58th AORS 2020

Army Operations Research Symposium

Army Resilience in the Face of Global Crisis

Virtual Symposium

20 – 23 October 2020

Welcome to the 58th Annual
Army Operations Research Symposium (AORS)

We selected this year's theme, "Army Resilience in the Face of Global Crisis," to emphasize the Army Operations Research community's ability to rise to a new challenge over the past seven months of the COVID-19 pandemic. The Army (and the world) has been challenged to be resilient as we battle a different kind of enemy. This year's AORS will highlight some of the great analyses the Army OR community has done to help the Army be more resilient and face this pandemic head-on.

We are honored to have General John M. (Mike) Murray, the Commanding General of the Army Futures Command, as our keynote speaker to kick off the symposium on 20 October. General Murray has many years of experience leading and making decisions that were informed by outstanding analyses. To further reinforce our theme, we will host a panel discussion on 21 October with senior members from the Army OR organizations to address resilience and how the analytic community has impacted the Army's response. The panel will field questions from the audience, so think about what you might want to ask them about how we have become more resilient.

The primary purpose of AORS is to provide the Army analytic community an opportunity to collaborate with peers and exchange professional knowledge, experiences, and insights. We will accomplish this through over 200 presentations related to ongoing and recently completed operations research and systems analysis (ORSA) projects over the next few days. We have organized these presentations across ten working groups, to include the addition of a new Pandemic Response Analysis group.

This year, we are also conducting a "Job Fair". You might remember this from last year's AORS, where several organizations collaborated in the inaugural AORS Job Fair (which focused on Army officers). This year we are expanding it to include civilians who are interested in learning about other opportunities in the Army OR community. Representatives from across the analytic community will be available to discuss career opportunities and job openings with military and civilian analysts. For officers, this can be a great assistance as you get ready to submit your duty preferences in the Assignment Interactive Module (AIM) this October and November. While we can't meet in person for the "Job Fair," we are demonstrating our resilience by hosting this event virtually. Plan to join the event on Thursday and Friday mornings before the Working Groups get going. I highly recommend taking a look at the AORS Gazetteer on the AORS website before the "Job Fair" to give you a little insight into the various OR organizations.

AORS also gives us an opportunity to acknowledge excellence in our profession. We will recognize the recipients of the 2020 Army Analysis Awards on Tuesday morning. Awards include the Dr. Wilbur B. Payne Award for Excellence in Analysis, Operational Analysis Award, Civilian Junior Analyst Award, Military Junior Analyst Award, and the 2019 Army Operations Research Symposium Best Paper. Additionally, we will announce three new inductees to the ORSA Hall of Fame in recognition of their distinguished service to our profession.

So, welcome to the 58th AORS! I sincerely hope you find the symposium engaging and fulfilling.

Sincerely,

Steven A. Stoddard, PhD
Director, Center for Army Analysis

Table of Contents

General Schedule of Events

Virtual Location	Start	End	Event
Tuesday - 20 October 2020			
Room 101	0900	0930	Understanding International Programs / How to Become Involved
Rooms 102 & 103	0930	1030	CP36 / FA49 Update Briefs *(simultaneously - 2 rooms)*
	1030	*1045*	*Break*
Conference Hall	1045	1100	Call to Order / Welcome / Administrative Remarks
	1100	1200	Keynote Speaker - Announcement of Awards, Hall of Fame, Wrap-up
	1200	*1245*	*Lunch*
Rooms 101 - 107	1245	1445	Working Groups *(4 x 30 minute presentations)*
	1445	*1500*	*Break*
	1500	1700	Working Groups *(4 x 30 minute presentations)*
Wednesday - 21 October 2020			
Conference Hall	0900	0935	AORS 2019 Best Presentation
	0935	1015	Operational Analysis Presentation
	1015	1045	Wilbur B. Payne Presentation
	1045	*1100*	*Break*
	1100	1200	Panel Discussion
	1200	*1245*	*Lunch*
Rooms 101 - 107	1245	1445	Working Groups *(4 x 30 minute presentations)*
	1445	*1500*	*Break*
	1500	1700	Working Groups *(4 x 30 minute presentations)*
Thursday - 22 October 2020			
Rooms 101 - 107	0900	1000	Job Fair
	1000	1200	Working Groups *(4 x 30 minute presentations)*
	1200	*1245*	*Lunch*
	1245	1445	Working Groups *(4 x 30 minute presentations)*
	1445	*1500*	*Break*
	1500	1700	Working Groups *(4 x 30 minute presentations)*
Friday - 23 October 2020			
Rooms 101 - 107	0900	1000	Job Fair
	1000	1200	Working Groups *(4 x 30 minute presentations)*
	1200	*1245*	*Lunch*
	1245	1445	Working Groups *(4 x 30 minute presentations)*
	1445	*1500*	*Break*
	1500	1700	Working Groups *(4 x 30 minute presentations)*

Note: all times are Eastern Daylight Time (EDT).

Rooms
GoToMeeting
(250 participants)

Conference Hall
GoToWebinar
(1,000 participants)

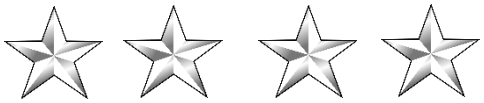
Virtual Job Fair Schedule

Day	Virtual Location	Organization
Thursday, October 22 0900 – 1000 EDT	Room 101	Center for Army Analysis (CAA)
	Room 102	Office of the Secretary of Defense - Cost Assessment and Program Evaluation (OSD-CAPE)
	Room 103	Army Futures Command (AFC)
	Room 104	Network Enterprise Technology Command (NETCOM)
	Room 105	United States Forces Korea/Eighth Army (USFK/8A)
Friday, October 23 0900 – 1000 EDT	Room 101	Defense Intelligence Agency (DIA)
	Room 102	U.S. Army Test and Evaluation Command (ATEC)
	Room 103	The Research and Analysis Center (TRAC)
	Room 104	Assistant Secretary of the Army (Acquisition, Logistics and Technology)(ASA(ALT))

Keynote Speaker

20 Oct, 1100-1200 EDT

General John M. Murray
Commanding General,
Army Futures Command



General Murray was commissioned as an Infantry officer in the U.S. Army upon graduation from the Ohio State University in 1982. Throughout his career, General Murray has served in leadership positions and commanded from Company through Division, with various staff assignments at the highest levels of the Army.

General Murray has held numerous command positions. His command assignments include: Commanding General Joint Task Force-3; Deputy Commanding General – Support for U.S. Forces Afghanistan; Commander Bagram Airfield; Commanding General 3rd Infantry Division at Fort Stewart, Georgia; Commander, 3rd Brigade, 1st Cavalry Division, at Fort Hood, Texas while serving in Operation IRAQI FREEDOM; Commander, 1st Battalion, 18th Infantry, 1st Infantry Division, United States Army Europe and Seventh Army, Germany; Commander, C Company, 1-12th Infantry Battalion, 4th Infantry Division (Mechanized), Fort Carson, Colorado.

Previously, he was the Deputy Chief of Staff, G-8, in the Pentagon; Director, Force Management, the Pentagon; Assistant Deputy Director for Joint Training, J-7, Joint Staff, Suffolk, Virginia; Director, Joint Center for Operational Analysis, United States Joint Forces Command, Suffolk, Virginia; Deputy Commanding General (Maneuver), 1st Cavalry Division, Fort Hood, Texas; Deputy Commanding General (Maneuver), Multi-National Division-Baghdad OPERATION IRAQI FREEDOM, Iraq; G-3 (Operations), III Corps, Fort Hood, Texas; Chief of Staff, III Corps and Fort Hood, Fort Hood, Texas; C-3, Multi-National Corps-Iraq, OPERATION IRAQI FREEDOM, Iraq; G-3 (Operations), 1st Infantry Division, United States Army Europe and Seventh Army, Germany; Chief, Space Control Protection Section, J-33, United States Space Command, Peterson Air Force Base, Colorado; S- 3(Operations), later Executive Officer, 1st Battalion, 5th Cavalry, 1st Cavalry Division, Fort Hood, Texas; Chief, Plans, G-1, III Corps and Fort Hood, Fort Hood, Texas.

General Murray's awards and decorations include: the Distinguished Service Medal w/ Oak Leaf Cluster, the Defense Superior Service Medal with Oak Leaf Cluster, the Legion of Merit with two Oak Leaf Clusters, the Bronze Star Medal with three Oak Leaf Clusters, the Defense Meritorious Service Medal, the Meritorious Service Medal with two Oak Leaf Clusters, the Army Commendation Medal with Oak Leaf Cluster, the Joint Service Achievement Medal, the Army Achievement Medal with Oak Leaf Cluster, the Ranger Tab, the Combat Infantryman Badge, the

Expert Infantryman Badge, the Parachutist Badge, the Air Assault Badge, the Joint Chiefs of Staff Identification Badge and the Army Staff Identification Badge.

General Murray hails from Kenton, Ohio. He and his wife, Jane, have three lovely daughters and eight grandchildren.

GoToMeeting/Webinar

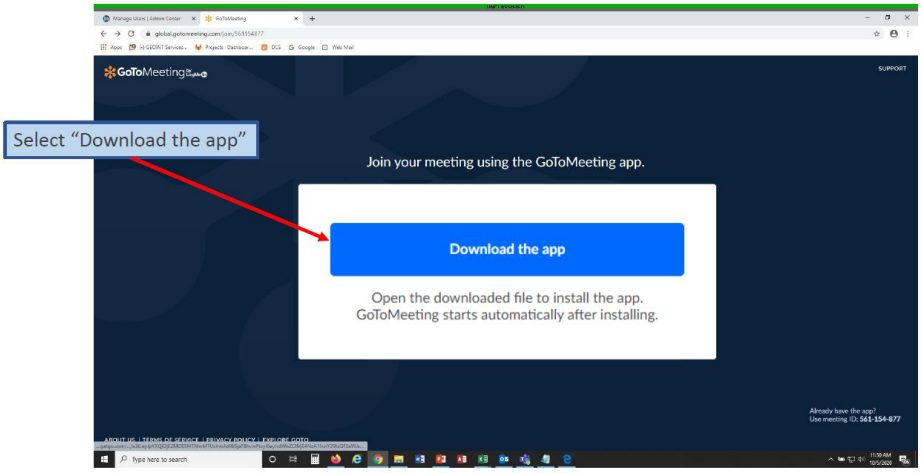
The Center for Army Analysis (CAA) will be hosting the 58th AORS 2020 Symposium, using GoToMeeting and GoToWebinar as the virtual platform. Using GoToMeeting, we will run seven rooms, AORS Room 101 through AORS Room 107 for the Working Groups, Tuesday – Friday 20-23 October 2020, as shown on the General Schedule. (These will be seven open-meetings, in GoToMeeting, running concurrently throughout each day.) All times scheduled are Eastern Daylight Time (EDT). We will also be using GoToWebinar to run the larger conference sessions on Tuesday and Wednesday mornings, in the virtual space shown on the General Schedule as the Conference Hall. There is a **registration requirement for each of the two conference sessions**, but the process is quick and easy. Use the following links to register for the two conference events (note: this info was also included in your recent AORS welcome email). Don't delay … register TODAY!

