wargames seek to create an environment for applying critical reasoning techniques and diagnosing the characteristics of competition under the "fog" and "friction" of war where incomplete and imperfect knowledge prevails."

From 2006 to 2010, JFCOM (J9) Experiments conducted simulation-supported wargaming using the Joint Analysis System (JAS), a minimally aggregated model with all weapon types explicitly represented, countable, and subject to destruction. Each has its own characteristics, kill rates, and consumes munitions when fired. If mounted on a vehicle, fuel is consumed.

JAS employs computer agents which respond to orders for movement, conduct combat or avoidance, call for fires, request logistics, etc. And JAS allows substituting humans for selected agents while the simulation is paused. JAS decisions are made on perceptions created by status reports and sensor inputs, with

• Simulated communications networks link all "thinking" units/players (agents and/or human)
• Internal message flows (orders, requests, status reports, etc.)
• Sensor inputs generating a displayable Common Operational Picture (COP) readable by both humans and agents

JAS was archived in 2011, when JFCOM was disestablished, but could be revived and has some major capabilities of advanced wargaming.

1. JAS records all inputs necessary to rerun a wargame since human inputs use the same meta-data as the computer agents. Thus, JAS can rerun a wargame at high speed with the human inputs executed by computer agents and get the same results as the original wargame. If external changes are made, e.g., weather, enemy forces, etc. the wargame can become a Monte Carlo simulation.
2. JAS allows rapidly reviewing the decisions made and what the outcomes of different decisions might have been

A perception-based wargame, with detailed Land maneuver, C4ISR, and linked to a simulation allows the best of both analytical tools (simulation and wargaming) to be combined in a study. Let's revive it.

Classification: UNCLASSIFIED
Working Group: WG30 Wargaming

59798 - Tools and Concepts for M&S-Powered Wargames

Start Date: 6/15/2022	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Mr. Chris R. Linhardt		

Abstract: With the advent of the Warlock capability in AFSIM several novel and very promising use cases for Warlock have surfaced. One of those use cases is the development of M&S-powered wargames to support Tactics, Techniques, and Procedures (TTP) development, mission rehearsal, and operator-in-the-loop mission simulation for new technology concepts as well as legacy systems. Warlock panels (operator user interfaces) are typically more quickly developed than traditional simulation interfaces to enable operator interactions in the simulation. In addition, a number of re-usable widgets are available in the library providing the simulation developer a ready-to-use library of useful interfaces. As a result, the AFSIM community has realized a paradigm shift where a scenario developed to support constructive mission analysis can be used to support virtual mission simulation with little or no modification. Use of Warlock in M&S-powered wargames further inspired the development of the Mission Planning Wizard. This operator user interfaces provides the capability for AFSIM scenario modification to support mission planning tasks by wargame participants with little to no AFSIM experience. This capability can be used as part of the environment for M&S-powered wargames as well as in operator-driven constructive analysis. This presentation will describe Warlock and the Mission Planning Wizard as well as the analysis concepts for M&S-powered wargames and operator-driven constructive analysis. Finally, the presentation will provide example results to illustrate the power of these tools and concepts.

Classification: SECRET NOFORN
Working Group: WG30 Wargaming

59942 - Incorporating Logistics Impact in the Center for Army Analysis Accelerated Wargame System (CAAAWS)

Start Date: 6/15/2022	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Christine Anderson		

Abstract: The conduct of operational wargames often excludes the impact of logistics operations. Overlooking this critical operational necessity typically results in an unconstrained and less realistic result when examining the feasibility, suitability, and acceptability of an operational course of action (COA). A logistically unconstrained wargame makes the implicit assumption that operational supplies, such as munitions and fuel, are pre-positioned and available for use as needed. Such an approach, however, avoids key questions such as how would participants adjust their combat operations if these supplies were available in limited quantities or how would logistics planners adjust to an attack on a logistics network?

The Center for Army Analysis team developed modules inside of the Center for Army Analysis Accelerated Wargame System (CAAAWS) to provide a simplified and highly aggregated representation of operational-level logistics operations to aid in exploring COA analysis. The development of CAAAWS Logistics provides an estimate of the theater logistical distribution system from a theater's main support area forward to the first tactical level supply nodes. The modules also incorporate the impact of enemy action against logistics support. These enemy actions can come in numerous forms, such as deep strikes against logistics nodes, destruction of haul assets, or disruption to a logistics network.

This presentation covers how CAAAWS Logistics models the operational impact of logistical operations and seeks to facilitate a discussion of lessons learned and challenges incorporating logistics amongst wargaming practitioners.

Classification: UNCLASSIFIED
Working Group: WG30 Wargaming

59734 - Polar Operations: Search and Rescue Distributed Table Top Exercise

Start Date: 6/15/2022	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Mr. Michael W. Garrambone, FS; Mr. Matthew Ledwith; Mr. Vince Raska		
Abstract: Our OR group was tasked to look at the highly dangerous and time sensitive mission of Search and Rescue (SAR) in the harsh climates of the Polar Arctic. We were asked to create a scenario of downed pilots in polar night with characteristic weather, complete with vast distances, solar storms, frozen terrain, and the threat of bears and arctic wolves. The mission was of international importance pulling limited resources from diverse rescue centers with unique and varied assets, jurisdictions, and operating procedures. Six new and novel system concepts were provided to the blue and maple planning cells who had minutes to plan and move air, land, and maritime teams into harm's way. The hotwash discussions and material assessments are both interesting and priceless—but don't let the bears get you! Classification: UNCLASSIFIED Working Group: WG30 Wargaming		

60049 - Creating Maps in Support of Wargaming

Start Date: 6/15/2022	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Mr. Luis R. Ramos		
Abstract: A definition for a general use map is a combined artistic and scientific representation of a geographic area over a landmass and/or area of the ocean surface. It is complete with textual information and depictions of physical features such as cities, roads, rivers, and a variety of points of interest. The Center for Army Analysis uses a specialized type of general use map, a wargame map, to help with the process of defining how military units are expect to behave under certain conditions as they encounter combat situations over a battlespace. While similar to a general use map, the wargame map will routinely integrate a few significant design differences. Primary factors that will guide the final design of a map intended to support operational wargame activities include the geographic extent of the area of operations, size of the game pieces, linear distance represented by the hexagonal grid, and the type and number of key map features. In addition, other crucial elements of the actual wargame event such as event location, room space, and the number and size of tables available to lay the main map play a significant role in the design details and print size of the final wargame map product. This presentation will discuss the necessary steps and encountered challenges during the planning and creation of wargame maps. Classification: UNCLASSIFIED Working Group: WG30 Wargaming		

60094 - PFT8 Global Constant Competition Wargame

Start Date: 6/15/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Mr Thomas Jonathan Giles Russell; Mr. Jonathan M. Parkman; Dr Kit Waterman		

Abstract: Planned Force Testing (PFT) 8 was a Global Constant Competition Wargame run for Financial Military Capability in the British Ministry of Defence. It was designed to assess the UK's Integrated Force 30 through the lens of persistent engagement. Running from September 2021 to January 2022, the Wargame blended the Strategic and Operational aspects into a novel design, distinct from all previous iterations of the PFT process. With participants up to 4* level from across UK Defence and Security and activity taking place in the UK's Defence Wargaming Centre and the MOD itself, the analysis is expected to enable Defence to understand the strengths and weaknesses of the planned force, enabling reprioritisation of policy, resources and effects ahead of the next Integrated Defence and Security review. This presentation will focus on the design, development and execution of the Wargame under the dispersion and other constraints imposed by the global pandemic.

Classification: UNCLASSIFIED
Working Group: WG30 Wargaming

60009 - The Global Strategic Competition to Crisis Game (G-SC2)

Start Date: 6/15/2022	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: MAJ Paul M Kearney

Abstract: (U) Title: (U) The Global Strategic Competition to Crisis Game (G-SC2)
(U) Keywords: (U) Wargaming, military competition
(U) Author Information: (U) MAJ Paul M Kearney, Center for Army Analysis, 6001 Goethals Road, Fort Belvoir, VA 22060, 703-806-5322, paul.m.kearney.mil@army.mil
(U) Classification of Briefing: SECRET
(U) Abstract:
(U) In 2021, the Chief of Staff of the Army (CSA) released "CSA Paper #2: The Army in Military Competition." This new strategic document has expanded the conversation about the U.S. Army's roles and responsibilities outside of the conflict paradigm. To educate and examine the Army's role in competition, the Center for Army Analysis (CAA) designed a strategic wargaming tool, the Strategic Competition to Crisis game. CAA used this wargaming tool to analyze military competition versus global adversaries and other opportunistic actors in the Global Strategic Competition to Crisis game. The first iteration of this game with the Army service component commands G-5 (Plans) and subject matter experts from Headquarters, Department of the Army and RAND Corp provided insights on theater prioritization, balanced competition, and setting the theater. This presentation will cover the design, execution, and insights from the project.

Classification: SECRET//REL TO FVEY
Working Group: WG30 Wargaming

60096 - Wargaming within the Nuclear Environment

Start Date: 6/15/2022	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Mr. Michael A. Ottenberg

Abstract: Warfare involving nuclear, biological, and chemical weapons is a continuing concern of defense analysis. Wargames routinely examine the effects of these weapons on combat operations at all levels of war. The Nuclear Wargame and Analysis division of Defense Threat Reduction Agency (DTRA) provides physics-based adjudication of nuclear effects to DoD wargames. While there are multiple models that examine quantitative nuclear effects down to the engineering level, the level of play included in most wargames has been highly abstracted.

This presentation will describe the collaborative effort to combine the DTRA's Nuclear Events Software (MINES) M&S suite with OSD CAPE's Standard Wargame Integration Facilitation Toolkit (SWIFT) to build Nuc-SWIFT. Nuc-SWIFT incorporates nuclear effects into tactical ground combat wargaming provided by the SWIFT instantiated Marine Corps Wargaming and Analysis Method–Tactical (MCWAM-T)). A DTRA-OSD CAPE-USMC wargame used Nuc-SWIFT to examine the effects nuclear weapons employment on the tactical battlefield.

Classification: UNCLASSIFIED
Working Group: WG30 Wargaming

60413 - An overview of Experimental Wargaming at Sandia National Laboratories

Start Date: 6/16/2022	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: Dr. Ruby Booth; Kiran Lakkaraju, Ph.D; Dr. Andrew Reddie		

Abstract: In this talk we provide an overview of experimental wargaming methods, with a particular emphasis on projects at Sandia National Laboratories and partner organizations. Experimental wargaming represents a methodology at the intersection of experimental sciences and wargaming that generates synthetic data for analysis of specific research questions—in our case, focused on national and international security challenges. In the talk, we reflect on the lessons learned in the development of the SIGNAL experimental wargaming platform as well as current efforts to create an experimental environment to test theories related to cyber deterrence. We also compare the analytical outputs provided by wargame data to those from alternative synthetic data-generating processes (e.g., formal models, mod/sim, survey experiments, etc.).

Classification: UNCLASSIFIED
Working Group: WG30 Wargaming

60383 - Educational Wargaming of Operational Energy

Start Date: 6/16/2022	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Nick Ulmer		

Abstract: We developed and played an educational DND-style game with an ultimate goal of providing an enriching experience of how operational energy is a critical component of military force development. The purpose of the game was explained to players as a visceral sense of winning or losing based on the operational energy decisions made in two phases of gameplay. They achieve this through connecting procurement and technology investment decisions to operational consequences. The focus has been on education and provocation vice analysis. However, comments from students afterwards provide evidence of lasting impression, understanding, and appreciation for the complexity of operational energy in warfare.

Classification: UNCLASSIFIED
Working Group: WG30 Wargaming

60414 - Keeping It Simple: Mechanics Complexity Metrics for Use in Wargame Design

Start Date: 6/16/2022	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Dr. Ruby Booth; Dr. Andrew Reddie		

Abstract: Wargame design must appropriately balance contextual realism, analytical utility, and player engagement. The mechanics a designer selects affect each of these, but generally affects player engagement most of all. Determining when a game's mechanics are sufficiently complex to

represent the problem of interest, but simple enough to allow for accessible play represents a meaningful and common design challenge. At present, designers generally rely on their experience, pilot playtests, and common sense to determine when a game has reached the right mix. We will discuss an alternative, more structured method for assessing the complexity that each new mechanic brings to design.

SNL is managed and operated by NTESS under DOE NNSA contract DE-NA0003525

Classification: UNCLASSIFIED
Working Group: WG30 Wargaming

60137 - Civil Considerations in Wargaming and COA Development

Start Date: 6/16/2022	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Ms. Holly E Barnes		

Abstract: While multiple tools and methods exist with which to assess enemy capabilities, environmental variables, and best courses of action, very few tools enable the assessment of civil considerations that, in some cases, may be just as mission-relevant. A problem framed without adequate understanding of civil factors - including key groups' influences, motivations, objectives and capabilities, as well as other "green" factors such as local governance, key infrastructure, instability drivers and local resiliencies – is an insufficiently understood problem. Failure to examine such factors is especially risky in complex operational environments such as urban settings where the presence of civilians and local government capabilities are highly relevant to military decision making, with implications at the tactical, operational and strategic levels.

Typical practice, engendered by a general discomfort with the "soft" and ambiguous aspects of involved in the human domain, is to relegate consideration of civil factors to later phases of the fight. Recent history has repeatedly proven that doing so results in unnecessary and preventable risks to mission, loss of operational momentum, and/or loss of life.

This presentation/discussion asks the question, "How can we improve wargaming to better reflect civil factors in order to enable more realistic representations of multilayered, complex urban environments?" Modeling and simulation methodology utilized in NATO experimentation on this subject matter is examined, along with a decision-support framework that helps to structure how civil considerations are presented in wargames.

Classification: UNCLASSIFIED
Working Group: WG30 Wargaming

60191 - Distributed Wargaming Visualization and Data Collection

Start Date: 6/16/2022	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: William Kirschenman		

Abstract: TRAC planned and executed the 2020 European Command Capstone Operational Wargame to inform decisions concerning the Army of 2030, the Calibrated Force Posture and the 31+4 Army Futures Command modernization priorities. Corona Virus Disease-2019 restrictions presented resource challenges and prevented bringing approximately 80 subject matter experts and role players to participate in onsite execution. These challenges forced the team to relook traditional methods,

models, and tools (MMT) used to conduct wargaming and data collection events in general, and specifically to support a distributed wargame in a classified environment.

The lessons learned during both this and multiple follow-on events have led to the evolution of MMTs to better support both wargames and data collection events focused on analytic efforts.

This presentation will discuss the critical elements of analytic wargame design and the MMT used to support both this wargame and follow-on events, with a focus on the development and evolution of the Visualization Application and Data Collection in R (VADR) tool, which was specifically developed to provide distributed role players an appropriate planning and data collection tool.