Tuesday, 20 October Plenary Session.
Wednesday, 21 Oct Award Winner Presentations and Panel Discussion.

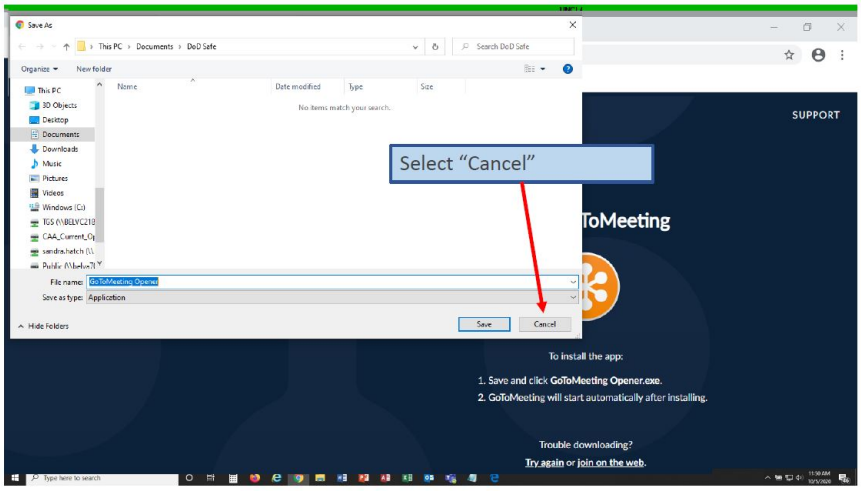
When you complete the above registrations, you will be sent a unique link to use for each of the sessions.

Instructions for Accessing GoToMeeting for the First Time:

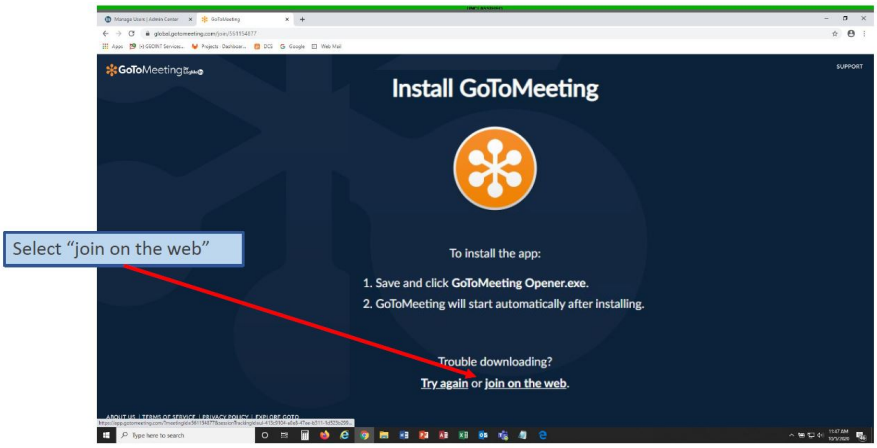
When you first go to a GoToMeeting link, it will want to download an app. If you do not wish to download or you don't have permissions to do so, select Download but then Cancel.



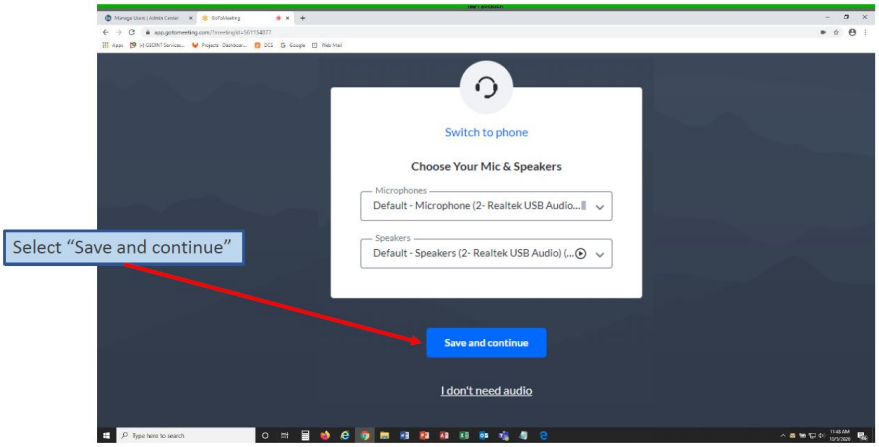
Select Cancel to proceed to other options.



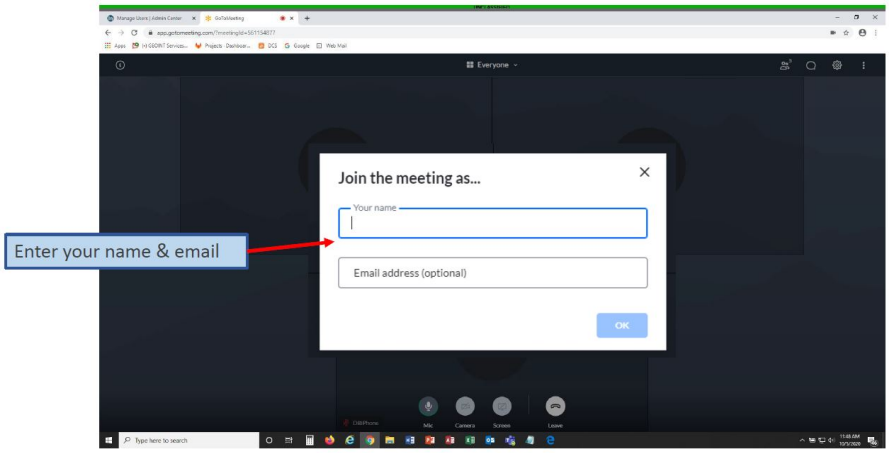
Select the option to join on the web.



Select choices for Microphone and Speakers (defaults are usually sufficient) and then save and continue.



Enter your name and email address, select OK and you will join the room.



Note: If you are connecting to AORS from a remote location (home or other telework site, etc.), recommend you **disconnect from any Virtual Private Networks (VPN)** before connecting to GoToMeeting or GoToWebinar. The connection seems to work much better when it's not going through a VPN.

If you experience any difficulty connecting to the GoToWebinar or GoToMeeting sites, you can reach the AORS Team via email using the link here – email AORS Team. We highly recommend using **Chrome** as the browser, **NOT going through a Virtual Private Network (VPN)** connection, and even considering using a **personal computer** if possible (to avoid possible firewall issues).

U.S. Army Analysis Award

2020 Dr. Wilbur B. Payne Award Winner

21 Oct, 1015 – 1045 EDT

Conference Hall

Study Title: "Fiscal Year 20 Strategic Fires Study"

Study Members:

Futures and Concepts Center (FCC) - The Research and Analysis Center (TRAC):

Ms. Danielle Aldrich	Mr. Matthew Harder	MAJ Kevin Porter
Mr. Laszlo Braun	Mr. Clarence Haubner	Ms. Kirstin Smead
COL Justin Brown	Mr. Kevin Hering	Dr. Jennifer Tarin-Robeck
Ms. Iris Chavez	Ms. Amanda Herrera	LTC Lawrence Tomaziefski
Mr. Rodney Eaton	Mr. Mark Hopson	Mr. Alexander Vanhoudt
MAJ Kurt Findlay	Mr. Miguel Ibarra	Mr. Kevin Wainer
Mr. Ryan Foullon	MAJ Zachary Martin	Dr. Richard Walden
LTC Christopher Frisbie	MAJ Michael Miller	Mr. Matthew Wesloh
MAJ Daniel Gossman	MAJ Nathaniel Nix	
MAJ Charles F. Gwynn	MAJ Andrew Pekarek	

Combat Capabilities Development Command - Data and Analysis Center (CCDC-DAC):

Mr. Kenneth Duvall	Mr. Todd Henry	Mr. James Ngan
Ms. Charlotte Evering	Mr. Thomas Koehler	Mr. Brian Ortega
Mr. Kim Frounfelker	Mr. Jason Ledesma	Mr. Eric Ruby
Mr. Richard Haberstroh	Mr. John Mazz	Mr. Nicholas Zello
Mr. Brian Hairfield	Mr. Eric Mortin	Mr. Zachary Zoller
Mr. William Harclerode	Mr. Gregory Navaline	

Futures and Concepts Center (FCC) - Future Operational Environment Directorate:

Mr. Bruce Tanner

SUMMARY: The Strategic Fires Study (SFS): Fast Track Towards Army Modernization study provided thorough analysis supporting a long and short-range capability and helped support increased funding for faster development. It highlighted the need for further analysis into a mid-range capability solution and the reallocation of funding. The AFC Commanding General commissioned a second iteration of the Strategic Fires Study to inform the Army's requirements

for a long-term mind-range capability solution. The team developed the first assessment highlighting the Army's role in a Joint Fires engagement in two areas of operations. The study results were briefed in 28 General Officer engagements supporting strategic fires-related decisions for senior leaders throughout the Army and in multiple Congressional committees.

Operational Analysis Award Winner

21 Oct, 0935 – 1010 EDT

Conference Hall

Study Title: "Analysis of Aviation Overhaul Requirements to Support Combat Operations in the Afghanistan Theater of War"

Study Members:
PEO Aviation – Multi-National Aviation Special Project Office:

COL John M. Vannoy	Mr. Andy Greer	Mr. Joey Chittam
COL Tim McDonald	Mr. Blake Anderson	Mr. Jonathan Roop
Dr. Wayne Hudry		

SUMMARY: Aviation Overhaul Requirements in the Afghanistan Theater of War Multi-National Aviation Special Project Office analysis tool was designed to forecast aviation overhaul requirements. Results from the analysis enabled senior U.S. Army leader decisions to move forward with additional overhauls.

AORS 2019 Best Presentation

21 Oct, 0900 – 0935 EDT

Conference Hall

Study Title: "Representation of Next Generation Squad Weapons Capabilities in Combat Modeling"

Study Members:
The Research and Analysis Center – White Sands Missile Range (TRAC-WSMR):

Mr. Tel Pickett

SUMMARY: Representation of Next Generation Squad Capabilities in Combat Modeling study provided an overview of squad level weapons representation in COMBATXXI and OneSAF combat models used during the Squad Lethality Study (SLS). The study team successfully provided PM IW with information regarding the operational impact of organic squad weapons and sensors. The combined understanding of performance data, scenario details, and model representation was critical to identifying and communicating relevant results.

U.S. Army Junior Analyst Awards

Civilian

Mr. Robert Ward, Center for Army Analysis

Military

MAJ Kurt Klingensmith, The Research and Analysis Center

ORSA Hall of Fame

Each year, AORS hosts the ORSA Hall of Fame Banquet, which features the induction of historically distinguished Army operations research practitioners into the ORSA Hall of Fame. This year's inductees are MG (Ret) John G. Ferrari, nominated by Dr. David Markowitz, Deputy Chief of Staff, G-8; Dr. Wm. Forrest Crain, nominated by Dr. Steven Stoddard, Director, Center for Army Analysis and Army Model and Simulation Office; and Ms. Donna Vargas, nominated by Dr. Garrett Lambert, Director, The Research and Analysis Center, White Sands Missile Range.

MG (Ret) Ferrari will receive his award at the virtual ceremony. Dr. Crain and Ms. Vargas will receive their recognition at next year's AORS.

MG (Ret) John G. Ferrari

Inducted 20 October 2020

1 July 1965 –
Retired from Federal Service September 2019

- 2014-2019: Director, Program Analysis and Evaluation, DCS, G-8
- 2013-2014: Deputy Director, Program Analysis and Evaluation, DCS, G-8
- 2012-2013: Director, Joint & Integration, Force Development Directorate, DCS G-8
- 2011-2012: Commanding General, White Sands Missile Range
- 2010-2011: DCG PROG (FWD AF), NTM-A/CSTC-Afghanistan
- 2008-2010: Chief, Contingency Operations Branch, The Joint Staff, Pentagon
- 2005-2008: Aide De Camp, Army Materiel Command
- 2004-2005: Officer of Management and Budget Fellow, Executive Office of the President
- 2004-2004: C/J-5 Strategic Planner (FWD Iraq), CJTF-7
- 2000-2004: Program Integrator, Program Analysis and Evaluation Directorate, DCS, G-8
- 1998-2000: Asst. Professor SOC SCI-ECON, US Military Academy, West Point
- 1993-1994: Tank Company Commander, 3rd ACR
- 1991-1993: Executive Officer, 2d ACR, HHT

ACHIEVEMENTS

- Transformed the Army Planning and Programming processes to foster timely and rigorous analysis to support senior leader decision.
- Led the Army through four programming cycles most notably 2013 drawdown through the 2019 buildup.
- Secured $20B of funding supporting preposition stocks in Europe, Armored Brigade Combat Team modernization, and Stryker lethality.
- Focused a senior leader "Deep Dives" that completely restructured Army modernization.
- Migrated the Army's first business system – the cPROBE programming database -- to the Cloud environment.

- Invested in state-of-the-art technology tools for data engineers for producers, data analytics for users, and data visualization for the decision-makers.
- Spearheaded the development of data analytics and cyber skills in the Army Operations Research Analyst Functional Area and community at large.

"Investing in people's skillsets to create the Army's Data Science foundation"

Congratulations to all of this year's inductees and thank you for your valuable contributions to Operations Research!

Previous ORSA Hall of Fame Recipients

2004	2011
Dr. Wilbur Payne GEN Max Thurman Dr. Joe Sperrazza Mr. Hunter Woodall	Mr. Morgan Smith Mr. Raymond Pollard
2005	**2012**
Dr. Marion Bryson Mr. Keith Myers	Mr. Leon Goode Mr. Philip Louer Mr. Roy Reynolds
2006	**2013**
Mr. Abe Golub Mr. Walt Hollis	Mr. E.B. Vandiver Mr. Michael Bauman
2007	**2014**
Dr. Samuel Parry	Dr. James Streilein GEN(R) David Maddox
2008	**2015**
Mr. Pete Reid Mr. Seymour Goldberg	GEN(R) Benjamin Griffin
2009	**2016**
Mr. Dan O'Neill	Mr. Robert Young Mr. Ronald Magee
2010	**2017**
COL(R) Leslie Callahan, Ph.D.	Mr. James Cooke
2018	**2019**
Mr. David J. Shaffer	BG (R) James L. Kays

Panel Discussion

21 Oct, 1100 – 1200 EDT
Conference Hall

The 58th AORS will host a panel discussion with senior members from Army OR organizations to address resilience and how the analytic community has impacted the Army's response. The panel will field questions from the audience, so think about what you might want to ask them about how we have become more resilient.

Moderator: Mr. Vern Bahm, Center for Army Analysis

Invited Members

Dr. Steven A. Stoddard
Director, Center for Army Analysis

Mr. James Amato
Director, Combat Capabilities Development Command Data & Analysis Center

Ms. Pamela Blechinger
Director, The Research Analysis Center

MG Karl H. Gingrich
Director, Program Analysis and Evaluation, Army G-8

Dr. Sally Sleeper
Director, RAND Arroyo Center

Special Session

Understanding International Programs and How to Become Involved

20 Oct, 0900 – 0930 EDT

Room 101

Presenter: Mr. Martin Dubbs, Center for Army Analysis

The U.S. Army operations research community has a long history of cooperation and analytic exchanges with allies around the world. However, many Soldiers and Army Civilians are unaware of the opportunities for professional development and collaboration available under the international exchange programs, do not know how to become involved, and have insufficient information about how the programs work. The purpose of this presentation is to provide the information required by U.S. Army operations research analysts to understand better how the international exchange programs work and how to become involved.

Career Field Updates

Plan to join the Career Program 36 (CP36) and Functional Area 49 (FA49) managers for an update on what is new and exciting in the career field. Civilians (or anyone considering becoming a civilian CP 36) should attend the CP 36 brief and the military ORSAs should join FA 49 room. The FA49 session will also cover topics about the proponent efforts.

Note that these sessions occur on Tue, 20 Oct before the Plenary Session – so, don't forget to jump into AORS early on 20 Oct!

CP36 Update Brief

20 Oct, 0930 – 1030 EDT

Room 102

Presenter: Ms. Patricia Hughes

Background: Career Program 36 (CP36) is the Department of Army's civilian Analysis, Modeling and Simulation career program, for training, educating and developing civilian human capital in a systematic fashion. The Program was approved by the Assistant Secretary of the Army {Manpower and Reserve Affairs, (ASAM&RA)} on 15 February 2005. The CP36 Army Civilian Training, Education, and Development Systems (ACTEDS), soon to be updated, was approved 15 April 2006. Analysis, modeling and simulation is pervasive throughout the Army, and is found in the Acquisition, Analysis, Operations, Testing, Training, Experimentation and Intelligence communities.

FA49 Update Brief

20 Oct, 0930 – 1030 EDT

Room 103

Presenter: MAJ Dana Eisenman

FA49 Mission: Functional Area 49, Operations Research/Systems Analysis (ORSA), provides the Army uniquely skilled officers -- problem solvers -- who produce analysis and decision support products to underpin critical decisions by leaders and managers at all levels of the Department of Defense (DoD). These officers recommend potential solutions for complex strategic, operational, tactical, and business issues. ORSAs are an integral part of Title 10 roles to organize, man, train, equip, sustain, and resource transformation in the Army.

The FA49 officer "introduces quantitative and qualitative analysis to the military's decision-making processes by developing and applying probability models, statistical inference, simulations, optimizations, and economic models. The ORSA FA encompasses diverse disciplines in personnel management, doctrine and force development, training, system acquisition and resource management, as well as tactical operational and strategic planning from division through combatant command, and from MACOM through the highest levels of DoD." -- DA PAM 600-3"

Working Groups

WG 1 (Room 101) - Current Operations: CCMD operations, Europe-Asia-Pacific analysis, Humanitarian Relief Operations, CONUS Disaster Relief, Homeland Security and current infrastructure.

WG 2 (Room 102) - Future Capabilities: Future capabilities integration, combat developments, manning and equipping the force, capabilities requirements, Analysis of Alternatives (AoA), development of concepts, doctrine and organization.

WG 3 (Room 103) - Sustainment: Fleet analysis, logistic, deploying and sustaining the force, optimization, materiel and fire sustainability, operational energy, distribution, equipment analysis, and test and evaluation.

WG 4 (Room 104) - Advances in OR, Data Science, and Technology: New methods in operations research (OR), data integration and collection and applications of information technology to operations research problems.

WG 5 (Room 105) - Manpower, Personnel and Training Analysis: Manpower requirements determination, enhance training, soldier and team performance (develop future leaders) recruiting, retention, casualty and medical analysis.

WG 6 (Room 101) & (Room 106) - Modeling and Simulation (M&S): M&S development, data collection in support of M&S, defining future requirements for M&S applications and best practices in support of wargaming.

WG 7 (Room 103) - Cyber Electromagnetic Activities (CEMA) Analysis: Analysis to examine the effects and capabilities of Cyberspace Operations, Signal/Communications Networks, and Electronic Warfare, and the impact on DOTMLP-F decisions and the Warfighter.

WG 8 (Room 107) - Wargaming: Existing and innovative wargaming techniques and tools, lessons learned, advances in analytical approaches, and data collection and synthesis.

WG 9 (Room 101) - Multi-Domain Operations: Analysis examining how the Army operates as part of the Joint Force by employing the Multi-Domain Operations Concept to overcome the challenges of the future operating environment.

WG 10 (Room 107) - Pandemic Response Analysis: Key metrics, trends and analytic methods related to the Coronavirus Disease 2019 (COVID-19) pandemic, providing a forum for analysts to present and discuss how their organizations contributed to the DOD response.