Classification: UNCLASSIFIED
Working Group: WG30 Wargaming

60075 - Fighting the *Next* War: Gaming Unrestricted Warfare

Start Date: 6/16/2022	Start Time: 11:30 AM	End Time: 12:00 PM

Authors: Dr John Keith Scott

Abstract: There is no legal definition of 'war', merely an ever-increasing series of categories and subcategories – asymmetric, hybrid, non-linear, unconventional… - which poses a challenge; if we cannot say what it is, how can we actually fight it successfully. Recent moves towards a multi-domain model of conflict are helpful in allowing us to gain a fuller picture of the modern battlespace, but as currently envisaged, multi-domain conflict fails to consider the extent to which 'conflict' is not a purely military concern. If we consider the current situation in Ukraine, what we see is 'warfare' waged kinetically, but also informationally (through influence campaigns), economically, and politically (i.e. by civilians). It may, in fact, offer an excellent example of 'unrestricted warfare' (UW), as posited by Qiao and Wang.
What this paper offers is a conceptual model for gaming UW as both training exercise and research tool. It draws on the author's experience in 4 main areas:
1. designing and delivering a Whole of Government Simulation exercise based on Information Warfare at an international level
2. designing and delivering wargames dealing with cyber warfare within the context of NATO
3. participation in the UK Ministry of Defence Workshop series on Multi-Domain Operations
4. experience in the application of cybernetic theory and systems of systems modelling within the battlespace.
The paper argues that to be truly successful, UW must be 'multi-domain' in the widest sense, cutting across traditional boundaries of civilian/military, war/peace, and kinetic/non-kinetic. It will demonstrate how its underlying model offers us a better way of understanding, analysing, and hypothesising the nature of future conflicts. It will also show how the model can be mapped onto a specific scenario, to demonstrate its possible practical applications.

Classification: UNCLASSIFIED
Working Group: WG30 Wargaming

WG31 Operational Environments

60929 - Optimal Placement of Shallow Water Sensors

Start Date: 6/15/2022	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Erik Vargas
Abstract: When placing sensors that detect spatial phenomena, it is important to identify the placement that can provide the largest amount of information about the locations where sensors are not placed. Historically the Navy has utilized onboard active and passive sonar systems to detect targets and surrounding environments. The utilization of remote sensors placed in locations of interest allow our sailors to learn information faster and safer. Research into the problem of sensor placement has been done to include scenarios with stationary targets in a 2-dimensional plane as well as using Gaussian processes to represent uncertainty about un-sensed areas. One approach we examine takes a statistical approach by looking at mutual information between sensors. This thesis intends to solve the problem of optimal sensor placement by framing it as a Max-Cut optimization problem. We create a graph with vertices representing sensor locations and weighted edges determined by the covariance matrix between two locations. It is this covariance matrix that we examine in depth to explore the precision and efficiency. The max-cut problem in itself is NP-hard, so we will use approximation algorithms to optimize. Using the max-cut approach we aim to have an approximation that is as good or better than the greedy algorithm developed by Krause, Singh and Guestrin while still producing a result in a reasonable amount of time. Classification: UNCLASSIFIED Working Group: WG31 Operational Environments

60226 - Demography and Security in Saudi Arabia

Start Date: 6/15/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Dr. Brian Nichiporuk		
Abstract: Saudi Arabia is one of America's most significant allies in the world. It occupies a pivotal strategic position in the Middle East/Persian Gulf region. Saudi Arabia is the world's second largest oil producer and the ninth largest natural gas producer. Since the Muslim holy cities of Mecca and Medina are on Saudi soil, the kingdom also is a major player in the development and propagation of Sunni religious thought. This presentation will assess how demographic factors influence Saudi Arabia's overall strategic posture. It will begin by examining the major demographic trends ongoing in Saudi Arabia (e.g., fertility rates, population growth rates, sectarian composition, urbanization, migration patterns etc.). This briefing will then determine how demography is affecting Saudi military capabilities, Saudi military doctrine, and the sources of conflict in and around Saudi Arabia. Finally, the briefing will conclude by laying out the implications of Saudi demographic realities for US national security policy. Classification: UNCLASSIFIED Working Group: WG31 Operational Environments		

59766 - 'Climate-affected conflict in East and West Africa – the case of water scarcity, migration and peripheral regions'

Start Date: 6/15/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Miss Ella Fleming		
Abstract: Abstract from (a snapshot of) Dstl sponsored PhD: Anthropogenic climate change is now a part of our reality (Ash et al, 2015). Due to its accelerating rate that is forcing global change, by 2050, the earth's population is expected to pass 9 billion. By 2040, almost 700 million people a year are likely to be exposed to droughts of at least six months		

duration, nearly double the global historic annual average. No region will be spared (Future of Life Institute, 2020). The expected impact upon human life, and human security, will be catastrophic. With its adverse consequences for agricultural productivity, competition for resources, economic activity and food security approaching, fears are mounting that the future may only bring more conflict and instability (Buhaug, 2016). The 'climate- conflict' nexus, therefore, examines the role of environmental degradation upon instances of violence and conflict and is becoming a burgeoning concern. This hostile and unstable future operating environment presents national and international forces with a challenge that is going to be like nothing we have ever witnessed or experienced. From humanitarian crises, an increase in forced migration and displaced peoples, to terrorism 'hubs', disease outbreak and serious organised crime - this new environment could trigger new threats, blind spots and scenarios. Combined with predicted changes to the physical terrain – an increase in temperature, extreme weather events expected and rising sea levels forecasted, the future operating environment will be drastically altered compared to life as we know it. Forces will need to think different, strategise differently and plan for not only threats to infrastructure functionality but how personnel themselves will operate to full capability. To address this, this research focuses on the rapidly changing climate in both Nigeria and Kenya as case studies to determine the causal links between the rapidly changing climate and resulting conflict – through the framework of forced migration and episodes of intense drought, leading to water scarcity. Specific triggers and 'tipping points' are examined that may lead to unrest, and why a change of migratory patterns may affect the likelihood of conflict amongst rising levels of drought vulnerability. The use of advanced mixed methods, drawing on both quantitative and qualitative approaches, is used as it is critical to addressing the expected change to security. This research intends to contribute as a 'futures-based' model (as a handrail for both predictive and diagnostic uses) for UK Security and Defence, that offers tools for the assessment of geographical areas affected by conflict and vulnerable to the risks of climate change.

Classification: UNCLASSIFIED
Working Group: WG31 Operational Environments

60473 - OneSAF Position, Navigation, & Timing (PNT) Model Enhancements

Start Date: 6/16/2022	Start Time: 8:30 AM	End Time: 9:00 AM

Authors: Mr. Joshua Taylor Lenig; Mr. Zachary Steelman

Abstract: The Army needed to enhance the capability to conduct analysis and experimentation that considers Positioning, Navigation and Timing (PNT) and the impact of Assured Positioning, Navigation and Timing (APNT) systems in the broader context of other systems/technologies, particularly in the ground fight. To fill this void, the Combat Capabilities Development Command DEVCOM Analysis Center (DAC) worked in conjunction with PNT subject matter experts to develop and implement methodologies to increase the fidelity of the representation of GPS technologies within One Semi-Automated Forces (OneSAF). Further improvements were made by adding behavioral models for a Call for Fires (CFF) mission thread in order to represent the crucial mission impacts of operating within a degraded or denied GPS environment. By adding these capabilities to OneSAF, mission effectiveness analysis support can be provided for upcoming PNT technology testing events.

Classification: UNCLASSIFIED
Working Group: WG31 Operational Environments

59688 - The Importance of Inland waterway Systems to the Global Maritime Transportation System

Start Date: 6/16/2022	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Dr. John R. Hummel, FS		
Abstract: The global economy is dependent upon an efficient maritime transportation system (MTS). The COVID-19 pandemic has demonstrated the significant impacts that can results from disruptions in the MTS. While most people know about the major U.S. ports where global shipments are off-loaded, many do not realize that many of the shipments still need to move by water to get to their final destinations. In a similar fashion, many products originate from inland locations before they get loaded onto ocean going freighters. This presentation will first give an overview of the major inland waterway systems that are coupled to the global MTS. The potential disruptions to the inland waterway systems will be discussed along with the impacts they may have from an economic and national security perspective. Classification: UNCLASSIFIED Working Group: WG31 Operational Environments		

WG32 Special Operations and Irregular Warfare

59803 - Optimal Placement of Shallow Water Sensors

Start Date: 6/14/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Erik Vargas		
Abstract: When placing sensors that detect spatial phenomena, it is important to identify the placement that can provide the largest amount of information about the locations where sensors are not placed. Historically the Navy has utilized onboard active and passive sonar systems to detect targets and surrounding environments. The utilization of remote sensors placed in locations of interest allow our sailors to learn information faster and safer. Research into the problem of sensor placement has been done to include scenarios with stationary targets in a 2-dimensional plane as well as using Gaussian processes to represent uncertainty about un-sensed areas. One approach we examine takes a statistical approach by looking at mutual information between sensors. This thesis intends to solve the problem of optimal sensor placement by framing it as a Max-Cut optimization problem. We create a graph with vertices representing sensor locations and weighted edges determined by the covariance matrix between two locations. It is this covariance matrix that we examine in depth to explore the precision and efficiency. The max-cut problem in itself is NP-hard, so we will use approximation algorithms to optimize. Using the max-cut approach we aim to have an approximation that is as good or better than the greedy algorithm developed by Krause, Singh and Guestrin while still producing a result in a reasonable amount of time. Classification: UNCLASSIFIED Working Group: WG32 Special Operations and Irregular Warfare		

59608 - Peak Guerrilla: The Origins of Modern Irregular Conflict

Start Date: 6/15/2022	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: William Buppert		
Abstract: One man, Gavrilo Princip, fired two rounds in a single attack in 1914 to forever change the face of modern warfare.		

This presentation will discuss the evolution of modern irregular warfare on three continents between 1916-1922 following the exploits of T.E. Lawrence, Paul Emil von Lettow-Vorbeck and Michael Collins in Southeast Asia, Africa and Europe respectively.

This is not about counterinsurgency, this is about insurgency.
We will discuss the individual exploits and accomplishments of the key actors in their respective theaters of conflict, compare and contracts methodologies and focus on extrapolated similarities in action and results. This presentation has no conceit that irregular warfare started in the twentieth century but merely seeks to demonstrate the evolution of new techniques and technologies afforded by the new century.

Operations Research (OR) always seeks to find the better and military OR seeks to improve the way the armed forces and associated organization optimize the tasks at hand. All three of these exemplars are insurgents and give a unique insight into the mind of the guerrilla.

Classification: UNCLASSIFIED
Working Group: WG32 Special Operations and Irregular Warfare

59609 - The Impossibility of Successful Western Counterinsurgency

Start Date: 6/15/2022	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: William Buppert		

Abstract: The recent departure from Afghanistan has certainly started some much-needed conversations on conducting irregular warfare by the western powers.

This presentation will make the firm case that despite the false triumphalism in the West in the past one hundred years, the track record for successful prosecution of counterinsurgency (COIN) [a sub-component of Irregular Warfare] conflict amounts to many more losses to even the paper-thin evidence of winning any victories. This project will confine itself to Western conflicts and not pretend to any authority in most Eastern attempts at COIN.

It will examine the reasons for this and the possible repercussions of ending the entire notion of tilting at COIN windmills that result in no value added for Western political capital or regional/national security.

Most fundamentally, I want to explain that Western beliefs about the processes of COIN and their efficacy have been manufactured out of whole cloth rather than based on the historical record.

Classification: UNCLASSIFIED
Working Group: WG32 Special Operations and Irregular Warfare

61071 - A new way to look at multi-resolution modeling

Start Date: 6/16/2022	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: J. Scott Thompson		

Abstract: Military operations researchers decompose systems and define simulation requirements based on the analytic questions at hand. Often, the need to answer multiple questions drives a need to represent systems at multiple levels of detail. This presentation leverages an apparently

abandoned line of research in multi-resolution modeling, expands on existing definitions, and proposes a method to assist analysts with selecting the appropriate level of detail.

Classification: UNCLASSIFIED
Working Group: WG32 Special Operations and Irregular Warfare

60426 - Battlefield Wall Street: Lessons Learned From HFT Practices For MDO

Start Date: 6/16/2022	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Richard M. Buchter		
Abstract: Presentation is about lessons learned on Wall Street in its High Frequency Trading (HFT) efforts to move data faster (less latency) than anyone else, a key aspect for MDO (Multi Domain Operations), Information Dominance, and the OODA loop. Presentation discusses methods employed in HFT for obtaining the fastest possible systems (least latency) for moving and acting upon data, strategic versus tactical data requirements, and a discussion of "Actionability" from a HFT aspect. Such an approach opens avenues for analysis and optimization for time critical applications and support for hard performance requirement enablement. Lessons learned include seeking performance improvements in software through optimization, the network used, the language selected for coding, selecting a few key data feeds versus all source data feeds, the impact of distance, and time as a weapon. Presentation concludes with a discussion of proximity on the battlefield and its impact on battlefield "edge" applied to operations at a distance. Classification: UNCLASSIFIED Working Group: WG32 Special Operations and Irregular Warfare		

WG33 Social Science Methods and Applications

60269 - Demography and Security in Saudi Arabia

Start Date: 6/14/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Dr. Brian Nichiporuk		
Abstract: Saudi Arabia is one of America's most significant allies in the world. It occupies a pivotal strategic position in the Middle East/Persian Gulf region. Saudi Arabia is the world's second largest oil producer and the ninth largest natural gas producer. Since the Muslim holy cities of Mecca and Medina are on Saudi soil, the kingdom also is a major player in the development and propagation of Sunni religious thought. This presentation will assess how demographic factors influence Saudi Arabia's overall strategic posture. It will begin by examining the major demographic trends ongoing in Saudi Arabia (e.g., fertility rates, population growth rates, sectarian composition, urbanization, migration patterns etc.). This briefing will then determine how demography is affecting Saudi military capabilities, Saudi military strategy, and the sources of conflict in and around Saudi Arabia. Finally, the briefing will conclude by laying out the implications of Saudi demographic realities for US national security policy. Classification: UNCLASSIFIED Working Group: WG33 Social Science Methods and Applications		

60066 - Weaponization of Language in Online Information Environment: Use of Metaphors in Disinformation Campaigns

Start Date: 6/14/2022	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Regina Kay;a Catipon; Dr. Onur Savas
Abstract: The Sapir–Whorf hypothesis, also known as the linguistic determinism hypothesis, posits that the structure of a language affects its speakers' cognition and categorization of experience (Fishman, 1982). Linguists and cognitive scientists have long debated the merits of this hypothesis, with opposing camps arguing instead that thought has a universal grammar (Chomsky, 2000). The weakened assumption of the hypothesis, known as neo-Whorfianism, offers the concept of language-relativity—that language may influence thought (Fishman, 1982). Academic work has since supported neo-Whorfianism, finding divergent experiences for color (Paul Kay, 1984), time (Boroditsky, 2001), and direction (Lera Boroditsky, 2010) that are dependent on language. Though it should be mentioned that the debate around the merits and reproducibility of the theory continues to this day (Mickan, 2014)(Kann, 2019), linguistic-relativity offers provoking corollaries. For example, given the softened assumptions, can language also be manipulated to influence perception? Journalistic and academic accounts have found examples of language manipulation in the online information environment. For example, more novel language was linked to the increased sharing of fake news stories in Twitter (Soroush Vosoughi, 2018) and the use of political-identity narratives (in addition to platform features) have contributed to the spread of disinformation (Starbird, 2019). In these narratives, metaphors and analogies have been used out-of-context and with carefully chosen associations in order to manipulate emotion, sow discord, and exploit polarized topics. In this paper, we quantify the role of metaphors in language manipulation, using disinformation campaigns against USA and its allies as a case study. Our team has been collecting Publicly Available Information (PAI) that consists of more than 10M+ posts from a broad range of platforms. In this presentation, we will demonstrate that systematic metaphor extraction and processing has applications to the detection and assessment of information operations. Our methodology for doing so consists of applying a comparative statistical model using NLP and text analytics as novel tools to find metaphors. We have empirically observed the use of metaphors in language manipulation and thus expect to find evidence that metaphors increase the accuracy of disinformation detection. We also expect to find that the efficacy of the metaphors employed will likely differ based on target audience. The results of the study can be used to combat misinformation and disinformation by improving detection and characterization of abuse of linguistic relativity. Classification: UNCLASSIFIED Working Group: WG33 Social Science Methods and Applications

60552 - What is Your Research Verb? The Actions You Take Determine the Analytical Techniques You Will Use.