Day	Presentation Time		Room 101	Room 102	Room 103	Room 104	Room 105	Room 106	Room 107
	Start	End	Working Group 1	Working Group 2	Working Group 3	Working Group 4	Working Group 5	Working Group 6	Working Group 8
Tuesday 20 Oct 2020	1245	1315	AP146 Is the War in Afghanistan over for good?	AP124 - Effects of Weaponized Commercial Unmanned Aerial Vehicles (UAVs) on Structures, Experimental Testing Comparison to Numerical Models	AP015 - Route Specific Fuel Consumption and Application to Vignettes within the Hybrid Military Vehicle Component Simulation (HMVCS) Model	AP130 Applications of DoD Supercomputers	AP116 The Impact of Two vs Three Soldier Crews in the Next Generation Combat Vehicle	AP036 Expanding Beyond Active Defense: Broadening the Effects of Program-level Capabilities in Force-on-force Level Modeling	AP082 RCS Averaged Values
	1315	1345	AP094 Distributed Low-Energy Wastewater Treatment	AP084 Development of the Next-Generation Off-Road Mobility Performance Models	AP045 Using Visualization and Statistics to Shape T&E	AP025 The Vision of the Future: Modern Data Science Techniques for Visualization	AP095 A Model for Optimising Personnel Allocation under Uncertainty	AP102 Rapid Development of New Model to Quickly Evaluate Air Defense Battery Effectiveness.	AP135 DAWN Rising: Distributed wargaming and analysis for Force Design
	1345	1415	AP036 Expanding Beyond Active Defense: Broadening the Effects of Program-level Capabilities in Force-on-force Level Modeling	AP075 Tactical Vehicle Solar Recharging	AP049 Initial Provisioning Analysis / Selected Essential-Item Stock For Availability Method (SESAME)	AP136 Cost Comparison Analysis Tool for Stationing (CCATS)	AP137 Emerging Growth Priority Analysis	AP118 Modeling Army Layered Air and Missile Defense (AMD)	AP018 Data Collection for a Distributed Capstone Wargame Series
	1415	1445	AP011 Resilient Telecommunications Systems	AP001 How Accuracy Requirements Create Weapon Effectiveness	AP054 Army Supply Chain Readiness Posture for Readiness Objectives	AP059 Material Identification Research with Target Identification Applications Using Infrared Polarimetric Methods	AP113 The Future of Data Standardization and Repository: Squad Performance Model	AP037 Force-on-Force Modeling of High Energy Lasers	AP080 Expanding Your Aperture to Explore and Leverage Emerging Technologies
	Break		Working Group 1	Working Group 2	Working Group 3	Working Group 4	Working Group 4	Working Group 6	Working Group 8
	1500	1530	AP144 Historical Force Employment	AP074 Using Machine Learning to Automate the Classification of Geospatial Data from Multi-Spectral Imagery	AP092 Incorporating a Fault Prediction Model into Maintenance Planning	AP124 Effects of Weaponized Commercial Unmanned Aerial Vehicles (UAVs) on Structures, Experimental Testing Comparison to Numerical Models	AP068 - The Accountability Paradox Examined: Evaluating the Effects of Accountability on Improvement in U.S. Federal Agencies	AP073 Likelihood Ratio Test on V50 with Multiple Factors	AP156 Analog vs. Digital: Logistics Wargaming Lessons Learned from the JETS Experience
	1530	1600	AP046 An Investigation of the Appropriateness of the Bhattacharyya Distance in Detecting Data Bias	AP091Operational Impacts of Modernization Decisions	AP075 Tactical Vehicle Solar Recharging	AP087Recipe for Using R Products to Produce Ad-Hoc Tables/Reports from Ad-Hoc Data	AP127Implementing a Data Science Capability in an Operational Command	AP035Capabilities-Based Teaming Analysis	
	1600	1630	AP007 CCDC Command Climate Assessment Survey Text Analysis	AP081 - AFC's Integrated Data Analysis Effort of an Artificial Intelligence (AI)-enabled Battlespace	AP143 Unmanned Aerial Resupply at the Tactical Edge	AP074 Using Machine Learning to Automate the Classification of Geospatial Data from Multi-Spectral Imagery	AP033 Estimating Ground Vehicle Fuel Consumption during Training Events	AP021 Modernized Compartment Methodology - A Vulnerability/Analysis Tool for Early Concepts	
	1630	1700	AP032 Barricaded Shooter/Enemy in Defilade - DOTMLPF-P Considerations	AP126 Tactical Intelligence Targeting Access Node: Analysis of Alternatives	AP086 Combinatorics Approach using Predictive Intervals (CAPI) for Forecasting Demand Boundaries	AP077 Using NLP to Improve Situational Awareness of Tactical Communications	AP020 Developing New and Practical Skills through the Training With Industry (TWI) Fellowship Program	AP031 - Uncertainty Quantification and Sensitivity Analysis Methodology for the Advanced Joint Effectiveness Model (AJEM)	
	End Day 1								

Day	Presentation Time Start	End	Room 101	Room 102	Room 103	Room 104	Room 105	Room 106	Room 107
			Working Group 9	Working Group 2	Working Group 3	Working Group 4	Working Group 5	Working Group 6	Working Group 10
21 Oct 2020	1245	1315	AP057 Resource and Risk Informed Modernization: Analysis to Create the 2028 AimPoint Force	AP123 Numerical Modeling of Vehicle Barriers to Develop Calculation Analysis Methods	AP062 Condition Assessment of Micro Nuclear Reactors Performance in Grid Disruption Scenarios	AP019 Applying a Reinforcement Learning Agent to a Combat Simulation	AP039 Distributed Gap Generation and Assessment	AP105 Component Error Representation of Sensor Target Location Errors (TLEs)	AP121 A Hybrid Approach to COVID-19 Prediction Using Machine Learning and Poisson Regression
	1315	1345	AP097 Strategic Fires Study (SFS): Fast-track Toward Army Modernization	AP027 Assessing U.S. Army Formations Enabling Multi-Domain Operations (MDO)	AP093 Combating the Impact of Operating in Resource Constrained Environments with Data Analytics	AP098 Continuous Autonomy Simulation Test Laboratory Environment (CASTLE) Verification and Validation	AP002 Implementing Verification, Validation, and Accreditation	AP048 Dagger Mission Mapping & Modeling Tool (DM3T) Development for PM PNT	AP115 Analytical Support to the Commanding General's COVID Messaging
	1345	1415	AP077 Using NLP to Improve Situational Awareness of Tactical Communications	AP098 Continuous Autonomy Simulation Test Laboratory Environment (CASTLE) Verification and Validation	AP094 Distributed Low-Energy Wastewater Treatment	AP079 Cost Benefit Analysis and Linear Optimization for Army Modernization Analysis	AP065 Self-equity as a Trustworthiness Measure: The Relationship Between Self-equity and Discharge Characterizations in U.S. Army Recruits	AP082 RCS Averaged Values	AP029 Development and Deployment of the ERDC SEIR COVID-19 Model
	1415	1445	AP068 Evaluating the Effects of Accountability on Improvement in U.S. Federal Agencies	AP021 Modernized Compartment Methodology - A Vulnerability/Analysis Tool for Early Concepts	AP109 Closing the Gap Between Materiel, Information and Payment Flows	AP107 Analytic Application Development, Delivery, and Sustainment Considerations	AP060 Achieving the Multi-Domain Operations (MDO) Whiteboard: "Ideal" Force - A Cost Perspective	AP051 Analysis of the effect of Imaging Sensor configuration on urban Situational Awareness	AP050 COVID-19 Analyses within an Organic Industrial Base
	Break		Working Group 9	Working Group 2	Working Group 3	Working Group 4	Working Group 5	Working Group 6	Working Group 10
Wednesday	1500	1530	AP117 Distributed Intelligence Framework for Cyber and Electromagnetic Technologies to Support Expeditionary Cyber as a Sociotechnical Challenge	AP057 Resource and Risk Informed Modernization: Analysis to Create the 2028 AimPoint Force	AP114 Air and Missile Defense Beyond 2035, Air and Missile Defense Concept Development and Assessment	AP038 FORGE: The Future of Army Experimentation	AP108 Using Data Science to Increase Recruitment at the Defense Language Institute	AP072 A Framework to Assess Detection and Defeat Capabilities Against UAS Intrusions	AP039 Distributed Gap Generation and Assessment
	1530	1600	AP027 Assessing U.S. Army Formations Enabling Multi-Domain Operations (MDO)	AP072 A Framework to Assess Detection and Defeat Capabilities Against UAS Intrusions	AP128 Data Analytics to Improve Operationally Relevant Fuel Consumption Estimates	AP007 CCDC Command Climate Assessment Survey Text Analysis	AP114 Air and Missile Defense Beyond 2035, Air and Missile Defense Concept Development and Assessment	AP124 - Effects of Weaponized Commercial Unmanned Aerial Vehicles (UAVs) on Structures, Experimental Testing Comparison to Numerical	AP016 COVID-19 9th Hospital Analytic Support
	1600	1630	AP126 Tactical Intelligence Targeting Access Node: Analysis of Alternatives	AP039 Distributed Gap Generation and Assessment	AP133 From the Crescent City to the Fertile Crescent: Contingency Engineering and Base Development	AP084 Development of the Next-Generation Off-Road Mobility Performance Models	AP077 Using NLP to Improve Situational Awareness of Tactical Communications	AP080 Expanding Your Aperture to Explore and Leverage Emerging Technologies	AP103 Assessing Effectiveness of Command Messaging During a Pandemic
	1630	1700	AP114 Air and Missile Defense Beyond 2035, Concept Development and Assessment	AP012 The Four Generations Model of Innovation	AP145 Unraveling a Gordian Knot: When Your Boss Asks You to Solve the Impossible	AP070 U.S. Army Performance Analytics in a Deployed Environment	AP125 Retention and Recruiting Data Analysis	AP138 Sustainment Transportation Energy Assessment Model (STEAM)	AP044 Bioprotection of Facilities from SARS-CoV-2 (COVID-19)
	End Day 2								

Day	Presentation Time		Room 101	Room 102	Room 103	Room 104	Room 105	Room 106	Room 107
	Start	End	Working Group 9	Working Group 2		Working Group 4	Working Group 5	Working Group 6	Working Group 10
Thursday 22 Oct 2020	1000	1030	AP118 Modeling Army Layered Air and Missile Defense (AMD)	AP109 Closing the Gap Between Materiel, Information and Payment Flows		AP083 An Interactive Visualisation Platform for Exploring Defence Workforce Transition Scheduling Solutions	AP042 - Army Officer Assignment: Using a Mixed Integer Program to Maximize Suitability while Minimizing Assignment Cost	AP098 Continuous Autonomy Simulation Test Laboratory Environment (CASTLE) Verification and Validation	AP034 The SEIR Model to Project the Spread of SARS-CoV-2
	1030	1100	AP081 Assessing Project Convergence: AFC's Integrated Data Analysis Effort of an Artificial Intelligence (AI)-enabled Battlespace	AP114 Air and Missile Defense Beyond 2035, Air and Missile Defense Concept Development and Assessment		AP008 Practical Applications of Topological Data Analysis	AP140 Total Army Analysis (TAA) Supporting Analysis	AP003 - Tactical Internet SIMulation Rapid Performance Analysis of Heterogeneous Large-Scale Tactical Communication Networks	AP134 Challenges Executing Verification and Validation for COVID-19 Modeling
	1100	1130		AP142 Theater Focused Forces (TFF) Analysis		AP131 - Using Neural Networks to Compress Grenade Lethality Data in the IWARS		AP006 Simplified SIGINT Performance Model	AP122 - COVID Modeling at Center for Army Analysis and Estimating the Effective Basic Reproduction Rate (R0)
	1130	1200		AP053 - APNT CFT Modeling & Simulation Integrated Project Team		AP078 DIY Dashboards		AP017 - Adding Communication Realism into One Semi-Automated Force (OneSAF)	AP129 - Building Tools for a Flexible and Scalable COVID Model in R
	Lunch			Working Group 2	Working Group 7			Working Group 6	Working Group 6
	1245	1315		AP113 The Future of Data Standardization and Repository: Squad Performance Model	AP028 Challenges and Insights from Developing an Analytical Baseline for Installation-Level Enterprise IT			AP015 Route Specific Fuel Consumption and Application to Vignettes within the Hybrid Military Vehicle Component Simulation (HMVCS) Model	AP076 Machine Learning Software Tools - The Importance of Getting Inside the Black Box
	1315	1345		AP043 - Assessing Emergency Telecommunication System Resiliency Using MATLAB	AP052 Framework to Analyze Cyber Information Warfare Operations			AP120 Modeling Timing Error Impacts on Operational Capability	AP055 Modeling with Noise in the Data – Examples, Effects, and Solutions
	1345	1415		AP097 - Strategic Fires Study (SFS): Fast-track Toward Army Modernization	AP120 Modeling Timing Error Impacts on Operational Capability			AP058 AiTR in Closed Form Simulations: a first look	AP063 - Implementing Scrum Project Management Methodology
	1415	1445		AP062 Condition Assessment of Micro Nuclear Reactors Performance in Grid Disruption Scenarios	AP114 - Air and Missile Defense Beyond 2035, Air and Missile Defense Concept Development and Assessment			AP004 - Limiting Runs for Computing Probability Estimates from Computationally Intense Models	AP151 Army COVID-19 Model for Epidemics: A tool for medical treatment facility pandemic response
	Break		Working Group 6	Working Group 2	Working Group 7			Working Group 6	
	1500	1530		AP014 - Bayesian Network Modelling for Military Utility Assessment of Direct Energy Weapon within Future Tactical Land Warfare	AP026 Distinguishing Between User Generated and Automatic Network Flows			AP141 - Blending Human-in-the-Loop and Constructive OneSAF Simulation Modeling to Support Maneuver Force Modernization During the COVID-19 Pandemic	
	1530	1600		AP143 Unmanned Aerial Resupply at the Tactical Edge	AP061 Developing Outside the Box: Balancing Trade-offs in a Constrained Operational Environment			AP047 - Exercise VIRTUAL EAGLE: an Armoured Infantry Battlegroup Experiment	
	1600	1630	AP153 Australian Simulation Study Process for Exploring Future Military Concepts and Capabilities	AP071 - A semi-qualitative Methodology for Optimising Wide Wet Gap Crossing Fleets	AP064 A Comparison of the Effectiveness of Deep Learning Models in Predicting Network Performance			AP140 - Total Army Analysis (TAA) Supporting Analysis	
	1630	1700	AP152 Common Pitfalls in the Design and Analysis of Simulation Experiments	AP013 In Search of 10X: Hunting Unicorns and Innovation for Future Battlefields	AP106 Insider Threat Anomaly Detection on Network Traffic			AP142 Theater Focused Forces (TFF) Analysis	
	End Day 3								

Day	Presentation Time Start	End	Room 101	Room 102	Room 103	Room 104	Room 105	Room 106	Room 107
Friday 23 Oct 2020			**Working Group 6**	**Working Group 2**				**Working Group 6**	
	1000	**1030**	AP099 Simulation System Requirements and Assessment Tools for Software in Loop Testing of Autonomous Systems	AP145 Unraveling a Gordian Knot: When Your Boss Asks You to Solve the Impossible				AP030 Data Development Process for Modeling, Simulating, and Assessing Competition and Penetration	
	1030	**1100**	AP016 COVID-19 9th Hospital Analytic Support	AP022 Autonomous Systems Test Capability (ASTC) Verification and Validation (V&V)				AP090 Modeling, Simulating, and Assessing Competition and Penetration	
	1100	**1130**	AP002 Implementing Verification, Validation, and Accreditation	AP133 From the Crescent City to the Fertile Crescent: Contingency Engineering and Base Development				AP128 Data Analytics to Improve Operationally Relevant Fuel Consumption Estimates	
	1130	**1200**	AP022 Autonomous Systems Test Capability (ASTC) Verification and Validation (V&V)	AP127 Implementing a Data Science Capability in an Operational Command				AP101 Development of Geo-Typical Urban Terrain Templates for Network Analysis	
	Lunch		**Working Group 6**	**Working Group 2**				**Working Group 6**	
	1245	**1315**	AP132 Measuring and Predicting Soldier Performance, Lethality, and Resilience Through Soldier-Systems Modeling	AP099 Simulation System Requirements and Assessment Tools for Software in Loop Testing of Autonomous Systems				AP067 Human Anatomy Representations for US Army M&S	
	1315	**1345**	AP084 Development of the Next-Generation Off-Road Mobility Performance Models	AP141 Blending Human-in-the-Loop and Constructive OneSAF Simulation Modeling to Support Maneuver Force Modernization During the COVID-19 Pandemic				AP100 Human Dynamics Analysis: Using modeling to build resilience in planning and operations	
	1345	**1415**		AP068 The Accountability Paradox Examined: Evaluating the Effects of Accountability on Improvement in U.S. Federal Agencies				AP123 Numerical Modeling of Vehicle Barriers to Develop Calculation Analysis Methods	
	1415	**1445**						AP110 Introduction to Artificial Intelligence	
	58th AORS 2020 Concludes								

WG 1 – Current Operations (Room 101)

	Time		WG 1-Room 101
Tuesday, 20 Oct 2020	1245	1315	AP146 Is the War in Afghanistan Over for Good?
	1315	1345	AP094 Distributed Low-Energy Wastewater Treatment
	1345	1415	AP036 Expanding Beyond Active Defense: Broadening the Effects of Program-level Capabilities in Force-on-force Level Modeling
	1415	1445	AP011 Resilient Telecommunications Systems
	Break		
	1500	1530	AP144 Historical Force Employment
	1530	1600	AP046 An Investigation of the Appropriateness of the Bhattacharyya Distance in Detecting Data Bias
	1600	1630	AP007 CCDC Command Climate Assessment Survey Text Analysis
	1630	1700	AP032 Barricaded Shooter/Enemy in Defilade - DOTMLPF-P Considerations

WG 2 – Future Capabilities (Room 102)

	Time		WG 2-Room 102
Tuesday, 20 Oct 2020	**1245**	**1315**	AP124 Effects of Weaponized Commercial Unmanned Aerial Vehicles (UAVs) on Structures, Experimental Testing Comparison to Numerical Models
	1315	**1345**	AP084 Development of the Next-Generation Off-Road Mobility Performance Models
	1345	**1415**	AP075 Tactical Vehicle Solar Recharging
	1415	**1445**	AP001 How Accuracy Requirements Create Weapon Effectiveness
	Break		
	1500	**1530**	AP074 Using Machine Learning to Automate the Classification of Geospatial Data from Multi-Spectral Imagery
	1530	**1600**	AP091 Operational Impacts of Modernization Decisions
	1600	**1630**	AP081 Assessing Project Convergence: AFC's Integrated Data Analysis Effort of an Artificial Intelligence (AI)-enabled Battlespace
	1630	**1700**	AP126 Tactical Intelligence Targeting Access Node: Analysis of Alternatives

	Time		WG 2-Room 102
Wednesday, 21 Oct 2020	**1245**	**1315**	AP123 Numerical Modeling of Vehicle Barriers to Develop Calculation Analysis Methods
	1315	**1345**	AP027 Assessing U.S. Army Formations Enabling Multi-Domain Operations (MDO)
	1345	**1415**	AP098 Continuous Autonomy Simulation Test Laboratory Environment (CASTLE) Verification and Validation (V&V)
	1415	**1445**	AP021 Modernized Compartment Methodology - A Vulnerability/Analysis Tool for Early Concepts
	Break		
	1500	**1530**	AP057 Resource and Risk Informed Modernization: Analysis to Create the 2028 AimPoint Force
	1530	**1600**	AP072 A Framework to Assess Detection and Defeat Capabilities Against UAS Intrusions
	1600	**1630**	AP039 Distributed Gap Generation and Assessment
	1630	**1700**	AP012 The Four Generations Model of Innovation

Thursday, 22 Oct 2020	Time		WG 2-Room 102
	1000	**1030**	AP109 Closing the Gap Between Materiel, Information and Payment Flows
	1030	**1100**	AP114 Air and Missile Defense Beyond 2035, Air and Missile Defense Concept Development and Assessment
	1100	**1130**	AP142 Theater Focused Forces (TFF) Analysis
	1130	**1200**	AP053 APNT CFT Modeling & Simulation Integrated Project Team
	Lunch		
	1245	**1315**	AP113 The Future of Data Standardization and Repository: Squad Performance Model
	1315	**1345**	AP043 Assessing Emergency Telecommunication System Resiliency Using MATLAB: An Integrated Value Model Approach
	1345	**1415**	AP097 Strategic Fires Study (SFS): Fast-track Toward Army Modernization
	1415	**1445**	AP062 Condition Assessment of Micro Nuclear Reactors Performance in Grid Disruption Scenarios
	Break		
	1500	**1530**	AP014 Bayesian Network Modelling for Military Utility Assessment of Direct Energy Weapon within Future Tactical Land Warfare
	1530	**1600**	AP143 Unmanned Aerial Resupply at the Tactical Edge
	1600	**1630**	AP071 A semi-qualitative Methodology for Optimising Wide Wet Gap Crossing Fleets
	1630	**1700**	AP013 In Search of 10X: Hunting Unicorns and Innovation for Future Battlefields

	Time		WG 2-Room 102
Friday, 23 Oct 2020	**1000**	**1030**	AP145 Unraveling a Gordian Knot: When Your Boss Asks You to Solve the Impossible
	1030	**1100**	AP022 Autonomous Systems Test Capability (ASTC) Verification and Validation (V&V)
	1100	**1130**	AP133 From the Crescent City to the Fertile Crescent: Contingency Engineering and Base Development
	1130	**1200**	AP127 Implementing a Data Science Capability in an Operational Command
	Lunch		
	1245	**1315**	AP099 Simulation System Requirements and Assessment Tools for Software in Loop Testing of Autonomous Systems
	1315	**1345**	AP141 Blending Human-in-the-Loop and Constructive OneSAF Simulation Modeling to Support Maneuver Force Modernization During the COVID-19 Pandemic
	1345	**1415**	AP068 The Accountability Paradox Examined: Evaluating the Effects of Accountability on Improvement in U.S. Federal Agencies
	1415	**1445**	