Start Date: 6/15/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Dr. Kenneth W. Lewis		
Abstract: What is your research verb? What is the action associated with your research question? What exactly are you observing from or acting upon the data you collect? Are you describing, counting, comparing, relating, predicting, explaining, simulating or costing behavior? While the vision of your research may be clear in your mind, if you don't clearly identify the correct research verbs then you may end up using an invalid or incorrect analytical method to get at the answers to your research questions. Each research verb you deal with has a descriptive or inferential technique associated with it. Kenneth Lewis, who has taught operations research, quantitative methods and educational research methods for over 35 years, will connect some of the dots of what to measure, how to analyze and how to interpret the results.		

Keywords: Data Analytics, Dimensions of Behavior, Research Methods, Computer Technology, Research Action Verbs

Classification: UNCLASSIFIED
Working Group: WG33 Social Science Methods and Applications

60685 - 'No Special Privileges'? British Nuclear Forces, Transatlantic Relations, and Arms Control

Start Date: 6/15/2022	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Mr Oliver Toby Barton

Abstract: On 26 June 2020, in response to repeated calls by the Trump Administration for China to join negotiations for a successor to New START, the Russian Deputy Foreign Minister, Sergei Ryabkov, told the TASS news agency that 'we insist that the United States' closest NATO allies possessing nuclear weapons should join these hypothetical talks. They are France and the United Kingdom.' In so doing, Ryabkov revived a long-standing Russian claim that so-called third-party systems must be included in the arms control process, if negotiations were to result in significant reductions in US and Russian stockpiles. The Russian Government made similar claims after the British Government recently announced an increase in the cap on the size of the British nuclear stockpile.

The UK's position on the role of British nuclear forces and arms control has remained largely unchanged for 39 years. In 1983, Britain's top foreign policy priority was the implementation of NATO's dual track decision. At the same time, as a nuclear power, the UK's strongest interest was the protection of it strategic deterrent. These goals were increasingly in tension the more that the Soviets found a sympathetic audience amongst European Allies for their claim that the exclusion of British and French nuclear forces was the main obstacle to reaching an INF agreement.

Having effectively blunted domestic opposition to Cruise by winning the 1983 General Election, the Thatcher Government encouraged the Allies to show continued resolve. However, the Germans, facing much stiffer opposition, wanted to avoid NATO being blamed for the failure of the negotiations and the need to deploy new systems. Consequently, the Germans called for the British and French to be more forthcoming about when and how their nuclear forces would be included in arms control. Although they claimed 'no special privilege', the British fiercely resisted such calls, fearing a slippery slope towards greater concessions.

Finding themselves increasingly isolated on an issue that they believed threatened their most vital national interest, the British eventually conceded that in the unlikely event that negotiations gave rise to 'substantial reductions' in US and Soviet arsenals, 'Britain would want to review its position'. Why, when the dual track decision had reached its critical stage and European public support hung in the balance, were the British not prepared to be more accommodating? In short, the Thatcher Government had reached a tipping point where protecting the viability of the British strategic deterrent trumped the imperative to implement the dual track decision.

With recent calls to broaden participation in future arms control negotiations, this episode highlights the central role that British and French nuclear forces have often played in arms control. The presentation serves a secondary purpose of highlighting how history can highlight recurring themes in national strategy.

Classification: UNCLASSIFIED
Working Group: WG33 Social Science Methods and Applications

59857 - Unpacking Deterrence: AI-Enabled Semantic Analysis of a Large Chinese Dataset

Start Date: 6/15/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Paul L Hartman; Brian Heath; Ross Jackson; Shweta D Kumar		
Abstract: Title: Unpacking Deterrence: AI-Enabled Semantic Analysis of a Large Chinese Dataset Authors: Paul Hartman, Shweta Kumar, Brian Heath, and Ross Jackson Abstract Cold war policies of the United States sought to deter aggression. Within that framework, deterrence for the United States was not limited to the military sphere alone, but also contained other instruments of national power to include entertainment, economic, and technological. Such a confluence suggests that for the United States, deterrence was integrated. A common error in strategy is to assume that others share one's conceptualizations of reality. As such, while deterrence has a meaning for the United States within a certain strategic framework, that meaning is contestable. Consequently, those dealing with the military strategy of deterrence benefit from unpacking its content within specific contexts. This study used a proprietary analytic approach and tool to interrogate over 1.5 million academic articles, written in Chinese, to identify collocations and sentiments associated with the keyword deterrence. The results are suggestive of the types of integrated understandings possible through the application of this technique and would be of pragmatic benefit to those engaged in military analysis and national strategy. Classification: UNCLASSIFIED Working Group: WG33 Social Science Methods and Applications		

WG34 Data Science and Analytics

60292 - In-Stride Analysis of Tactical Network Data During Project Convergence

Start Date: 6/14/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Matthew Smith		
Abstract: During operational experiments, tactical networks can generate large volumes of data in the form of packet capture data, system logs, instrumentation measurements, and even manual data entries. As tactical networks have evolved from low-throughput radio systems to high-capacity IP-enabled networks, this data can easily exceed 1 TB per day, making it difficult to process and extract insights in near-real time to track exercise event and inform upcoming exercise planning decisions. This talk presents a unified assessment framework applying data analysis methods to conduct in-stride analysis of experimentation data for the Army's Project Convergence. We apply data reduction, machine learning, and data visualization techniques to processing and analyze large volumes of network data to extract meaningful insights in real time or near real time. We demonstrate how this analysis can deliver key operational insights during experiment execution, including assessment of tactical network health and performance, the optimal placement or realignment of sensor nodes within the network topology, and highlighting performance and uncovering issues or concerns within the system of systems under evaluation. Classification: UNCLASSIFIED Working Group: WG34 Data Science and Analytics		

59837 - Machine Learning-Based Priority Scoring for Search and Rescue Satellite Aided Tracking (SARSAT) Alerts

Start Date: 6/14/2022	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Justin Sherman; ET3 Tyree Cruse; LCDR Justin Fellers; CDR Gregory E Higgins; LT Jessica Mulroy; OSCM Dan Schlangen
Abstract: United States Coast Guard Command Centers receive emergency position indicating radio beacon (EPIRB) alerts via the SARSAT system, which notifies the Coast Guard of possible maritime emergencies. With less than 4% of alerts representing distress, an expanding reliance on SARSAT, and an increasing surge of alerts during climate change induced extreme weather events, there is increased risk of an oversight. A Coast Guard team analyzed SARSAT alert data from the Seventh Coast Guard District in Miami, FL. and National Oceanic and Atmospheric Administration (NOAA) weather data. Next, the team employed classical machine learning algorithms to develop a cost-sensitive predictive model to calculate the likelihood an incoming new alert represents actual distress based on historical alert data and geospatial conditions. Interestingly, despite the lack of apparent clustering between data types for actual distress and false distress, a random forest classifier achieved 78% true positive rate for both classes on the test dataset (1,813 data points) . In a novel application, the model not only informs response priority but provides justification, thereby enabling optimized human-machine pairing to achieve overall mission performance. Classification: UNCLASSIFIED Working Group: WG34 Data Science and Analytics

60126 - Using Neural Networks to Detect Battle Damage From Satellite Images

Start Date: 6/14/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Charlotte Ellison		
Abstract: Battle Damage Assessment in denied regions using satellite imagery is crucial for situational awareness and decision-making but can be labor intensive. Using artificial intelligence, convolutional neural networks in particular, we developed techniques for automatically detecting damage to houses and buildings from satellite images. These methods ingest images taken before and after damage occurrence and produce a mask labeling the damage severity. Given the complexity inherent to the visual appearance of damage, it is necessary to investigate various aspects of the methods on the detection of damage. We explore the advantages and disadvantages of treating damage detection as an instance segmentation versus semantic segmentation task. In addition, we present the effects of various factors such as image resolution, architecture, and inclusion of before-damage image. Classification: UNCLASSIFIED // FOUO Working Group: WG34 Data Science and Analytics		

60217 - StormTrackeR: STORM Data Analysis with R

Start Date: 6/15/2022	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: Mr Jeffrey Scott Schrad		
Abstract: StormTrackeR is an R language extension, or package, designed to facilitate data mining, visualization, and analysis of output from STORM (Synthetic Theater Operations Research Model). Its primary purpose is to put the power of R data science language into the hands of the STORM analyst. This tool automates the more technical processes required for applying R to STORM data. This drastically reduces the learning curve for STORM analysts with limited experience with R as well as simply reduces the coding overhead for analysts at all levels. It provides numerous data wrangling tools specifically tailored for dealing with STORM output data. It also provides a number of automated data visualization tools to assist the analyst in quickly assessing performance and behavior of model entities. In this this session we will demonstrate a data mining and analysis process for		

STORM using R and StormTrackeR. In addition, we will discuss the benefits, hurdles, and lessons learned along the way in our efforts to apply more advanced data science techniques to STORM.

Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

60093 - U.S. Army SATCOM Throughput Requirements Study (STRS)

Start Date: 6/15/2022	Start Time: 8:30 AM	End Time: 9:00 AM

Authors: Mr. Christopher Brassel

Abstract: 90th MORSS
The Research and Analysis Center

Principal Author: Mr. Christopher Brassel
Briefer: Mr. Christopher Brassel
Classification of Presentation: CUI
Presentation Distribution Statement: DISTRIBUTION D
Length of Presentation: 25 minutes
Working Group: WG 34 – Data Science and Analytics

U.S. Army SATCOM Throughput Requirements Study (STRS)
Keywords: Satellite Communications; Wideband; Discrete-Event Simulation, Data Visualization

The U.S. Army requires access to secure and reliable communications to succeed in the future operational environment. The Army's transformation to Multi-Domain Operations (MDO) and investment in associated modernization capabilities rely upon a network that is expeditionary, mobile, hardened, and intuitive. Access and availability of data is central to achieving the battlefield advantage and increasing the speed of operations required for decision dominance. This study estimates satellite communication (SATCOM) throughput requirements for the Army AimPoint Force 2035 (Corps and below) in large scale combat operations to identify drivers, challenges, and implications.
The study team first updated and refined data collected during the Army Wideband SATCOM study performed by TRAC in 2017, prior to the development of MDO and AimPoint Force 2035. To determine the wideband SATCOM throughput demands, the study team coordinated across the community of interest to identify approximately 4.1 million operationally relevant communication demands for battalion to corps sized elements in two separate operational environments. With the demands established, the team used a discrete-event simulation to determine SATCOM throughput requirements and capability gaps. The team then worked to successfully overcome challenges with simulation run-time, data analytics on 500 GB of simulation output, and server load-time to develop an interactive, CAC-enabled dashboard in R Shiny to share analysis with the community of interest. This presentation describes the study scope, methodology, and an overview of the simulation used to generate the Army SATCOM throughput requirements. It also describes the challenges and limitations overcome during the refinement of simulation excursions and the development of the CAC-enabled dashboard.

Classification: UNCLASSIFIED // NOFORN
Working Group: WG34 Data Science and Analytics

59179 - Characterizing the Joint Distribution of Cyber Data and Generating Synthetic Training Examples

Start Date: 6/15/2022	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Capt Marc Winczer Chale; Dr. Nathaniel D. Bastian		
Abstract: Attacks against enterprise cyber networks cost billions of dollars in economic losses each year. Intrusion detections systems (IDS) are a ubiquitous tool to audit cyber traffic for malicious activity. Modern IDS are adopting artificial intelligence (AI) to trigger threat alerts, preventing excessive loss. However, AI techniques such as machine learning require very large training sets. The lack of high-quality cyber training data has proven a major limitation in the advancement of IDS technology. This research uses generative methods to characterize the joint distribution of cyber data and to generate realistic synthetic data to aid in training IDS classifiers. Markov Chain Monte-Carlo, generative adversarial networks, and variational autoencoders are compared experimentally as methods for modeling the joint distribution of cyber data and for generating synthetic training data. Classification: UNCLASSIFIED Working Group: WG34 Data Science and Analytics		

60218 - Community and Infrastructure Adaptation to Climate Change (CIACC)

Start Date: 6/15/2022	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Joshua D. Bergerson; John K. Hutchison		
Abstract: Critical infrastructure systems throughout the U.S. are increasingly at risk due to systemic underinvestment and intensifying natural hazards driven by anthropogenic climate change. Disruptions of critical infrastructure systems, such as drinking water and electric power systems, threaten the safety and well-being of people and communities, cause significant financial damage, and may inflict socioeconomic damages that span years or decades. Research on climate change, impacts on infrastructure, and infrastructure adaptation is constantly evolving and researchers are publishing at a blistering pace. This makes it nearly impossible for individuals – or even teams – across government, academia, and industry to review scientific and engineering advancements and to use them to inform their climate adaptation decision-making. Decision-makers require actionable, understandable guidance on location-specific climate conditions projected at future time periods, the potential impacts of these future conditions on infrastructure systems, and remedial climate change adaptation strategies to enhance the resilience of these systems and reduce risk associated with their future disruptions. To address this need, a team of researchers at Argonne National Laboratory is developing the Community and Infrastructure Adaptation to Climate Change (CIACC) tool which leverages several artificial intelligence methodologies, including natural language processing, topic modeling, and machine learning, to read millions of articles – offering a solution to the challenge decision-makers face in wrapping their arms around research on climate change and infrastructure impacts. A fundamental component of CIACC's development is the creation of a dynamic critical infrastructure and climate change corpus of research documents. As a first step towards establishing such a data pipeline, the project team is using the Allen Institute's Semantic Scholar Open Research Corpus. Trained machine learning models in CIACC serve as lenses for identifying documents discussing specific topics. CIACC is currently equipped with three lenses to identify individual or combinations of climate change hazards (comprised of 9 extreme events and 9 climate trends), 16 critical infrastructure sectors, and 55 national critical functions. These lenses enable users to identify subsets of the corpus of interest and boils it down to summary data and synthesized trends. The tool offers decision-makers cutting-edge and actionable information on climate hazards, threats to critical		

infrastructure, and climate adaptation best practices – helping them better safeguard systems and communities. In this discussion, we present 1.) an analysis of weak to strong supervised learning that minimizes human-in-the-loop feedback, 2.) an overview of CIACC architecture, and 3.) a discussion of challenges and opportunities surrounding effective visualization and communication of aggregated NLP results to empower decision makers.

Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

59650 - A Nuclear Security Enterprise Study of High-Reliability Systems, Collaboration, and Data

Start Date: 6/15/2022	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Mr. Terry Michael Josserand

Abstract: It may seem simple and trivial, but defining the difference between data and information is contested and has implications that may affect the security of United States interests and even cost lives. For security, data are raw facts or figures without context, while information is the compilation or articulation of data that forms context. Security depends on clarity in the differences between data and information and controlling them.

Control is necessary to ensure that data and information are not inadvertently released to foreign governments, the public, or those without Need-to-Know. A primary concern in the practice of security is the control of data to avoid the inadvertent conversion to sensitive information. The complexity of this concern is further augmented when institutions are part of tightly coupled networks that informally share data and information. Additionally, those that share data as a function of legislative action—and/or formally integrate data and information system infrastructures—may be a higher security risk. This paper will present a case study that utilizes elements of literature from Knowledge Management and networks to tell a story of an issue in security—specifically, controlling the conversion of data to information.

Classification: UNCLASSIFIED // FOUO
Working Group: WG34 Data Science and Analytics

59640 - An Analysis of C/C++ Datasets for Machine Learning-Assisted Software Vulnerability Detection

Start Date: 6/15/2022	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Daniel Grahn

Abstract: As machine learning-assisted vulnerability detection research matures, it is critical to understand the datasets being used by existing papers. In this paper, we explore 7 C/C++ datasets and evaluate their suitability for machine learning-assisted vulnerability detection. We also present a new dataset, named Wild C, containing over 10.3 million individual open-source C/C++ files -- a sufficiently large sample to be reasonably considered representative of typical C/C++ code. To facilitate comparison, we tokenize all of the datasets and perform the analysis at this level.
We make three primary contributions. First, while all the datasets differ from our Wild C dataset, some do so to a greater degree. This includes divergence in file lengths and token usage frequency. Additionally, none of the datasets contain the entirety of the C/C++ vocabulary. These missing tokens account for up to 11% of all token usage. Second, we find all the datasets contain duplication with some containing a significant amount. In the Juliet dataset, we describe augmentations of test cases making the dataset susceptible to data leakage. This augmentation occurs with such frequency that a

random 80/20 split has roughly 58% overlap of the test with the training data. Finally, we collect and process a large dataset of C code, named Wild C. This dataset is designed to serve as a representative sample of all C/C++ code and is the basis for our analyses.

Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

60268 - Safe Machine Learning Prediction and Optimization via Extrapolation Control

Start Date: 6/15/2022	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Dr. Thomas A. Donnelly; Christopher Gotwalt

Abstract: Uncontrolled model extrapolation leads to two serious kinds of errors: (1) the model may be completely invalid far from the data, and (2) the combinations of variable values may not be physically realizable. Optimizing models that are fit to observational data can lead to extrapolated solutions that are of no practical use without any warning. In this presentation we introduce a general approach to identifying extrapolation based on a regularized Hotelling T-squared metric. The metric is robust to certain kinds of messy data and can handle models with both continuous and categorical inputs. The extrapolation model is intended to be used in parallel with a machine learning model to identify when the machine learning model is being applied to data that are not close to that model training set or as a non-extrapolation constraint when optimizing the model.

Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

60464 - Weaponization of Language in Online Information Environment: Use of Metaphors in Disinformation Campaigns

Start Date: 6/15/2022	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Regina Kay;a Catipon; Dr. Onur Savas

Abstract: The Sapir–Whorf hypothesis, also known as the linguistic determinism hypothesis, posits that the structure of a language affects its speakers' cognition and categorization of experience (Fishman, 1982). Linguists and cognitive scientists have long debated the merits of this hypothesis, with opposing camps arguing instead that thought has a universal grammar (Chomsky, 2000). The weakened assumption of the hypothesis, known as neo-Whorfianism, offers the concept of language-relativity—that language may influence thought (Fishman, 1982). Academic work has since supported neo-Whorfianism, finding divergent experiences for color (Paul Kay, 1984), time (Boroditsky, 2001), and direction (Lera Boroditsky, 2010) that are dependent on language. Though it should be mentioned that the debate around the merits and reproducibility of the theory continues to this day (Mickan, 2014)(Kann, 2019), linguistic-relativity offers provoking corollaries. For example, given the softened assumptions, can language also be manipulated to influence perception?

Journalistic and academic accounts have found examples of language manipulation in the online information environment. For example, more novel language was linked to the increased sharing of fake news stories in Twitter (Soroush Vosoughi, 2018) and the use of political-identity narratives (in addition to platform features) have contributed to the spread of disinformation (Starbird, 2019). In these narratives, metaphors and analogies have been used out-of-context and with carefully chosen associations in order to manipulate emotion, sow discord, and exploit polarized topics. In this paper, we quantify the role of metaphors in language manipulation, using disinformation campaigns against USA and its allies as a case study. Our team has been collecting Publicly Available Information (PAI)

that consists of more than 10M+ posts from a broad range of platforms. In this presentation, we will demonstrate that systematic metaphor extraction and processing has applications to the detection and assessment of information operations. Our methodology for doing so consists of applying a comparative statistical model using NLP and text analytics as novel tools to find metaphors. We have empirically observed the use of metaphors in language manipulation and thus expect to find evidence that metaphors increase the accuracy of disinformation detection. We also expect to find that the efficacy of the metaphors employed will likely differ based on target audience. The results of the study can be used to combat misinformation and disinformation by improving detection and characterization of abuse of linguistic relativity.

Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

60291 - A Probabilistic Approach to Monitor Supervised Machine Learning Models with Natural Language Processing in Production

Start Date: 6/15/2022	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Abhishek Paul; Joshua Mutugi; Neel Shah

Abstract: Over the past several years, there have been many advancements with machine learning (ML) and identifying the impact this new technology can have across industries. Through this process, supervised ML and natural language processing (NLP) have proven to be effective for automating tasks in logistics, reliability, and maintainability through predictive maintenance with problems such as multi-class text classification. As organizations move to productionizing ML models, they will have to identify methods to monitor and ensure quality of the ML model in production. A major underlying assumption with supervised ML models is that they work well in environments that are similar to the environment in which the model was trained and tested. If the environment changes while the machine learning model is in production, this could cause erroneous predictions from the model. To mitigate this risk, new tools will need to be created to monitor production environments. The purpose of this study is to propose and demonstrate a probabilistic approach to monitoring a supervised ML model with NLP in production; a notional aircraft maintenance dataset is applied. The effort produces a new methodology that measures the textual environment in production and compares the measure to the model training environment, to provide an end user a signal that alerts of a potential environmental change for the model. This probabilistic monitoring approach can be tailored for use on supervised ML applications with NLP.

Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

59970 - No black boxes: explaining ML model explain-ability

Start Date: 6/15/2022	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Joseph Troy Morgan

Abstract: Machine Learning models are often accused of being “black boxes”, much to the chagrin of any dutiful analytic profession worth the length of their latest code. However, many advanced techniques are now commonly available to be able to explain high level and individual observation/prediction level insight, unfortunately making your explanation of decisions to leadership more complicated than “I don’t know why the black box model predicted that.” Several methods and examples will be shown and their advantages/disadvantages discussed.

Classification: UNCLASSIFIED Working Group: WG34 Data Science and Analytics

59641 - The Prediction Management Framework: Ethical, Governable, and Interpretable Deployment of Machine Learning

Start Date: 6/15/2022	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Daniel Grahn; Melonie Richey		
Abstract: As the military integrates machine learning into evermore critical operations, especially those at the tactical edge with near real-time decision making, the necessity of a standardized, robust framework for deployment and management is increasing. In this paper we propose a Prediction Management Framework (PMF) to provide comprehensive visibility into the deployment of machine learning models. We begin by exploring different requirements for the framework paired with example use cases. The requirements include aspects such as: deployment-to-retirement model governance, model and prediction explainability, end-user prediction interpretability, prediction integrity, model & prediction revocability, and more. Next, we offer a novel solution for communicating model information and safety based on the well-known FDA Nutrition Facts Label and OSHA Hazard Communication Standards. We extend this solution to individual predictions and provide a method for notifying decision-makers of the bottom-line/up-front information regarding AI/ML processed data. Further, we recommend security measures to ensure data and/or predictions are not modified after processing. Finally, we provide a reference architecture for the Prediction Management Framework. We implement the basic functionality of this system and make recommendations for extending it to a production-ready system. Classification: UNCLASSIFIED Working Group: WG34 Data Science and Analytics		

60574 - Using social simulations to train, test, and evaluate ML models for social prediction

Start Date: 6/15/2022	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Dr. Asmeret Naugle; Kiran Lakkaraju, Ph.D		
Abstract: Disinformation and social media manipulation campaigns are a large and growing national security challenge. The prevalance of disinformation has accelerated with the use of online social media. Predictive algorithms, based on artificial intelligence (AI) and machine learning (ML) can provide powerful tools to combat disinformation through detecting false information by content analysis, assessing the reach of disinformation, and identifying ways to stop influence. These methods require enormous amounts of data to identify patterns of behavior. We are developing a new method for training, testing and evaluating these methods using social simulations as test beds, which will facilitate rigorous algorithm development in situations where real-world data is insufficient. We use social simulations to generate data with varying underlying causal mechanisms and use that data to test the ability of ML algorithms to perform well under under varying conditions. Classification: UNCLASSIFIED Working Group: WG34 Data Science and Analytics		

59561 - Determining informative maintenance groupings from a large aircraft dataset using natural language processing

Start Date: 6/15/2022	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Emily F. Joback; Cynthia Engholm; Dr. Qinxian Chelsea Curran; Yan Glina; Erin Mitchell
Abstract: Title: Determining informative maintenance groupings from a large aircraft dataset using natural language processing Authors: Emily Joback, Cynthia Engholm, Qinxian Chelsea Curran, Yan Glina, Erin Mitchell MIT Lincoln Laboratory is working with the Air Mobility Command (AMC) to explore the application of machine learning techniques to derive insights from aircraft data and develop a predictive maintenance capability. The dataset used in this work consists of KC-135 maintenance activity logs over a one-year period between 2017-2018, which contain large quantities of free text describing aircraft system discrepancies and corrective actions. Previously, we presented several approaches for analyzing aircraft maintenance data that leverage natural language processing (NLP) techniques, demonstrating the potential of NLP techniques for determining groupings of related maintenance activities from the free text [1]. However, refinements to the process were required to achieve groupings specific enough to inform a predictive maintenance model. For the follow-on analysis, multiple enhancements were made, but these changes increased the volume of data, compounding the complexity of the problem and making many of the standard steps within the NLP framework unfeasible without additional data processing. Data reduction methods were considered to address this issue, which enabled the application of new clustering techniques that were previously impractical due to computational tractability. In this presentation, we will provide a review of prior results as well as a deep dive into the recent enhancements. A comparison of the two result sets will reveal insights about the effectiveness of the NLP process for determining informative aircraft maintenance groupings. It is expected that the resulting NLP framework will play a key role toward building a predictive maintenance capability. [1] E. Joback, C. Engholm, Q. C. Curran, Y. Glina, A. Chang. “Application of Natural Language Processing to Aircraft Maintenance Data.” The 88th MORS Symposium, Working Group 34 – Data Science and Analytics. June 19, 2020. *DISTRIBUTION STATEMENT A. Approved for public release. Distribution is unlimited. This material is based upon work supported by the United States Transportation Command under Air Force Contract No. FA8702-15-D-0001. Any opinions, findings, conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the United States Transportation Command. Classification: UNCLASSIFIED Working Group: WG34 Data Science and Analytics

59860 - The Utility of Data Science Applied to Military Assessment and Selection for Holistic Systems Improvement

Start Date: 6/15/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Hayden Deverill; Dr. William T Scherer		
Abstract: Elite military units use an in-depth assessment and selection (A&S) process to acquire the most qualified candidates. A unique challenge is to objectively evaluate the human dimension of attributes like leadership, resilience, and initiative in candidates. Additionally, the A&S process requires significant time and resources to execute. The specific A&S studied for this research is eight		

weeks long and has a high logistical demand between supplies, personnel, and facilities. Screening the best Soldiers prior to starting the A&S is essential, because candidates who are not selected are a high cost to the system. Likewise, selecting the best candidates during the A&S is essential, because the unit demands top performers to conduct the highly specialized missions. Thus, improving the system will reap dividends for the military.

Most studies about military A&S have used small, biased data sets, used descriptive statistics for analysis, and focused on identifying predictors of candidate success. This research is broader in scope. Our data set was large: we used 11,885 candidate records of archival data from an eight week US Military Special Operations A&S taken over a five years. The data has 90 total features that include administrative, performance, and psychological data on each candidate. We applied a robust data science approach involving feature engineering, feature selection, optimized predictive models, and data subsets analysis to extract more meaningful information from the data. Our objective for this research was to evaluate the utility of applying data science techniques to a specific military A&S data set with the goal of improving the holistic A&S system.

We applied multiple classification models to a variety of feature and candidate subsets created using data science techniques. Using all the data, model accuracy ranged between 62% and 77%. The strongest predictors of candidate success using all the data were performance features, specifically (number of push-ups, sit-ups, and 2 mile run time). Although prediction accuracy is not high (<90%), there is utility in applying data science techniques to the A&S. We discovered that there are distinct thresholds for features (such as fitness scores) that were highly predictive of candidate rejection. Likewise, the modest predictive capability using these features suggests that our data does not adequately capture important variables. For example, resilience may play a role in candidate success but is a challenging feature to measure and highly variable between subjects. Based on the data science techniques used and results, this study 1) validates the importance of having A&S to observe the human dimension of a candidate's response to challenges and 2) proposes several ways to modify the A&S for more effective candidate screening and evaluation.

Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

59809 - Performance Variability of Maintenance Predictions for the KC-135 Tanker

Start Date: 6/15/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Cynthia Engholm		

Abstract: Title: Performance Variability of Maintenance Predictions for the KC-135 Tanker
Authors: Cynthia Engholm, Yan Glina, Brian Bassham, Qinxian Chelsea Curran, Emily Joback, Erin Mitchell
Topics: WG17 Logistics, Reliability and Maintainability, WG34 Data Science and Analytics

Due to an aging airframe and operational demands, KC-135 fleet maintenance is a challenge for the Department of Defense—making fleet mission readiness an elusive standard to achieve and maintain. To address this, MIT Lincoln Laboratory is working with Air Mobility Command to demonstrate the utility of flight recorder data for a variety of applications related to aircraft operational effectiveness and efficiency. One such application seeks to derive predictive insights for maintenance issues. The predictive capability, which is based on survival forest modeling, ingests features drawn from maintenance log entries, daily aircraft status metrics, and flight recorder data. To make predictions

for a targeted issue, related maintenance activities are grouped into case studies of varying specificity, and a model is built for each grouping to assess the likelihood of near-term maintenance. These likelihoods can be combined in various ways to provide guidance on maintenance scheduling. While one set of groupings emerge naturally from hierarchical component numbering, alternative groupings from the free text were generated via natural language processing techniques. This talk will cover the advantages and disadvantages of the various grouping strategies as well as ways of combining likelihood estimates to generate the most informative results.

Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

60001 - Use of big data and the operationalization considerations for suicide risk prediction models

Start Date: 6/15/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: LTC Edward Norman Edens		
Abstract: Presentation of the Person-event Data Environment (PDE) which is a very large database containing longitudinal records of over 40 million government employees (both military and civilian). Additionally, discussion of the facets of operationalization that were optimized in the creation of suicide risk prediction models using data from the PDE as well as the metrics that were selected to measure effectiveness. The models addressed limitations in predictive modeling in suicide by stratifying the population, cross-validation to ensure generalizability, and automated Machine Learning (ML) to determine the optimal algorithm. For operational considerations, the models were optimized with the goal of predicting the highest number of suicides in the lowest number of patients, thereby limiting behavioral health clinicians' potential case load. Ultimately, a comparison of outpatient model predictions versus outpatient clinician assessments on the same patients during the same time period demonstrated the potential utility that model predictions and insights could provide to clinicians. Classification: UNCLASSIFIED Working Group: WG34 Data Science and Analytics		

60254 - Ontologies, Interfaces, and Graph Stores, Bringing Object Based Production to Analysts

Start Date: 6/15/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Daniel Gossman		
Abstract: Legacy approaches to data management and processing do not support the modern analyst attempting to unite data across sources to render a multi-source assessment or their customers who need integrated analyses, often in near real time. Further, attempts to collaborate rather than stovepipe are inherently stymied by legacy data approaches. This presentation will outline the difference between tabular and linked data, and why that difference matters to analysts and advanced data analytic methods. Specifically, this presentation will talk about a form of linked data called Object Based Production (OBP). This presentation will talk about what OBP is, the information architecture and processes that enable it, and how it enables automated and semi-automated processes to associate data across sources with machine readable linkages that enable machine reasoning and the same kind of graph based modeling techniques that enable industry powerhouses like Google and Facebook to target users effectively.		

The presentation will use a real world example where legacy processes were used, the problems it caused, the barriers we faced attempting to implement OBP, how we accomplished it, and the gains that were realized once we did.

Classification: SECRET//REL TO FVEY
Working Group: WG34 Data Science and Analytics

59847 - Utilizing flight recorder data for predicting aircraft engine maintenance

Start Date: 6/15/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Erin Mitchell		

Abstract: Title: Utilizing flight recorder data for predicting aircraft engine maintenance *
Authors: Erin Mitchell, Cynthia Engholm, Brian Bassham, Qinxian Chelsea Curran, Yan Glina, Emily Joback

MIT Lincoln Laboratory is working with the Air Mobility Command (AMC) to leverage artificial intelligence and machine learning algorithms to derive insights from aircraft flight and maintenance data. One example of this research effort is the development of a machine learning model to improve aircraft mission readiness by predicting future maintenance needs. The base model — developed for the KC-135 Stratotanker — relies on input features from two aircraft maintenance datasets: the first captures each maintenance task performed on the airframes, and the second details each airframe's mission capability status and daily activities. A companion set of flight recorder data, consisting of sensor data collected while in-flight, was then incorporated into the data model to test the hypothesis that the addition of flight data will make a more accurate predictive model than maintenance data alone.

To further model development, a specific maintenance action was selected as a case study. Engine coke buildup, or "coking," refers to the accumulation of solid oil residue on the aircraft engine over time. The engine coke cleaning maintenance action — performed on all aircraft in our dataset — is of interest because optimizing its frequency and timing offers the potential to reduce unscheduled aircraft maintenance and therefore improve mission readiness. In-flight events expected to be correlated with increased engine coking were extracted from the flight recorder data and added as input features with the goal of improving the model's ability to predict when coke buildup will negatively affect aircraft engine performance. This talk will discuss the feature development process and the impact on accuracy and timeliness of the machine learning model predictions.

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Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

60554 - Estimating the Statistics of Operational Loss Through the Analyzation of a Time Series

Start Date: 6/16/2022	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: Dr. Kenneth W. Lewis		

Abstract: In the world of finance, appropriately understanding risk is key to success or failure because it is a fundamental driver for institutional behavior. As such, calculating risk is of upmost importance. We focus on risk as it relates to the operations of financial institutions, namely operational risk. Quantifying operational risk begins with data in the form of time series of realized losses, with the goal of developing sound methods to calculate important statistics of various loss categories that may be utilized to benefit
the institution. Losses can occur for a number of reasons, and the loss statistics can vary over different time intervals (e.g., daily, yearly, monthly basis). Operational losses include fraud, production defect, technological issues, faulty processes, and property damage, to name a few. Our desire is to estimate the risk of losses on a long-time scale by developing mathematical techniques that estimate mean, variance, and covariances of various loss categories. This challenge is exacerbated by having to account for both the frequency and severity distributions of losses. We introduce a stochastic point process
model for the frequency distribution that has two important parameters (average frequency and time scale or memory half-life). The advantages of this model are that the parameters can be _t with sufficient data but are also intuitive enough to rely on expert judgement when data is insufficient. When coupled with an independent severity distribution model, the auto- and cross-correlation functions are mathematically tractable, enabling analytic calculations of cumulative loss statistics over larger time
horizons that would otherwise be intractable due to temporal correlations of losses for long time windows. Finally, we will demonstrate the strengths and shortcomings of our new approach by using available loss data from several operational risk categories. Our loss distribution model and correlation calculations will be compared to common industry practices that, in particular, heavily rely on data for fitting a heavy-tailed copula.

Maurice L. Brown and Cheng Ly, Doctoral students in the Department of Statistical Sciences and Operations Research, Virginia Commonwealth University, Richmond, VA, will share their insights with the MORS audience.

Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

60225 - Informing Army Modernization Resourcing Decisions

Start Date: 6/16/2022	Start Time: 8:30 AM	End Time: 9:00 AM

Authors: Dr Xander Console

Abstract: 90th MORSS
U.S. Army The Research and Analysis Center (TRAC)

Principal Author: Dr. Xander Console
Briefer: Dr. Xander Console
Classification of Presentation: Unclassified
Presentation Distribution Statement: Unclassified and Approved for Public Release; Distribution Unlimited
Length of Presentation: 30 minutes
Suggested Working Groups: WG 27 Decision Analysis, WG 34 Data Science and Analytics

Informing Army Modernization Resourcing Decisions

Keywords: Multiple-criteria decision analysis, Army Senior Leader, Modernization, Decision Analysis, Clustering

Army Senior Leaders (ASLs), facing an uncertain fiscal environment with rising costs and flat topline budget, must make difficult resourcing decisions to meet modernization needs while maintaining a balanced budget. As part of an effort to support these decisions, The Research and Analysis Center (TRAC) of the Army Futures Command supported Headquarters, Department of the Army staff with modernization program assessments.

To distinguish programs' operational benefit, the TRAC team developed a data elicitation tool in R Shiny to gather several key operational metrics for modernization programs: relevance to warfighting tasks in either of two theaters (European Command and Indo-Pacific Command) and operational benefit in each theater. To gain an understanding of the relevance to the warfighting tasks, the team solicited input from Army General Officer Commanders across the generating and operating Army communities. Additionally the study team solicited input from capability analysts whose operational benefit assessments were underpinned by capability studies such as Analyses of Alternatives and combat simulations.

The team used the TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution) method to transform the metrics into a single score for each program. These scores determined theater-specific sorted lists with uncertainty estimates for programs' operational benefit. To complement these lists, the team pursued a binning approach. K-means clustering provided program bins. The team ultimately delivered information papers and an R Shiny Dashboard to communicate the results.

The presentation details the decision space, the techniques used and why they were chosen, and how the team communicated results.

Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

59896 - Algorithmic Prediction in Survival Analysis with Time-Varying Covariates

Start Date: 6/16/2022	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Prof. Samuel E Buttrey; Dr. Lyn Rehder Whitaker

Abstract: Survival analysis builds models for times (the "survival" time) until an event. To illustrate military applications, we model distribution (or survival function) of the time that an Army recruit survives until the event that he or she ("they") either complete their first term or attrite for any reason, which might be medical, disciplinary, or something else. Our data set includes predictors that describe the soldier and their job and also includes detailed medical information on the soldier. Many predictors – for example, marital status, number of times deployed, and injury level – change with time. Methods for accounting for these time-varying covariates have recently been expanded to include the algorithmic models: survival trees and survival random forests. When it comes time to predict the survival function for a new soldier, or for a soldier who is currently enlisted, one must combine the estimated survival functions from a number of different sources. For example, if marital status is important in predicting attrition, the prediction strategy needs to account for a soldier's current marital status, and also estimate, even if only indirectly, the probability of future status

changes, if any, and the likely time of those changes for that soldier. In this talk we describe these new directions in algorithmic prediction of survival functions based on time-varying covariates. We give examples of their use in comparing attrition patterns among different groups of soldiers and in predicting end-strength based on a cross-section of current enlistees.

Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

59983 - Delivering a more efficient workforce planning capability through simulation and data analytics

Start Date: 6/16/2022	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Ms Katie Mortimer		

Abstract: The Australian Defence Force (ADF) currently faces a challenge in supplying and sustaining its workforce. New platforms and capabilities are driving changes in Defence, requiring robust workforce plans that will minimise workforce supply risks in the future. However, the complexity of the Defence workforce, with its hierarchical nature and highly interconnected structure, makes this advanced planning difficult. To assist in this planning, a decision-support environment has been created. This environment combines simulation, design of experiments, data analytics, and interactive visualisations to predict the future of the workforce, effectively demonstrate workforce supply risks, and perform what-if analysis on the workforce. A simulation engine was specifically designed and developed to model the Defence workforce. This engine is able to model and simulate the progression of personnel through their careers, including training courses, skill transitions, postings, promotions and loss of personnel through attrition, while respecting workforce-specific prerequisites and conditions. Design of experiments and data analytics techniques, including correlation and Bayesian network analysis, are then used to discover key dependencies, vulnerabilities and understand why they are occurring through the analysis of relationships between inputs and outputs, and between different outputs. These techniques can then be used by workforce planners and analysts by providing them with a deployable software platform, containing highly interactive support tools and visualisations. While the tool suite is in the continuous research and development phase, a mature version has been deployed to the ADF network and used extensively by the Defence workforce planning organisations for both long-term workforce forecasting and risk analysis, as well as to inform critical workforce requirements and policy decisions.

Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

59654 - Data-enabled approaches for enhancing capability development planning

Start Date: 6/16/2022	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Matthew Walsh; Dr. Lance Menthe; David J. Myers, Ph.D.		

Abstract: Problem Statement
The Air Force 2030 Science and Technology (S&T) Strategy calls for enhanced investment in transformational technologies to enable new warfighting concepts with leap-ahead capabilities. A key question in this regard is how to identify and evaluate the most promising concepts to feed into the transformational capability pipeline.

Approach to Solving Problem

We evaluated data-enhanced approaches to identify, select, and promote the most promising concepts to feed into the transformational capability pipeline. From this, we propose a human-centered, data-enhanced decision process that incorporates a prototype data science tool and a collection of foresight methods. The data science tool extracts information from free text data sources pertaining to operational capability gaps and technology solutions. The foresight methods are future-focused techniques that help human experts to combine information from data sources, along with domain knowledge and creativity to arrive at potential solutions. We demonstrate the data science tool and foresight methods in three case studies focused on high-speed vertical take-off and landing (HSVTOL), Joint All-Domain Command and Control (JADC2), and human capital management (HCM).

Techniques Used
We compiled over 10,000 statements of capability gaps and operational needs and more than 140,000 descriptions of technology solutions from various sources. To extract information from these sources, we applied classic (e.g., latent semantic analysis) and cutting edge (e.g., Bidirectional Encoder Representations from Transformers) natural language processing techniques. This analysis revealed the feasibility of locating records based on their semantic relatedness to search phrases, and of discovering clusters of semantically related records within the database.

In addition, we surveyed more than thirty foresight methods and developed an approach to select the most suitable methods given the characteristics of the problem or research program. This analysis revealed the potential opportunity to increase use of creative foresight methods in DoD research.

Challenges, Results, and Conclusions
During this research, we observed several challenges and limitations: (1) Data sources for capability gaps are widely referenced but not centrally managed within the DoD; (2) Data sources for technology solutions are intractably vast; and (3) Software tools are not commonly used within the DoD to manage these data sources. We found that modern data science techniques can be used to extract information from these data sources. However, due to the incomplete nature of descriptions in the data sources, and the need for contextual knowledge and creativity, capability development planning will remain as a primarily human-centered endeavor.

Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

60179 - USMA Hollis Award Capstone Presentation

Start Date: 6/16/2022	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: LTC Brandon Thompson; LTC James Bluman, PhD		
Abstract: The Hollis Award was established by the United States Military Academy in 1995 to annually recognize an individual cadet or group of cadets that excel in their application of Operations Research/Systems Analysis methods in solving a real-world problem. This award is competitive among cadets and is presented in the name of Walter W. Hollis, former Deputy Undersecretary of the Army for Operations Research. The Hollis Award winner is determined by a professional panel of judges at the General Donald R. Keith Memorial Capstone Conference at West Point. The winning individuals will present their research at the 90th MORS Symposium.		

Abstract: As drone technology becomes increasingly accessible in commercial and defense sectors, it is important to establish efficient ways of employing the technology to leverage its inherent advantages. In the context of a chemical, biological, radiological, and nuclear (CBRN) attack, an unmanned aerial system (UAS) can provide an understanding of the area affected by contaminants in a faster and safer way than a manned reconnaissance mission. Commonly used deterministic paths provide comprehensive coverage but they can require a substantial amount of time to reach each sector within a search space. The recently proposed Lissajous search pattern provides easily tunable parameters that can be adjusted according to the search space and anticipated size of the target. This paper provides an evaluation of Lissajous patterns against canonical search patterns and investigates ways of maximizing their efficiency for various target sizes.
Keywords: Lissajous curves, Drones, Unmanned Aerial System, Optimal Search Patterns

Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

59972 - Automating Staged Rollout with Reinforcement Learning

Start Date: 6/16/2022	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Shadow Pritchard; Vidhyashree Nagaraju; Dr. Lance Fiondella		

Abstract: Staged rollout [1] is a strategy of incrementally releasing software updates to portions of the user population in order to accelerate defect discovery without incurring catastrophic outcomes such as system wide outages. Some past studies have examined how to quantify and automate staged rollout, but stop short of simultaneously considering multiple product or process metrics explicitly. This talk demonstrates the potential to automate staged rollout with multi-objective reinforcement learning in order to dynamically balance stakeholder needs such as time to deliver new features and downtime incurred by failures due to latent defects.

Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

60213 - Extracting Structured Data from PDF Documents with iPyPDF

Start Date: 6/16/2022	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Joel Stansbury		

Abstract: A huge portion of data that we use at GTRI is in the form of PDF documents. A few common tasks are: structuring the information within (i.e. creating a nested and hyperlinked table of contents); extracting tabular data (e.g. into a csv file); named entity recognition and linking between documents. Each of these tasks are made significantly more difficult by the fact that simply extracting raw text from a pdf file is not always trivial. Some pdf documents have no text at all (e.g. scanned images) but the worst offenders include obfuscated metadata, invalid characters which will crash the pipeline if not properly handled, and/or improperly ordered lines of text (i.e. shuffling two columns of text into one).

iPyPDF started from the assumption that fully automated parsing is neither possible nor is it desirable as requirements vary from project to project. Hence, our goal is to automate what is possible and to provide tools which make the manual work easier.

The first advancement was the provision of a text-block utility which allows the user to draw a box around a block of text. This box is then cropped out and passed through Google's Tesseract OCR

engine to extract the text. In practice, users will typically select these blocks in the natural reading order, bypassing one of the most elusive hurdles of fully autonomous pipelines. This proved extremely effective in reducing the manual effort required to parse the most offensive pdf files and was about as fast as traditionally highlighting text. With proper infrastructure, denoting contextual hierarchy imposes very little additional effort.

The next advancement was the inclusion of a computer vision (CV) pipeline to detect titles, text-blocks, images, and tables from images of documents. This pipeline allows the tool to assist the hierarchical structuring procedure, and provides the ability to retrieve images and tables from the document.

The semi-structured format resulting from the fully-automated CV pipeline, while incomplete, is sufficient for some interesting and novel NLP tasks. For example, performing Named Entity Recognition on specific sections of a document (e.g. “References” or “Major Contractors”). The ability to detect and extract images/graphs is of obvious, albeit potentially limited, utility. Parsing tabular data is the current focus of research.

The primary difficulties have centered around the need for an intuitive interface, a flexible code-base, and cross-platform compatibility.

The tool is fully open-sourced and available for download at https://github.com/JoelStansbury/ipypdf or via `pip install ipypdf`

Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

59768 - Generalized Robust Feature Selection

Start Date: 6/16/2022	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Bradford Lott; Dr. Mark A. Gallagher, FS; Lt Col Bruce A Cox, PhD

Abstract: Feature selection may be summarized as identifying salient features to a given response. Understanding which features affect the response enables in the future only collecting the consequential data; hence, the feature selection algorithm may lead to saving effort spent collecting data, storage resources, as well as computational resources for making predictions. We propose a generalized approach to select the salient features of data sets. Our approach may also be applied to unsupervised datasets to understand which data streams provide unique information. We contend our approach identifies salient features robust to the subsequent predictive model applied. The proposed algorithm considers all provided variables, square variables, and two-way interactions as an extended data set. The algorithm implements a forward selection approach, based on correlation with the response, while fitting deep neural networks to the selected variables. These deep neural networks maintain an adaptive architecture which mirrors a full factorial design. These networks assess numeric and categorical values for both features and responses. Our algorithm performs well compared to current feature selection algorithms in both data sets generated with known features and common data sets.

Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

59982 - Natural Language Processing with Air Force Contracts

Start Date: 6/16/2022	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Dr Brad Guthrie; Ojustwin Naik		
Abstract: The AFLFMC/LZIA DART (Data Analytics Resource Team) team is currently undergoing an effort to process, extract, structure, and analyze text from over 4.7 million Air Force (AF) contract documents (pdf). The team has applied several natural language processing (NLP) methods to extract key pieces of information from both unstructured text and structured tables. These extractions have directly supported the team's ability to quickly respond to contract-related questions from AF customers relating to data rights, data item description assignments, and cost to name a few. This presentation covers technical details, outcomes, and lessons learned from applying (i) text classification to identify contract statement of works (ii) named entity recognition to extract lines of accounting, vendors, cage codes, part numbers, and (iii) topic modeling to categorize contracts. Classification: UNCLASSIFIED Working Group: WG34 Data Science and Analytics		

60344 - Enterprise Data Management Data Catalog

Start Date: 6/16/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Katherine Urabe; Ms. Cindy L. Grier		
Abstract: Since 2019, the Army has planned to establish a future Hybrid Cloud Framework "to deliver the right data, to the right consumers, at the right time in a joint, multi-domain, highly contested operating environment" (Army Data Plan, 2019). On 21 May 2021, Headquarters Department of the Army (HQDA) issued Execute Order 188-21, which outlines Army 365 implementation and establishes a timeline for the decommissioning of shared drives and network drives. With these extensive changes to data storage and integration capabilities, how can analysts find the most up-to-date, accurate data to conduct their work? Amidst these larger Department of Defense data efforts, The Research and Analysis Center- Fort Leavenworth (TRAC-FLVN) initiated its own enterprise data management (EDM) program in March 2021. EDM is the process of enabling knowledge flow of analytic data to enhance shared understanding, learning, and decision-making. The TRAC-FLVN EDM Program establishes data architecture and governance structures while fostering a data-sharing culture that maximizes accessibility, discoverability, usability, and utility of data required to execute TRAC studies. A key element of EDM is the data catalog, an organized inventory of data that helps users in an organization search for, browse, and manage their data, similar to a library card catalog. This presentation will focus on the TRAC-FLVN data catalog and how it will organize analytic data and make it discoverable to enable more efficient analyses. Classification: UNCLASSIFIED Working Group: WG34 Data Science and Analytics		

59866 - Autonomous Data Advisor (ADA)

Start Date: 6/16/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Miss Bethany Joy Taylor; Kurt Frederiksen		
Abstract: In 2021, the Finance Department of Naval Information Warfare Center (NIWC) Pacific initiated the Autonomous Data Advisor (ADA) project. This effort is focused on developing a virtual		

assistant that automates financial data science and analytics through predictive modeling, data engineering pipelines, and financial reasoning. With ADA, financial managers will be provided with the analytical insight to make faster, better high-level decisions. At the completion of the first development phase, ADA is currently deployed as a web application hosted in the Naval Research & Development Establishment (NRDE) GovCloud. The application maintains several financial time series models, which are updated using an automated data engineering pipeline in Amazon Web Services (AWS). The ADA interface offers analysts the opportunity to visualize and interact with the financial models as well as test out planning scenarios for future budgeting. Using data science to enhance financial decision-making is a key aspect to the DoD's overall mission as financial resources enable the research and logistics that support the American warfighter. This brief will summarize the development process of the ADA application as well as lessons learned in implementing machine learning in the Finance domain.

Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

60243 - Air Force VAULT Platform Data Pipeline

Start Date: 6/16/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Mark Bryant; Mr. Christopher Gillie; Mr. Isaac Jerome Roberts, IV		
Abstract: In today's environment the speed to exploiting enterprise level data is a fast moving train. Analysts are plagued with a haystack of data often in the range of 5-10GB per authoritative data source and cutting down the discovery learning curve is how we in the Chief Data Office are charged with tackling. To this end the VAULT engineers are partnering with industry leaders in fine grain access controls on our high value data assets. During our MORS presentation we are going to discuss leading examples of how we are architecting scalable data access procedures in order to democratize data that any DoD analyst could use to inform their data-driven decision makers. Classification: UNCLASSIFIED Working Group: WG34 Data Science and Analytics		

WG35 AI and Autonomous Systems

59191 - Outbrief MORS AI and Autonomy II Workshop; 25-28 October 2021

Start Date: 6/14/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Mr. Donald H. Timian; Dr. Nathaniel D. Bastian; Dr. Daniel Thomas Maxwell		
Abstract: Title: Outbrief MORS AI and Autonomy II Workshop; 25-28 October 2021 Authors: Dr. Nate Bastian, Dr. Dan Maxwell, and Mr. Don Timian The Military Operations Research Society (MORS) hosted its second Artificial Intelligence (AI) and Autonomy Workshop at the Johns Hopkins University Applied Physics Laboratory in Laurel, Maryland, October 25-28, 2021. Purpose of this presentation is to briefly summarize the Workshop and report recommendations. During the Workshop, four Tutorials and five Sessions with 22 presentations were given, along with Keynotes from Lieutenant General Michael Groen (USMC), Director Joint Artificial Intelligence Center and Ms. Rachael Martin who leads the National Geospatial-Intelligence Agency's (NGA) Artificial		

Intelligence, Automation, and Augmentation (AAA) effort. Points emphasized by our two Keynotes will be reported, along with summarizing session, presentations, and panel observations. Lastly, recommendations – as to path ahead for MORS – will be presented.

Minus Questions: Approx. 25 Minutes Need for Presentation

Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

59749 - Enabling Course-of-Action Analysis in Wargames with Reinforcement Learning

Start Date: 6/14/2022	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Mr. William Leonard; Christina Rinaudo; Dr. Jonathan Alt; Dr. Christopher Morey; Dr. Simon R. Goerger

Abstract: Recent advances with artificial intelligence (AI) in industry and academia provide an opportunity to develop intelligent system agents capable of reliably competing against human experts in course-of-action (COA) analysis. The team trained agents using deep reinforcement learning in a prototype wargaming framework in ground-based and naval scenarios. Team members conducted experiments to evaluate the performance of AI threat agents trained using multiple algorithms and parameter configurations in each scenario; through benchmarking, researchers identified configurations providing superior COA results. Trained agents competed in a desktop wargaming framework that enabled the team to examine current agent capabilities and identify areas for improvement. This presentation provides an overview of the wargaming framework, results of experimentation, and next steps, including the potential to train new agents versus previously trained agents for COA development.

Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

60238 - AI for Combat Simulations

Start Date: 6/14/2022	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Myles Durkin; Dr. Chris Darken; Mr. David DiCarlo; Charles Timm; Brian Wade

Abstract: Military course of action development relies heavily on subject matter expert input and tabletop wargaming to develop and evaluate plans. Additionally, wargames and simulations typically only explore a small portion of the potential simulation trajectory. An artificial intelligence (AI) agent is a potential way to mitigate some of these issues through automated course of action development, non-fragile agent behavior, and greater exploration of decision space. To advance this idea, The Research and Analysis Center (TRAC), working with students and faculty at the Naval Postgraduate School, are developing a framework for training reinforcement learning agents to develop courses of action in different training scenarios using a combat simulation.

This presentation will outline the simulation and hardware requirements for this type of analysis. It will then discuss a proof-of-principle application using the OpenAI gym framework environment to train an agent in basic principles of war such as closing with the enemy and massing of fires. The trained agents are then tested in the TRAC wargaming simulation, Versatile Assessment and Simulation Tool (VAST). This framework can be applied to different combat simulations in order to produce agents useful as adversaries during training, or to enable faster comparative analysis of competing capability sets.

Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

60402 - A Software-in-the-Loop Modeling and Simulation Environment for Autonomous Unmanned Ground Vehicles

Start Date: 6/15/2022	Start Time: 8:30 AM	End Time: 9:00 AM

Authors: Dr. Jeff Durst; Garrett Holden; Juan David Fernandez; Mr. Burhman Q. Gates, Jr; Dr. Peilin Song

Abstract: Autonomy and artificial intelligence are the cornerstones of the fighting forces of the future. The U.S. military and its international allies are betting on big breakthroughs in autonomous technologies. Some military analysists express concerns over a coming "AI arms race" and look to autonomy to provide a tactical advantage over near-peer adversaries. As such, significant science and technology investments are going towards accelerating the development and fielding of autonomous systems. However, due to the complex nature of autonomous systems, advancements in technology and practical functionality are not matching the pace of military needs.

The defining issue is that autonomous systems incorporate technologies that cut across many engineering disciplines. Often, the resources required to produce a physical platform capable of autonomy leave little room for autonomy algorithm development. The cost of creating these physical platforms also limits the amount of live testing sponsors can execute due to the risk of damaging these expensive assets. In light of these challenges, it has become apparent that developing robust autonomous vehicle (AV) systems is impossible without the aid of modeling and simulation (M&S).

In general, AVs operate in over four steps: sensing the environment, reasoning about the environment, sending commands to the vehicle, and executing these commands. To date, M&S tools for AVs focused on only one or two of these steps, but not all four running in real-time. Separate M&S tools exist for simulating sensor data and feeding it to autonomy algorithms, simulating vehicle dynamics, and simulating autonomy-vehicle communications; yet, no one M&S toolset simulates closed-loop autonomous operations. To that end, the proposed presentation will show a newly developed M&S environment capable of simulating full-scale AV operations.

The U.S. Army Engineer Research and Development Center (ERDC) began development of the Virtual Autonomous Navigation Environment (VANE) M&S testbed in 2009. In the last 12 months, VANE has been expanded to include an interface for communicating directly with autonomy solutions. VANE can pass simulated sensor data and vehicle positioning to AV autonomy stacks, take commands back from these algorithms, and execute AV actions inside the simulation environment using actuator and vehicle dynamics simulations. As such, VANE provides a software-in-the-loop (SIL) M&S environment for AVs.

The VANE SIL links M&S and autonomy components via the Robot Operating System (ROS), which allows it be the missing tool for simulating closed-loop, full-scale autonomous operations. This presentation will provide details on the VANE SIL, its ability to communicate with autonomy solutions, and its applications for AV development and testing. This will include the results for an evaluation test of an AV autonomously following a path using GNSS and lidar data.

Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

60180 - Enabling Warfighter Risk Management of AI Enabled Systems

Start Date: 6/15/2022	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: LTC Benjamin Hung

Abstract: While AI is a crucial enabling capability to the DoD mission, its incorporation into warfighting missions will present unique challenges, especially to end users. Despite the best efforts from developers, program managers, and test and evaluation engineers to reduce risks, fielded AI systems are still expected to have unknown operational envelopes, unknown failure modes, and only a fraction of its operational space tested. Moreover, the current practice of capturing algorithmic and data risks in model cards and risk cards are primarily developer-centric and lacking in connection with operational contexts. Warfighters will ultimately bear the responsibility to first understand and then to manage residual technological and mission risks associated with these fielded capabilities. It is therefore incumbent upon those developing, deploying, and testing AI systems to take a more active role in supporting user risk management. This initiative also further advances Responsible AI implementation by prescribing the methods that enable warfighter users to exercise appropriate judgement and care when utilizing AI in an operational environment.

This work ultimately recommends a three-phased approach to enabling warfighter risk management. First, we recommend providing warfighters with written risk assessments of AI technologies to better communicate product-specific risks revealed through testing and to enable risk management through a familiar, DoD-standard framework. Written in plain, non-scientific language, these assessments aim to provide tactical commanders and operational users with a clearer understanding of the capabilities, limitations, and hazards of operationally employing a particular AI technology as well as a recommended set of actions plans to increase the likelihood of mission success.

Second, we recommend establishing for warfighters an experiential onboarding processes prior to system use to educate them about system performance. Beyond a written risk assessment baseline, this hands-on onboarding process supports the early creation of more accurate mental models of the tasks and conditions when the AI system is performant. It will also increase system boundary awareness, further calibrate operator trust, and train the warfighter to identify risks and rehearse controls to mitigate risks.

Third, we recommend accelerating explainable AI in order to give warfighters real-time awareness and understanding of system performance. After a written risk baseline and onboarding process, warfighters still need an ability to comprehend system performance at run-time to best mitigate risks.

Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

60230 - Assurance Techniques for Learning Enabled Autonomous Systems

Start Date: 6/15/2022	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Christian Ellis; Dr. Lance Fiondella; Dr. Maggie Wigness

Abstract: Learning enabled autonomous systems provide increased capabilities compared to traditional systems. However, the complexity of and probabilistic nature in the underlying methods enabling such capabilities present challenges for current systems engineering processes for

assurance, and test, evaluation, verification, and validation (TEVV). This presentation provides a preliminary attempt to map recently developed technical approaches in the assurance and TEVV of learning enabled autonomous systems (LEAS) literature to a traditional systems engineering v-model. This mapping categorizes such techniques into three main approaches: development, acquisition, and sustainment. We review the latest techniques to develop safe, reliable, and resilient learning enabled autonomous systems, without recommending radical and impractical changes to existing systems engineering processes. By performing this mapping, we seek to assist acquisition professionals by (i) informing comprehensive test and evaluation planning, and (ii) objectively communicating risk to leaders.

Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

59180 - Meta-learning for Robust Intrusion Detection

Start Date: 6/15/2022	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Capt Marc Winczer Chale; Dr. Nathaniel D. Bastian		
Abstract: Ongoing research suggests that adversaries can fool intrusion detection systems (IDS) by intentionally perturbing packets of cyber data. By studying the nature of normal, malicious, and perturbed cyber traffic, we identify a meta-learning approach for robust IDS. A multi-level stack ensemble includes a low level ensemble classifiers tuned for (a) unperturbed cyber traffic and (b) perturbed cyber traffic. A high level ensemble learns when to trust the decision from either respective low level classifier. This ensemble design does not require perturbed examples to be explicitly labeled. We seek to demonstrate improved accuracy in each traffic type. Classification: UNCLASSIFIED Working Group: WG35 AI and Autonomous Systems		

59763 - Transfer Learning for Raw Network Traffic Detection

Start Date: 6/15/2022	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: David Arthur Bierbrauer; Dr. Nathaniel D. Bastian		
Abstract: Traditional machine learning models used for network intrusion detection systems rely on vast amounts of network traffic data with expertly engineered features. The abundance of computational and expert resources at the enterprise level allow for the employment of such models; however, these resources quickly dwindle in edge network scenarios. As Internet of Battlefield Things (IoBT) networks become common place in tactical environments there is a need for improved and distributed models trained without these enterprise resources. Transfer learning – which allows us to take information learned in one domain and apply it to another – provides one way to create and distribute these models towards the edge. Using neural networks, we demonstrate the feasibility of transfer learning for anomaly detection using only raw network traffic in computationally limited environments. Classification: UNCLASSIFIED Working Group: WG35 AI and Autonomous Systems		

60290 - Poisoning Hidden-Markov-Model Inferences on Batch Data

Start Date: 6/15/2022	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Tahir Ekin; Capt William Nicholas Caballero; Roi Naveiro; Jose Manuel Camacho Rodriguez		

Abstract: Time-series models typically assume untainted and legitimate streams of data. However, a self-interested adversary may have incentive to poison this data, thereby altering a decision maker's inference. This research focuses on poisoned hidden Markov models, an understudied area in the adversarial machine learning literature. We provision a suite of poisoning problems for filtering, smoothing, and decoding inferences leveraging an adversarial risk analysis approach. Multiple stochastic programming models are provisioned that incorporate realistic uncertainties and varied attacker objectives. A collection of general solution methods is developed by alternatively viewing the problem from frequentist and Bayesian perspectives. The efficacy of each method is illustrated via extensive, empirical testing. The developed methods are characterized by their solution quality and computational effort, resulting in a stratification of techniques across varying problem-instance architectures. This research highlights the weaknesses of Hidden Markov Models under adversarial activity, thereby motivating the need for robustification techniques to ensure the security of AI-based autonomous systems.

Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

60277 - Autonomous Spectrum Sensing using Faster Region Based Convolutional Neural Networks

Start Date: 6/15/2022	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Todd Morehouse, Jr.; Charles Montes; Ruolin Zhou

Abstract: Intelligent radio must contend for spectrum resources in an increasingly complex and dynamic environment. These radio systems continue to become more mobile, sustain higher data rates, and support complex behaviors, such as the ability to learn and adapt in dynamic environments. Therefore, to operate in this field, radios must sense the spectrum and respond accordingly. This spectrum sensing can be used actively, such as avoiding harmful interference, or passively, to detect anomalous and malicious usage of the spectrum. The dynamic nature of the wireless environment makes this a particularly challenging task. Traditional methods detected transmissions by finding parts of the spectrum where the energy exceeded the noise floor, so-called energy-based detection. However, this approach required statistical analysis of the channel, and was not reliable, lacking the ability to handle complex and dynamic scenarios. Convolutional neural networks (CNNs) were found to greatly exceed the ability to detect signals within a channel, without prior statistical information, but could only detect single signals within a band. Our research focuses on extending the ability of CNNs to multi-signal cases. We used faster region-based CNN (FRCNN) to reliably detect multiple signals within a band and characterize them. Region based CNNs allow bounding box detection of objects within an image. In our implementation, the CNN simultaneously predicts the location in frequency domain for each signal within a wide band. In order to achieve this, we modified the baseline FRCNN to process 1-D signals, greatly reducing computation time, a feature that was not previously available. The use of FRCNN allows detection of the center frequencies and bandwidth of all signals within a frequency band, instead of detecting the presence of signals. This information can be used to optimize spectrum usage by allowing multiple signals to share the spectrum. Additionally, it enables the ability to detect signals in any environment, where allocations may not be known or exist, improving the ability of sensing missions. We tested our system over-the-air using software defined radio (SDR). Software defined radio allowed us to model complex transmitter behavior, in a dynamic and cluttered environment, to show the effectiveness of our system. We test with signals at various center frequencies, bandwidths, and behaviors.

Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

60396 - Condition-based Maintenance for Multi-component Systems

Start Date: 6/15/2022	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Yisha Xiang

Abstract: Condition-based maintenance (CBM) is an effective maintenance strategy to im-prove system performance while lowering operating and maintenance costs. Real-world systems typically consist of a large number of components with various in-teractions between components. However, existing studies on CBM focus on single-component systems. Multi-component condition-based maintenance, which joins the components' stochastic degradation processes and the combinatorial maintenance grouping problem, remains an open issue in the literature. In this paper, we study the CBM optimization problem for multi-component systems. We first develop a multi-stage stochastic integer model with the objective of minimizing the total maintenance cost over a finite planning horizon. We then investigate the structural properties of a two-stage model. Based on the structural properties, two efficient al-gorithms are designed to solve the two-stage model. Algorithm 1 solves the problem to its optimality and Algorithm 2 heuristically searches for high-quality solutions based on Algorithm 1. Our computational studies show that Algorithm 1 obtains optimal solutions in a reasonable amount of time and Algorithm 2 can find high-quality solutions quickly. The multi-stage problem is solved using a rolling horizon approach based on the algorithms for the two-stage problem.

Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

59642 - The Prediction Management Framework: Ethical, Governable, and Interpretable Deployment of Machine Learning

Start Date: 6/15/2022	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Daniel Grahn; Melonie Richey

Abstract: As the military integrates machine learning into evermore critical operations, especially those at the tactical edge with near real-time decision making, the necessity of a standardized, robust framework for deployment and management is increasing. In this paper we propose a Prediction Management Framework (PMF) to provide comprehensive visibility into the deployment of machine learning models. We begin by exploring different requirements for the framework paired with example use cases. The requirements include aspects such as: deployment-to-retirement model governance, model and prediction explainability, end-user prediction interpretability, prediction integrity, model & prediction revocability, and more. Next, we offer a novel solution for communicating model information and safety based on the well-known FDA Nutrition Facts Label and OSHA Hazard Communication Standards. We extend this solution to individual predictions and provide a method for notifying decision-makers of the bottom-line/up-front information regarding AI/ML processed data. Further, we recommend security measures to ensure data and/or predictions are not modified after processing. Finally, we provide a reference architecture for the Prediction Management Framework. We implement the basic functionality of this system and make recommendations for extending it to a production-ready system.

Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

60052 - Ethical AI: Some Practical Practices

Start Date: 6/16/2022	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: Joseph Troy Morgan; Jared Shamwell		
Abstract: The U.S. Department of Defense adopted a series of ethical principles for the use of Artificial Intelligence (AI) in 2020. The adoption of AI ethical principles aligns with the DOD AI strategy objective directing the U.S. military lead in AI ethics and the lawful use of AI systems. The department's AI ethical principles encompass five major areas: Responsible, Equitable, Traceable, Reliable, Governable. However, from an AI practitioner perspective, there remains a significant gap between these guiding principles and the practical implications for putting AI/ML tools into production. This discussion will cover some prudent measures that can be realistically implemented short-term. These practices are based upon experiences within a financial institution's robust model risk management processes and best practices from a MLOps perspective. Classification: UNCLASSIFIED Working Group: WG35 AI and Autonomous Systems		

60304 - Exploring Minimally Constrained Neural Architecture Search in CNNs using Genetic Algorithm

Start Date: 6/16/2022	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Charles Montes; Todd Morehouse, Jr.; Ruolin Zhou		
Abstract: Title: Exploring Minimally Constrained Neural Architecture Search in CNNs using Genetic Algorithm Charles Montes, Todd Morehouse, and Ruolin Zhou Department of Electrical and Computer Engineering University of Massachusetts – Dartmouth Abstract Neural architecture search (NAS) is an optimization problem for neural networks, such as convolutional neural networks (CNNs), to find the optimal architecture for an objective function. With much research going into neural networks many researchers use manually created networks instead of optimal networks. Choosing the optimal architecture can be done by applying genetic algorithm (GA) to perform the NAS. Much work has gone into NAS as the architecture greatly affects the network's performance and enables automated machine learning. Most existing research for NAS using GA uses highly constrained network building operations but not much research has gone into minimally constrained network building operations. Unconstrained operations such as considering the network layers and layer hyperparameters at the same time, allowing layers to appear anywhere within the network, or allowing skip connections between any layers. We have implemented a GA framework for NAS in CNNs with minimal constraints in the network building process and ability to add any number of layers anywhere within the network, skip connections between any layers, and deciding layer hyperparameters at the same time. Leveraging our implementation, we explore the possibilities of minimal constraints in NAS using GA and their effects on performance of the resulting CNN and apply it to baseband modulation classification. Additionally, due to the minimal constraints, we use GA to provide insight and to get a better understanding into why certain layers or parameters are chosen as a result from the NAS. Performance metrics considered are network evaluation or inference time, network training time, network accuracy, and NAS runtime. Performance metrics are		

evaluated on automatic modulation classification datasets such as DeepSig RadioML2018, DeepSig RadioML2016 and simulation-based Mathworks example.

Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

60293 - A Probabilistic Approach to Monitor Supervised Machine Learning Models with Natural Language Processing in Production

Start Date: 6/16/2022	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Abhishek Paul; Neel Shah; Joshua Mutugi

Abstract: Over the past several years, there have been many advancements with machine learning (ML) and identifying the impact this new technology can have across industries. Through this process, supervised ML and natural language processing (NLP) have proven to be effective for automating tasks in logistics, reliability, and maintainability through predictive maintenance with problems such as multi-class text classification. As organizations move to productionizing ML models, they will have to identify methods to monitor and ensure quality of the ML model in production. A major underlying assumption with supervised ML models is that they work well in environments that are similar to the environment in which the model was trained and tested. If the environment changes while the machine learning model is in production, this could cause erroneous predictions from the model. To mitigate this risk, new tools will need to be created to monitor production environments. The purpose of this study is to propose and demonstrate a probabilistic approach to monitoring a supervised ML model with NLP in production; a notional aircraft maintenance dataset is applied. The effort produces a new methodology that measures the textual environment in production and compares the measure to the model training environment, to provide an end user a signal that alerts of a potential environmental change for the model. This probabilistic monitoring approach can be tailored for use on supervised ML applications with NLP.

Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

60386 - Frameworks for Design of Entrusted Systems (FIDES)

Start Date: 6/16/2022	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Michael Woudenberg; Joshua Deiches; Troy Shideler

Abstract: Ensuring trust in an autonomous system is a challenge that does not typically improve with more detailed design. All too often, drivers of trust are considered too late in the design process when expectations and performance requirements have become established. As the design matures it becomes increasingly difficult to meet the objectives while providing an assured product that the customer will effectively and appropriately use. Further compounding this challenge is the risk of increased cost and heavy human governance that arises as a stopgap to address designs that attempt to overcome trust issues later in the design maturity.

This presentation addresses this problem by baselining the foundations of autonomy and trust, investigating the relationship of environmental complexity to trust risk, and proposing a measurement system that allows systems architects and designers to establish entrusted design space either for a specific entity or across an integrated system such as manned-unmanned teaming. In this manner, trust is forefront in the design phase and measured to reduce complexity and risk while focusing on ensuring trust.

Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

59729 - Intelligent Agents: Strategic Geometry

Start Date: 6/16/2022	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Louis Bove; Kevin Alcedo; Alex Kim; David Rosenbluth; David Sewell

Abstract: MORS Symposium Abstract – Intelligent Agents: Strategic Geometry
1. Title: Intelligent Agents: Strategic Geometry
2. Author and Co-Authors: Kevin Alcedo, David Rosenbluth, David SeWell, Alexander Kim
3. Submission Group:
WG 35 –AI and Autonomous Systems
WG 30 –Wargaming
WG 28 -Advances in Modeling and Simulation Techniques
4. Classification of Presentation: Unclassified/FOUO 5. Distribution Statement for your Presentation:
• N/A
6. Abstract text (Abstracts limited to 250 words/3000 characters):
Lloyd Austin, the current Secretary of Defense, voices the need for a modernized mix of technologies and capabilities that is "so credible, flexible and formidable that it will give any adversary pause" (U.S. DoD, 2021). This new mix of technologies will enable the United States to exercise Integrated Deterrence in an environment emerging with new undefined threats. Adopting processes that exploit AI-enabled autonomy across the battle network is a factor to achieving a higher relative system operating tempo than U.S. competitors.
Strategic geometry (SG) is a mathematical framework developed by the Lockheed Martin Artificial Intelligence Center (LAIC) under DARPA's Gamebreaker AIE. SG leverages empirical game-theory and graph-theory, specifically Hodge Theory on graphs, in order to characterize the structure on tournament graphs. This characterization allows one to understand and analyze the trade-offs (balance and imbalance) between options by accounting for both cyclic and transitive components of competition. More generally, one can think of SG as a Principal Component Analysis (PCA) method for competitive analytics, where any given tournament graph can be decomposed into a sequence of 2D geometric embeddings each representing a component of the game-space. This sequence can be truncated to give low dimensional approximations of the game description. SG could be a useful tool for decision makers in reducing strategic uncertainty and maximizing probability of win; examples of applications include: optimal force-composition, trade-offs in platform trait/configuration and comparison and selection of Courses-of-Action (COA).
Reference:
Darpa.mil. 2021. [online] Available at: <https://www.darpa.mil/work-with-us/darpa-tiles- together-a-vision-of-mosiac-warfare> [Accessed 6 December 2021].
U.S. Department of Defense. 2021. Defense Secretary Says. [online] Available at: <https://www.defense.gov/News/News-Stories/Article/Article/2592149/defense- secretary-says-integrated-deterrence-is-cornerstone-of-us-defense/> [Accessed 6 December 2021].

Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

59705 - Intelligent Agents: Towards Conjunctive Teamwork

Start Date: 6/16/2022	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Louis Bove; Kevin Alcedo
Abstract: MORS Symposium Abstract – Intelligent Agents: Towards Conjunctive Teamwork 1. Title: Intelligent Agents: Towards Conjunctive Teamwork 2. Author and Co-Authors: Kevin Alcedo 3. Submission Group: WG 35 –AI and Autonomous Systems WG 30 –Wargaming WG 28 -Advances in Modeling and Simulation Techniques 4. Classification of Presentation: Unclassified/FOUO 5. Distribution Statement for your Presentation: • N/A 6. Abstract text (Abstracts limited to 250 words/3000 characters): Lloyd Austin, the current Secretary of Defense, voices the need for a modernized mix of technologies and capabilities that is "so credible, flexible and formidable that it will give any adversary pause" (U.S. DoD, 2021). This new mix of technologies will enable the United States to exercise Integrated Deterrence in an environment emerging with new undefined threats. Adopting processes that exploit AI-enabled autonomy across the battle network is part of the path to achieving a higher relative system operating tempo than U.S. competitors. The Intelligent Agents (IA) team resides under the AI Innovations Directorate within the Lockheed Martin Artificial Intelligence Center (LAIC). IA is composed of 10 engineers and researchers focusing on the research and development of foundational methods, algorithms and technologies that enable end-to-end behaviors, integrating all parts of the OODA loop, from sensory input to motor output. In 2020, the IA team developed PHANG-MAN (Policy Hierarchy for Adaptive Novel Generation of MANeuvers), a Deep Reinforcement Learning Agent designed for air-to-air combat, placing 2nd at DARPA's Alpha Dogfight Trials. In 2021, as part of DARPA's Gamebreaker AIE, the IA team developed the Strategic Geometry (SG) framework. SG can be used to characterize and analyze the trade-offs (balance and imbalance) between options by accounting for both cyclic and transitive components of competition. Allowing one to reduce strategic uncertainty and maximize probability of win. This presentation will highlight how integrating these methods could lead to conjunctive teamwork between intelligent agents, a first step towards solving problems in Manned- UnManned Teaming (MUM-T). Reference: U.S. Department of Defense. 2021. Defense Secretary Says. [online] Available at: <https://www.defense.gov/News/News-Stories/Article/Article/2592149/defense- secretary-says-integrated-deterrence-is-cornerstone-of-us-defense/> [Accessed 6 December 2021]. Classification: UNCLASSIFIED Working Group: WG35 AI and Autonomous Systems

59731 - Accelerating Operations Analysis and Wargaming with the Total Operations Analysis Simulation Tool (TOAST)

Start Date: 6/16/2022	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Louis Bove		
Abstract: MORS Symposium Abstract – Accelerating Operations Analysis and Wargaming with the Total Operations Analysis Simulation Tool (TOAST)		

1. Title: Accelerating Operations Analysis and Wargaming with the Total Operations Analysis Simulation Tool (TOAST)
2. Author and Co-Authors: Kevin Alcedo, Maygan Best, Louis Bove, Geoffrey Gaugler, James Kilian, Ron McCall, Edward McPadden, Giuseppe Pantalone, Matthew Peddle, Thayne Walker
3. Submission Group:
WG 35 –AI and Autonomous Systems
WG 30 –Wargaming
WG 28 -Advances in Modeling and Simulation Techniques
4. Classification of Presentation: Unclassified/FOUO 5. Distribution Statement for your Presentation:
• N/A
6. Abstract text (Abstracts limited to 250 words/3000 characters):
The 2018 National Defense Strategy outlined the need for a modernization of key military capabilities including Command, control, communications, computers and intelligence, surveillance, and reconnaissance (C4ISR), Missile defense, and Advanced autonomous systems. Lloyd Austin, the current Secretary of Defense, also voices the need for a modernized mix of technologies and capabilities that is “so credible, flexible and so formidable that it will give any adversary pause” (U.S. DoD, 2021). This new mix of technologies will enable the United States to exercise Integrated Deterrence in an environment emerging with new undefined threats.
Lockheed Martin (LM) is developing an attack reconnaissance variant of Future Vertical Lift (FVL) to answer the DoD’s approach to identify, develop, and produce the next generation of vertical lift capabilities to meet the needs of the future warfighter. In order to accelerate the engineering prototyping cycle, Lockheed Martin is developing a software tool that will empower engineers and analysts in their Operations Analysis (OA) and Wargaming workflows. The Total Operations Analysis Simulation Tool (TOAST) architecture is composed of a modern software technology stack that enables: (1) Scalability thru containerization and micro-services (2) Seamless insertion of AI/ML algorithms across the stack, treating AI as a first-class citizen (3) Intuitive and modern web-based interface (UI/UX) and (4) Construction of faster and flexible OA workflows by representing them as a Directed Acyclic Graph (DAG).

The presentation will include an introduction of the teams working on this effort, a high-level overview of TOAST’s architecture, demonstrations using the tool, and future plans.
**All Abstracts must be cleared for public release
** If abstract is accepted, please be prepared for a 25-minute presentation plus an additional 5-minute discussion period. This time can only be adjusted with permission of that group's chair.
Reference:
U.S. Department of Defense. 2021. Defense Secretary Says. [online] Available at: <https://www.defense.gov/News/News-Stories/Article/Article/2592149/defense- secretary-says-integrated-deterrence-is-cornerstone-of-us-defense/> [Accessed 6 December 2021].

Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

60513 - Machine Learning for Navy Financial Deobligations

Start Date: 6/16/2022	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Dr. Warren Travis Sutton		
Abstract: Over the past five years, the Department of the Navy (DON) has returned over $14.2B of unused funding to the Treasury (an average of $2.8B/year). A significant portion of these funds are in		

accounts that are both critical to the DON and have significant resourcing challenges. The DON requires the capability to make rapid, data-driven decisions in how it manages the execution of the budget and in monitoring the status of obligations at the Command level. By augmenting the execution of the budget with more advanced analytic capabilities, the DON will be better positioned to make the best use of its resources each year in further support of the warfighter.
The Financial Management Systems (FMS) Financial Management Data & Digital Transformation (FMDDT) Division under the Assistant Secretary of the Navy's Financial Management and Comptroller's Office (ASN FM&C) has partnered with the Center for Naval Analysis to develop a data science solution within the Navy's Jupiter environment, an enclave of DoD's Advana platform, to better predict the probability of a de-obligations during the expired period of funding.
Data is streamed from Navy Enterprise Resource Planning (ERP), Navy and Marine Corp Standard Accounting, Budgeting, and Reporting System (SABRS) and Standard Financial & Reporting System – Field Level (STARS-FL) on a daily basis and aggregated historically from 2013 to present into monthly obligations and de-obligations at the document level directly from the general ledger system using the Databricks environment and Apache Spark.
The objective was to classify the probability of a financial obligations into 3 classes including no de-obligation, small de-obligations of less than 10%, and a large de-obligations of greater than 10% of the total financial obligation. Once the financial data was labeled with the appropriate class, a random forest decision tree model was developed and used to predict the likelihood of a large or small de-obligation.
This effort allows stakeholders to use enterprise data to analyze and identify obligations and de-obligations trends in budget execution and have greater insight into what funding has already expired and what funding might expire in the future with high probability. A predictive analytics tool of this capacity, leveraged early in the lifecycle of the execution of resources provides ample time to conduct analysis on the validity of balances where decisions and changes can garner immediate financial benefit.

Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

59764 - Distributed Multi-Robot Rendezvous with Limited Communication

Start Date: 6/16/2022	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Lauren Bramblett		

Abstract: Autonomous multi-robot coordination research has gained significant attention in recent years due to the propensity for decentralized application strategies. Typically defined as a rendezvous, robots must flock to a predetermined location at static times to share information necessary for a cooperative strategy when communication is limited, intermittent, or unreliable. In this work, a consensus strategy is proposed that allows for dynamic and adaptive rendezvous strategies based on a modified particle filter approach where robots estimate the location of other members and independently find an optimal meeting location. The inclusion of each system model and a dynamic strategy allows for a rendezvous location that i) accounts for the reachability of heterogeneous vehicles in the system, ii) minimizes the travel time to rendezvous, and iii) corrects for noisy or unreliable communication. The utility, generality, and scalability of the proposed approach is demonstrated using extensive simulations and experiments with unmanned ground vehicles in various cluttered environments.

Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

60305 - Human and AI Strengths and Weaknesses in Joint Face Recognition Systems: Implications for Role Heterogeneity in Human-AI Teaming

Start Date: 6/16/2022	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Myke C. Cohen; Michelle Mancenido; Dr. Erin Chiou; Yang Ba; David Mosallanezhad; Dr. Nancy J. Cooke

Abstract: The use of artificial intelligence (AI) in high-stakes domains, such as national security, has amplified the need for designing decision support systems with humans-in-the-loop. In this presentation, we question the validity of traditional teaming constructs in human-AI decision support systems. Teams have been defined as systems in which two or more individuals with interdependent, heterogeneous roles interact with each other to accomplish a common goal. However, interaction dynamics can be drastically different for human-AI teams due to task processing intricacies that are unique to either humans or AI alone, requiring a reconsideration of how role interdependence and heterogeneity are operationalized. To this end, we propose a research framework that extends the concept of role heterogeneity to teams where members perform the same task directed towards a singular goal but possess different sets of strengths and weaknesses. We will discuss a case study in security checkpoint 1-to-1 face verification, where a human agent and an automated face recognition system (AFRS) should be perceived as a dyadic team. We show that distinguishing the strengths and weaknesses of each agent significantly magnifies insights regarding overall system performance and human behavioral metrics. By proposing an extended definition of what constitutes a team, we promote the training and design of self-aware humans and AI systems, respectively, for critical application areas that necessitate human-in-the-loop decision-making.

Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

59771 - Evaluation, Hardening, and Implementation of The Robot Operating System (ROS)

Start Date: 6/16/2022	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Ari Goodman

Abstract: Evaluation, Hardening, and Implementation of The Robot Operating System (ROS)

The Robot Operating System (ROS) is a useful middleware suite for developing robotic systems. ROS was not developed with security in mind and is unsafe for many military applications. Since its inception, several projects have been created to remove security flaws in the original ROS system while maintaining its usability. Several of these projects are under active development. This effort was focused on hardening a target robot and creating a guide with the processes involved with selecting, installing, and developing with ROS software in a cyber-aware context.

NAVAIR Public Release 2022-63 Distribution Statement A - "Approved for public release; distribution is unlimited"

Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

59544 - Qualitative Methods for Systems Verification and Validation in Simulation and Modeling for Autonomous Ground Vehicles

Start Date: 6/16/2022	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Dr. Jessica Lyons; Josh Fairley; Mr. Burhman Q. Gates, Jr; Jeanie Jackson; Stephanie Price		
Abstract: Systems verification and validation (V&V) on virtual models is a challenging and complex task. Virtual testing of autonomous ground vehicles (AGVs) combines simulation tools made up of vehicle and sensor models represented in a virtual scene with performer observations and modeling and simulation observations and data collection. Field testing and virtual testing of an AGV performer for the United States Army began in 2020. Virtual simulations were developed of the physical environment and vehicle by the US Army Corps of Engineers (USACE) Engineering Research and Development Center (ERDC), using Virtual Autonomous Navigation Environment (VANE), a high-fidelity physics simulation, to create replicate the scene and Autonomous Navigation Virtual Environment Laboratory (ANVEL), to build a complete virtual model of the AGV performer. These simulations were used in conjunction with the Army's Robotic Technology Kernel and Warfighter Machine Interface. Using the same methodologies, data was collected from both field and virtual testing and a comparative study using both quantitative and qualitative data was conducted. Initial results were promising and indicated areas for increased resilience. Using an AGV performer as a case study, this presentations reviews the findings from the first comparative study and offers an improved methodology and plan for systems V&V of the ERDC's virtual testing environment. Classification: UNCLASSIFIED Working Group: WG35 AI and Autonomous Systems		

60024 - Rapid Generation of Large-Scale Virtual Environments for UGV M&S Using Off-The-Shelf Data Sources and Automation Scripts

Start Date: 6/16/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Dr. John Gabriel Monroe; Mr. David McInnis; Ms. Rebekah Jackson; Mr. Zachary Aspin; Dr. Stanton R. Price; Josh Fairley		
Abstract: Modeling and simulation (M&S) tools play an essential role in developing and evaluating autonomous unmanned ground vehicles (UGVs). Software-in-the-loop (SIL) simulations enable rapid UGV development independent of a physical platform by providing autonomy with a synthetic sensor feed of a virtual environment and a virtual vehicle model to control. These types of simulations also allow the exploration of an autonomous vehicle's limitations and capabilities based on combinations of scenarios and environmental conditions. ERDC's Virtual Autonomous Navigation Environment (VANE) is a suite of M&S tools that has supported multiple Army UGV development efforts by providing validated sensor and vehicle models for autonomy simulation. VANE sensor and vehicle models interact with a virtual environment, which must be sufficiently complex to elicit realistic responses from the autonomy. Developing high-fidelity and diverse virtual environments (i.e., scenes) for M&S tools is a complex task with many data requirements and sub-processes. ERDC has developed a new method for rapidly generating geotypical and quasi-geospecific scenes using automation scripts, up-sampling techniques, and off-the-shelf GIS data sources. This presentation will introduce these capabilities and describe a test case that leveraged them to create a new virtual environment for VANE simulations. Classification: UNCLASSIFIED Working Group: WG35 AI and Autonomous Systems		

59789 - Wing Walker

Start Date: 6/16/2022	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Mr. Ezra Idy		

Abstract: Due to the chaotic environment, harsh weather conditions, basic human error, as well as aircraft carriers becoming more tightly packed, Aircraft Ground Mishaps (AGMs) are becoming more common during taxiing and towing operations on the flight deck. AGMs lead to a decrease in mission readiness and an increase in operational and airframe rework cost. The objective of the Wing Walker project is to incorporate sensors and obstacle detection algorithms to existing tow tractors, in order to augment current personnel and practices to reduce AGMs. Using multiple perception based sensors, in addition to the existing personnel, the system will provide appropriate warnings that an aircraft collision is eminent.

The project consists of two systems that when combined will encompass the aircraft of interest. The first system is a LiDAR based system that will be mounted to the tow tractors on the flight deck. Using point cloud detection, the aircraft and its immediate surroundings can be identified. The second system is a wearable technology system that will be worn by the crew members walking the aircraft (blue shirts). The wearable technology system will allow for additional coverage of the aircraft of interest.

The project is currently in development, but early results show that with additional situational awareness on the flight deck, Aircraft Handlers are more comfortable and confident when taxiing aircraft, resulting in fewer AGMs.

Classification: UNCLASSIFIED

Working Group: WG35 AI and Autonomous Systems