WG 3 – Sustainment (Room 103)

	Time		WG 3-Room 103
Tuesday, 20 Oct 2020	**1245**	**1315**	AP015 Route Specific Fuel Consumption and Application to Vignettes within the Hybrid Military Vehicle Component Simulation (HMVCS) Model
	1315	**1345**	AP045 Using Visualization and Statistics to Shape T&E
	1345	**1415**	AP049 Initial Provisioning Analysis - Selected Essential-Item Stock For Availability Method (SESAME)
	1415	**1445**	AP054 Army Supply Chain Readiness Posture for Readiness Objectives
	Break		
	1500	**1530**	AP092 Incorporating a Fault Prediction Model into Maintenance Planning
	1530	**1600**	AP075 Tactical Vehicle Solar Recharging
	1600	**1630**	AP143 Unmanned Aerial Resupply at the Tactical Edge
	1630	**1700**	AP086 Combinatorics Approach using Predictive Intervals (CAPI) for Forecasting Demand Boundaries

	Time		WG 3-Room 103
Wednesday, 21 Oct 2020	**1245**	**1315**	AP062 Condition Assessment of Micro Nuclear Reactors Performance in Grid Disruption Scenarios
	1315	**1345**	AP093 Combating the Impact of Operating in Resource Constrained Environments with Data Analytics: A Fiscal Management Case Study
	1345	**1415**	AP094 Distributed Low-Energy Wastewater Treatment
	1415	**1445**	AP109 Closing the Gap Between Materiel, Information and Payment Flows
	Break		
	1500	**1530**	AP114 Air and Missile Defense Beyond 2035, Air and Missile Defense Concept Development and Assessment
	1530	**1600**	AP128 Data Analytics to Improve Operationally Relevant Fuel Consumption Estimates
	1600	**1630**	AP133 From the Crescent City to the Fertile Crescent: Contingency Engineering and Base Development
	1630	**1700**	AP145 Unraveling a Gordian Knot: When Your Boss Asks You to Solve the Impossible

WG 4 – Advances in OR, Data Science, and Technology (Room 104)

	Time		WG 4-Room 104
Tuesday, 20 Oct 2020	**1245**	**1315**	AP130 Applications of DoD Supercomputers
	1315	**1345**	AP025 The Vision of the Future: Modern Data Science Techniques for Visualization
	1345	**1415**	AP136 Cost Comparison Analysis Tool for Stationing (CCATS)
	1415	**1445**	AP059 Material Identification Research with Target Identification Applications Using Infrared Polarimetric Methods
	Break		
	1500	**1530**	AP124 Effects of Weaponized Commercial Unmanned Aerial Vehicles (UAVs) on Structures, Experimental Testing Comparison to Numerical Models
	1530	**1600**	AP087 Recipe for Using R Products to Produce Ad-Hoc Tables/Reports from Ad-Hoc Data
	1600	**1630**	AP074 Using Machine Learning to Automate the Classification of Geospatial Data from Multi-Spectral Imagery
	1630	**1700**	AP077 Using NLP to Improve Situational Awareness of Tactical Communications

	Time		WG 4-Room 104
Wednesday, 21 Oct 2020	**1245**	**1315**	AP019 Applying a Reinforcement Learning Agent to a Combat Simulation
	1315	**1345**	AP098 Continuous Autonomy Simulation Test Laboratory Environment (CASTLE) Verification and Validation (V&V)
	1345	**1415**	AP079 Cost Benefit Analysis and Linear Optimization for Army Modernization Analysis
	1415	**1445**	AP107 Analytic Application Development, Delivery, and Sustainment Considerations
	Break		
	1500	**1530**	AP038 FORGE: The Future of Army Experimentation
	1530	**1600**	AP007 CCDC Command Climate Assessment Survey Text Analysis
	1600	**1630**	AP084 Development of the Next-Generation Off-Road Mobility Performance Models
	1630	**1700**	AP070 U.S. Army Performance Analytics in a Deployed Environment

	Time		WG 4-Room 104
Thursday, 22 Oct 2020	**1000**	**1030**	AP083 An Interactive Visualisation Platform for Exploring Defence Workforce Transition Scheduling Solutions
	1030	**1100**	AP008 Practical Applications of Topological Data Analysis
	1100	**1130**	AP131 Using Neural Networks to Compress Grenade Lethality Data in the Infantry Warrior Simulation (IWARS)
	1130	**1200**	AP078 DIY Dashboards

WG 5 – Manpower, Personnel and Training Analysis (Room 105)

	Time		WG 5-Room 105
Tuesday, 20 Oct 2020	**1245**	**1315**	AP116 The Impact of Two versus Three Soldier Crews in the Next Generation Combat Vehicle
	1315	**1345**	AP095 A Model for Optimising Personnel Allocation under Uncertainty
	1345	**1415**	AP137 Emerging Growth Priority Analysis
	1415	**1445**	AP113 The Future of Data Standardization and Repository: Squad Performance Model
	Break		
	1500	**1530**	AP068 The Accountability Paradox Examined: Evaluating the Effects of Accountability on Improvement in U.S. Federal Agencies
	1530	**1600**	AP127 Implementing a Data Science Capability in an Operational Command
	1600	**1630**	AP033 Estimating Ground Vehicle Fuel Consumption during Training Events
	1630	**1700**	AP020 Developing New and Practical Skills through the Training With Industry (TWI) Fellowship Program

	Time		WG 5-Room 105
Wednesday, 21 Oct 2020	**1245**	**1315**	AP039 Distributed Gap Generation and Assessment
	1315	**1345**	AP002 Implementing Verification, Validation, and Accreditation
	1345	**1415**	AP065 Self-equity as a Trustworthiness Measure: The Relationship Between Self-equity and Discharge Characterizations in U.S. Army Recruits
	1415	**1445**	AP060 Achieving the Multi-Domain Operations (MDO) Whiteboard: "Ideal" Force - A Cost Perspective
	Break		
	1500	**1530**	AP108 Using Data Science to Increase Recruitment at the Defense Language Institute
	1530	**1600**	AP114 Air and Missile Defense Beyond 2035, Air and Missile Defense Concept Development and Assessment
	1600	**1630**	AP077 Using NLP to Improve Situational Awareness of Tactical Communications
	1630	**1700**	AP125 Retention and Recruiting Data Analysis

	Time		WG 5-Room 105
Thursday, 22 Oct 2020	1000	1030	AP042 Army Officer Assignment: Using a Mixed Integer Program to Maximize Suitability while Minimizing Assignment Cost
	1030	1100	AP140 Total Army Analysis (TAA) Supporting Analysis
	1100	1130	
	1130	1200	

WG 6 – Modeling and Simulation (Room 106)

	Time		WG 6-Room 106
Tuesday, 20 Oct 2020	**1245**	**1315**	AP036 Expanding Beyond Active Defense: Broadening the Effects of Program-level Capabilities in Force-on-force Level Modeling
	1315	**1345**	AP102 Rapid Development of New Model to Quickly Evaluate Air Defense Battery Effectiveness. (Air Defense Raid Analysis Tool (ADRAT) Development, Using Python, and Employment)
	1345	**1415**	AP118 Modeling Army Layered Air and Missile Defense (AMD)
	1415	**1445**	AP037 Force-on-Force Modeling of High Energy Lasers
	Break		
	1500	**1530**	AP073 Likelihood Ratio Test on V50 with Multiple Factors
	1530	**1600**	AP035 Capabilities-Based Teaming Analysis
	1600	**1630**	AP021 Modernized Compartment Methodology - A Vulnerability/Analysis Tool for Early Concepts
	1630	**1700**	AP031 Uncertainty Quantification and Sensitivity Analysis Methodology for the Advanced Joint Effectiveness Model (AJEM)

	Time		WG 6-Room 106
Wednesday, 21 Oct 2020	**1245**	**1315**	AP105 Component Error Representation of Sensor Target Location Errors (TLEs)
	1315	**1345**	AP048 Dagger Mission Mapping & Modeling Tool (DM3T) Development for PM PNT
	1345	**1415**	AP082 RCS Averaged Values
	1415	**1445**	AP051 Analysis of the Effect of Imaging Sensor Configuration on Urban Situational Awareness
	Break		
	1500	**1530**	AP072 A Framework to Assess Detection and Defeat Capabilities Against UAS Intrusions
	1530	**1600**	AP124 Effects of Weaponized Commercial Unmanned Aerial Vehicles (UAVs) on Structures, Experimental Testing Comparison to Numerical Models
	1600	**1630**	AP080 Expanding Your Aperture to Explore and Leverage Emerging Technologies
	1630	**1700**	AP138 Sustainment Transportation Energy Assessment Model (STEAM)

	Time		WG 6-Room 106
Thursday, 22 Oct 2020	**1000**	**1030**	AP098 Continuous Autonomy Simulation Test Laboratory Environment (CASTLE) Verification and Validation
	1030	**1100**	AP003 Tactical Internet SIMulation (TISIM) for Rapid Performance Analysis of Heterogeneous Large-Scale Tactical Communication Networks
	1100	**1130**	AP006 Simplified SIGINT Performance Model
	1130	**1200**	AP017 Adding Communication Realism into One Semi-Automated Force (OneSAF)
	Lunch		
	1245	**1315**	AP015 Route Specific Fuel Consumption and Application to Vignettes within the Hybrid Military Vehicle Component Simulation (HMVCS) Model
	1315	**1345**	AP120 Modeling Timing Error Impacts on Operational Capability
	1345	**1415**	AP058 AiTR in Closed Form Simulations: A First Look
	1415	**1445**	AP004 Limiting Runs for Computing Probability Estimates from Computationally Intense Models
	Break		
	1500	**1530**	AP141 Blending Human-in-the-Loop and Constructive OneSAF Simulation Modeling to Support Maneuver Force Modernization During the COVID-19 Pandemic
	1530	**1600**	AP047 Exercise VIRTUAL EAGLE: an Armoured Infantry Battlegroup Experiment
	1600	**1630**	AP140 Total Army Analysis (TAA) Supporting Analysis
	1630	**1700**	AP142 Theater Focused Forces (TFF) Analysis

	Time		WG 6-Room 106
Friday, 23 Oct 2020	**1000**	**1030**	AP030 Data Development Process for Modeling, Simulating, and Assessing Competition and Penetration
	1030	**1100**	AP090 Modeling, Simulating, and Assessing Competition and Penetration
	1100	**1130**	AP128 Data Analytics to Improve Operationally Relevant Fuel Consumption Estimates
	1130	**1200**	AP101 Development of Geo-Typical Urban Terrain Templates for Network Analysis
	Lunch		
	1245	**1315**	AP067 Human Anatomy Representations for US Army M&S
	1315	**1345**	AP100 Human Dynamics Analysis: Using Modeling to Build Resilience in Planning and Operations
	1345	**1415**	AP123 Numerical Modeling of Vehicle Barriers to Develop Calculation Analysis Methods
	1415	**1445**	AP110 Introduction to Artificial Intelligence

WG 6 – Modeling and Simulation (Room 101)

	Time		WG 6-Room 101
Thursday, 22 Oct 2020	1500	1530	
	1530	1600	
	1600	1630	AP153 Australian Simulation Study Process for Exploring Future Military Concepts and Capabilities
	1630	1700	AP152 Common Pitfalls in the Design and Analysis of Simulation Experiments

	Time		WG 6-Room 101
Friday, 23 Oct 2020	**1000**	**1030**	AP099 Simulation System Requirements and Assessment Tools for Software in Loop Testing of Autonomous Systems
	1030	**1100**	AP016 COVID-19 9th Hospital Analytic Support
	1100	**1130**	AP002 Implementing Verification, Validation, and Accreditation
	1130	**1200**	AP022 Autonomous Systems Test Capability (ASTC) Verification and Validation (V&V)
	Lunch		
	1245	**1315**	AP132 Measuring and Predicting Soldier Performance, Lethality, and Resilience Through Soldier-Systems Modeling
	1315	**1345**	AP084 Development of the Next-Generation Off-Road Mobility Performance Models
	1345	**1415**	
	1415	**1445**	

WG 7 – Cyber Electromagnetic Activities Analysis (Room 103)

	Time		WG 7-Room103
Thursday, 22 Oct 2020	**1245**	**1315**	AP028 Challenges and Insights from Developing an Analytical Baseline for Installation-Level Enterprise IT
	1315	**1345**	AP052 Framework to Analyze Cyber Information Warfare Operations
	1345	**1415**	AP120 Modeling Timing Error Impacts on Operational Capability
	1415	**1445**	AP114 Air and Missile Defense Beyond 2035, Air and Missile Defense Concept Development and Assessment
	Break		
	1500	**1530**	AP026 Distinguishing Between User Generated and Automatic Network Flows
	1530	**1600**	AP061 Developing Outside the Box: Balancing Trade-offs in a Constrained Operational Environment
	1600	**1630**	AP064 A Comparison of the Effectiveness of Deep Learning Models in Predicting Network Performance
	1630	**1700**	AP106 Insider Threat Anomaly Detection on Network Traffic

WG 8 – Wargaming (Room 107)

	Time		WG 8-Room 107
Tuesday, 20 Oct	1245	1315	AP082 RCS Averaged Values
	1315	1345	AP135 DAWN Rising: Distributed Wargaming and Analysis for Force Design
	1345	1415	AP018 Data Collection for a Distributed Capstone Wargame Series
	1415	1445	AP080 Expanding Your Aperture to Explore and Leverage Emerging Technologies
	Break		
	1500	1530	AP156 Analog vs. Digital: Logistics Wargaming Lessons Learned from the JETS Experience
	1530	1600	
	1600	1630	
	1630	1700	

WG 9 – Multi-Domain Operations (Room 101)

	Time		WG 9-Room 101
Wednesday, 21 Oct 2020	**1245**	**1315**	AP057 Resource and Risk Informed Modernization: Analysis to Create the 2028 AimPoint Force
	1315	**1345**	AP097 Strategic Fires Study (SFS): Fast-track Toward Army Modernization
	1345	**1415**	AP077 Using NLP to Improve Situational Awareness of Tactical Communications
	1415	**1445**	AP068 The Accountability Paradox Examined: Evaluating the Effects of Accountability on Improvement in U.S. Federal Agencies
	Break		
	1500	**1530**	AP117 A Distributed Intelligence Framework for Cyber and Electromagnetic Technologies to Support Expeditionary Cyber as a Sociotechnical Challenge
	1530	**1600**	AP027 Assessing U.S. Army Formations Enabling Multi-Domain Operations (MDO)
	1600	**1630**	AP126 Tactical Intelligence Targeting Access Node: Analysis of Alternatives
	1630	**1700**	AP114 Air and Missile Defense Beyond 2035, Air and Missile Defense Concept Development and Assessment

	Time		WG 9-Room 101
Thursday, 22 Oct 2020	1000	1030	AP118 Modeling Army Layered Air and Missile Defense (AMD)
	1030	1100	AP081 Assessing Project Convergence: AFC's Integrated Data Analysis Effort of an Artificial Intelligence (AI)-enabled Battlespace
	1100	1130	
	1130	1200	

WG 10 – Pandemic Response Analysis (Room 107)

	Time		WG 10-Room 107
Wednesday, 21 Oct 2020	1245	1315	AP121 A Hybrid Approach to COVID-19 Prediction Using Machine Learning and Poisson Regression
	1315	1345	AP115 Analytical Support to the Commanding General's COVID Messaging
	1345	1415	AP029 Development and Deployment of the ERDC SEIR COVID-19 Model
	1415	1445	AP050 COVID-19 Analyses within an Organic Industrial Base
	Break		
	1500	1530	AP039 Distributed Gap Generation and Assessment
	1530	1600	AP016 COVID-19 9th Hospital Analytic Support
	1600	1630	AP103 Assessing Effectiveness of Command Messaging During a Pandemic
	1630	1700	AP044 Bioprotection of Facilities from SARS-CoV-2 (COVID-19)

	Time		WG 10-Room 107
Thursday, 22 Oct 2020	1000	1030	AP034 The SEIR Model to Project the Spread of SARS-CoV-2
	1030	1100	AP134 Challenges Executing Verification and Validation for COVID-19 Modeling
	1100	1130	AP122 COVID Modeling at Center for Army Analysis and Estimating the Effective Basic Reproduction Rate (R0)
	1130	1200	AP129 Building Tools for a Flexible and Scalable COVID Model in R
	Lunch		
	1245	1315	AP076 How Long is a Person Contagious with COVID-19?
	1315	1345	AP055 Modeling with Noise in the Data – Examples, Effects, and Solutions
	1345	1415	AP063 Implementing Scrum Project Management Methodology to Manage COVID-19 Modeling
	1415	1445	AP151 The Army COVID-19 Model for Epidemics: A tool for Medical Treatment Facility Pandemic Response

Abstracts

AP001:
How Accuracy Requirements Create Weapon Effectiveness

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Working Groups: WG2

System requirements documents typically specify weapon accuracy using a combination of two different methods. The first specification is group size measured at a specific range from a test stand. The second specification is probability of hitting a specific target at a specific range measured in a representative system test. The first is a measure of the mechanical accuracy of the weapon. The second is a measure of the accuracy of the system but may also include human factors and some environmental effects. New systems are generally expected to perform as well or better in both these measures compared to the systems they are replacing.

A sensitivity analysis performed by the CCDC DAC Soldier and Small Arms Team shows how these two requirements interrelate. More significantly, this analysis shows that improving the mechanical accuracy of a system may alter the system's resulting probability of hit in ways which are counterintuitive for some types of weapons systems. This informs requirements development. It also informs operational behavior for the employment of some weapons.

AP002:
Implementing Verification, Validation, and Accreditation

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Capability Developers at the National Simulation Center conduct validation on simulation solutions that Materiel Developers field for training exercises and military operations. Their validation activities include involvement with verification and accreditation activities. Operations Research Analysts at the National Simulation Center team with Capability Developers to inform validation by testing the solutions.

This presentation will describe the end-to-end process, scope, methodologies, and techniques used by Operations Research Analysts at the National Simulation Center. The description will emphasize how the testing is conducted and how the testing integrates with verification, validation, and accreditation. The description will also include observations on principles transferable to implementing verification, validation, and accreditation in other situations.

AP003:
Tactical Internet SIMulation (TISIM) for Rapid Performance Analysis of Heterogeneous Large-Scale Tactical Communication Networks

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TISIM (Tactical Internet SIMulation) is a rapid large-scale heterogeneous network modeling & simulation (M&S) capability that gives the U.S. Army Combat Capabilities Development Command Data and Analysis Center (CCDC DAC) the ability to quickly and efficiently, analyze large-scale Army communication networks early in the acquisition and/or network architecture design cycles, when high-fidelity contractor models are either: A. not readily available; B. not obtainable due to intellectual property restrictions; or C. simply not scalable due to prohibitively large memory and/or CPU processing requirements. In that regard, TISIM is very well-suited for quick-turnaround M&S studies of large-scale heterogeneous networks due to its: A. modular design; B. minimum memory and processing power requirements; and C. minimum configuration time.

TISIM is an integrated suite of multiple medium-fidelity, rapidly configurable military waveform models, and multiple commercially available, standard transport, routing and Medium Access Control (MAC) protocol models developed by the "contractor" Riverbed; it utilizes a set of data inputs comprising: A. the node mobility patterns super-imposed over a preselected terrain as a function of time, i.e., the scenario; B. the network channel, subnet and routing architectures; C. the time-scripted aggregate network traffic profile; and D. the tunable design/behavior parameters of each individual network protocol and radio/waveform that is part of the integrated network being analyzed.

TISIM's primary data outputs include message completion rate (MCR) and delay statistics for: A. end-to-end (ETE) time-scripted application layer messages; B. mission-threaded messages; and C. subnet layer (IP) datagrams; as well as, various statistics on packet queue drops, routing and subnet utilization. The outputs produced by the TISIM give the U.S. Army networking community valuable insight into assessing/quantifying the integrated network's capacity, scalability, reliability and resiliency.

AP004:
Limiting Runs for Computing Probability Estimates from Computationally Intense Models

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Computing probability estimates in a complex model with stochastic logic has challenges with respect to the nature of the underlying distribution, which in our effort is assumed to be binomial. We use a highly complex and computationally intense model to estimate probabilities of multiple

outcomes conditioned on engagement scenarios and using thousands or even millions of iterations. Because of the amount of computation time needed, and the increasing use of the model, limiting the number of iterations is important. From a binomial perspective we have a response range on (0,1), but our model response range includes the interval endpoints and thus is [0,1]. It is the endpoints of zero and one that provide those challenges. Using a fixed value as a requirement or a relative requirement is an oversimplified approach to a conditional problem. This presentation details a hybrid approach to provide a user-customizable solution.

AP006:
Simplified SIGINT Performance Model

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The CCDC (Combat Capabilities Development Command) Data and Analysis Center (DAC) requires a model that can estimate the performance of Signals Intelligence (SIGINT) sensors when they attempt to determine the location of a Radio Frequency (RF) emitter. We would like the model to be broad enough that it can be used to model the performance of SIGINT systems using Angle of Arrival (AoA), Time Difference of Arrival (TDOA), and/or Frequency Difference of Arrival (FDOA) to determine the location of the emitter even if the emitter happens to be moving. We have developed a model that uses computation optimization to map out how uncertainties in each input variable can affect the total uncertainty in finding the target. The model is simple enough that it can be used to determine the total uncertainty in finding the location of the target for SIGINT systems no matter what type of algorithm they are using. In the future, we could even expand our model to estimate the performance of other sensors that are used for Positioning Navigation and Timing (PNT.)

AP007:
CCDC Command Climate Assessment Survey Text Analysis

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The Defense Organizational Climate Survey (DEOCS) is an annual survey administered by Defense Equal Opportunity Management Institute (DEOMI). The survey consists of Likert scale questions and open-text questions and sections. The DEOCS survey provides Commands with a report to address areas for improvement regarding their workforce based on their survey results. This report analyzes the Likert scale questions and provides the text-responses to several free-text questions, but includes no analysis of text responses. The Combat Capabilities Development Command (CCDC) Headquarters (HQ) requested data scientists from the CCDC Data and Analysis Center conduct an analysis of the free-text responses for all Centers and ARL to extract additional insight.

DAC used text analysis methodologies such as word frequency analysis, sentiment analysis, and topic analysis to perform an exploratory analysis of the text responses. The approach to the analysis focused on whether or not the responses were favorable or unfavorable and identifying the most common themes present in the responses.

All of the analysis was conducted using the Python programming language and its open-source data analytics libraries. The sentiment analysis included both a Lexicon-based approach (VADER lexicon) and a machine learning based approach (multi-class classification models). The topic analysis was conducted using the Latent Dirichlet Allocation (LDA) topic clustering model. A communications expert analyzed the topic clusters from the LDA model and developed refined themes for the most common topics.

The results of the analysis for each question included a word-cloud based on the most common words, the number of positive, neutral, negative responses produced from the sentiment analysis, and the most common themes identified from the topic analysis. The results from the text analysis will be used in conjunction with the Likert scale results to inform the Command on areas of improvements for which IPTs and focus groups will be formed to address.

This presentation will contain CCA survey background, response statistics, a detailed look at the text analysis methodologies used, lessons learned and the way-ahead for future analyses.

AP008:
Practical Applications of Topological Data Analysis

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Topological Data Analysis (TDA) is a growing area of Mathematics that uses fundamental concepts of Topology to analyze complex high dimensional data. The data is represented by a topological network and TDA uses the network to look at the shape of the data to identify features in the network which correspond to patterns in the data. These patterns are extracting knowledge from the data. TDA provides a framework to advance machine learning in order to understand and analyze large complex data. This presentation provides background information and real-world examples using TDA.

AP011:
Resilient Telecommunications Systems

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The ISER (Institute for Systems Engineering Research) team conducted a background study of relevant existing ERDC and government solutions to integrate with a systems engineering perspective in order to identify and mitigate strategic issues and challenges related to the impact of hurricanes to support resilient telecommunication systems. The research focused on technical and strategic issues related to modeling the effects of hurricanes on the federal emergency telecommunications. Insights from modeling and simulation of resilient infrastructure for telecommunication systems provide a path forward to weigh investments in preparation for future disasters. Furthermore, modeling can help decision makers to make strategic decisions on how

and where to commit given resources available in response to a disaster. This presentation provides an overview of findings from recent background research and model integration efforts.

AP012:
The Four Generations Model of Innovation

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The Four Generations Model of Innovation builds upon Christianson's "Three S-Curves Model" [1], and Baghai, Coley and White's "Three Horizons Model" [2], by adding 2 missing components: The Barrier to Innovation and the Fourth Generation of Innovation. Christianson's Three S-curves model discusses current generation, the next generation, and the generation after next. It emphasizes the progression of technologies within a well-defined business (such as the progression of CPU improvements in the computer industry). Baghai, Coley and White's Three Horizons Model (The McKinsey Model) also discusses generations and serves as the basis of the 70-20-10 rule for effort allocation at Google. Neither explicitly calls out the 10X principal used by Venture Capitalists (VCs) in Silicon Valley, and large industries such as Intel, nor what lies beyond. As a result, Program Managers (PMs) using these existing models focus on technology investments that provide incremental and sustaining improvements. The Four Generations model adds a "Barrier to Innovation" defined as a system improvement that incorporates two or more of the following from either a technical or business strategy approach: a 10X or greater improvement in performance in some important dimension over the base system currently in use (reusable rockets for space launch); a significant technical or managerial improvement that causes a large change in market behavior; a new industry (such as the first cell phone); a significant difficulty barrier to reproduction by the competition ("A Secret Sauce"); replaces an existing standard; or solves a hard problem (an existing, long standing, intractable, technical or business problem). The Fourth Generation is the result of surpassing these performance barriers allowing competition free trade spaces from which to conduct future business using a entirely new game, or new rules to the current game. Developing a model within these four generations establishes a space for PMs to focus on advances that can potentially replace their current line of effort and in turn allowing them to remain competitive. This brief will highlight a use case that sets the foundation for focused technical hunting that supports such a strategy.

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2. Baghai, Mehrdad & Coley, Stephen & White, David, The Alchemy of Growth: Practical Insights for Building the Enduring Enterprise, McKinsey & Co., Basic Books, 1999, pp. 4-7

AP013:
In Search of 10X: Hunting Unicorns and Innovation for Future Battlefields

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The pursuit of identifying emerging innovation to meet the needs of of a strategy has long been one with many difficulties. Chief among these is how does one winnow the thousands of potential

solutions in the Innovation pipeline to focus in on only those few that may meet the goals of that strategy? Both the Federal government and commercial entities (such as Venture Capitalists (VCs)) share much of the same problem set. In the federal community, the focus is on technologies that offer a 10 times better technical capability (10X) than the prior technology (sometimes known as Offsets). In the VC community, they are solely focused on a 10X return on their investment, but have a less than a 1-in-10 success rate of identifying a 10X technology, they consider it a “Holy Grail” [1] to make technology investment selections even a small percentage better than. Both seek 10X, but in different domains. With similar success rates for "picking winners", can their 10X goals in these domains be linked to develop a common framework that supports both their needs? Ismail, Michael and Diamandis in their 2014 book, “Exponential Organizations”, provide that linkage in observing that 10X technologies have a ”strong correlation” to 10X valuations (VC "Unicorns") [2]. With this observation it becomes possible to link the two and develop a set of tools to identify 10X technologies based that are better able to provide the required 10X payoff. This presentation builds upon the earlier presentation “In Search of 10X: The Four Generations Model of Innovation” [3] to demonstrate a set of tools developed for actively hunting technology pre-investment to identifying those few technologies that are both aligned to a strategic need and have the potential for creating a 10X capability improvement ("Revolutionary"). These tools are applied to a time sensitive use case (a need), that of reducing globally sent compressed streaming digital video latency for pro drone racing teleoperation today, contrasted against the reported latencies for the Predator UAS of 2012 (the use case baseline), to illustrate the process.

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3. Buchter, Richard M., In Search of 10X: The Four Generations Model of Innovation, 2020 Army Operational Research Symposium (AORS), October 20-22, 2020

AP014:
Bayesian Network Modelling for Military Utility Assessment of Direct Energy Weapon within Future Tactical Land Warfare

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Defence Science and Technology Group (DST) is investigating future concepts of use (CONUSE) and operational characteristics of Directed-Energy Weapons (DEW) within tactical land warfare with a view to inform decisions on priority areas for further investment in DEW technologies. In this paper, we focus on the application of High-Energy Laser (HEL) and High Power Radio Frequency (HPRF) weapons within a future combat team. CONUSE, which we define as novel operational applications of specific technologies, were developed by a previous study and include

options such as: large, medium and small HPRF, HPRF Active Denial; high, medium and low power HEL, HEL retro and HEL UAV etc.
Using a combination of Bayesian Network Modelling (BNM), Multi-Criteria Decision Analysis (MCDA) and Multi-Objective Evolutionary Algorithms (MOEA), we have developed a quantitative approach for the Military Utility Assessment (MUA) of DEW technologies for future combat teams. In this context, we define MUA to be the evaluation of the relative contribution that DEW technologies contribute to the effectiveness of the future combat team across a relevant scenario space. BNM is employed to model the probabilistic effects of blue force DEW technology options and CONUSE on red force fighting capability and to estimate MUA for each DEW technology/CONUSE option or combinations thereof. The military utilities considered in this paper are based on the operational effectiveness metrics of the combat team such as: mission success, survivability, lethality, discrimination and operational cost. MCDA techniques are employed to aggregate multiple utilities based on the elicited Decision Makers (DMs) preferences. Finally, DEW options are ranked and prioritised by maximised expected utility and aggregated utilities. Moreover, MOEA is adopted to remove the subjectivity of the elicitation process in quantifying DMs' preferences, and to heuristically search for the 'best' combination of DEW/CONUSE options.

AP015:
Route Specific Fuel Consumption and Application to Vignettes within the Hybrid Military Vehicle Component Simulation (HMVCS) Model

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CCDC DAC is leveraging geospatial road network information and the Fuel Consumption Prediction Model (FCPM) to mitigate planning factor fuel consumption limitations. For years military planners have relied on sustainment-based planning factor estimates. These planning factors are, by design, general enough to address world-wide operations, but insufficient for specific areas of operation. The gap between geospecific fuel consumption and planning factor estimates was analytically assessed during a 2018 OSD-sponsored Capability Improvement Fund analysis. The study utilized on-board fuel consumption measurements recorded during road missions. In some cases, the fuel consumed was more than 80% of the fuel estimated by the planning factor method.

In order to illuminate the gap, CCDC DAC used geospecific road network information, as input into FCPM, to generate color coded road network maps highlighting the magnitude of the delta between the two estimates. The georeferenced maps capture the difference between planning factors and FCPM fuel estimates based on geospatial information from relevant theater of operations (e.g., Europe). The planning factor-based estimates are limited in their capability to accurately estimate fuel consumption. This level of fidelity is necessary to support the highly distributed / non-linear sustainment capability necessary to support MDO conducted over vast distances. CCDC DAC will continue to develop this capability and attempt to integrate the geospecific planning factors into pre-existing military planning tools. In addition, this developmental process will lead to wargame community support by highlighting MDO sustainment challenges within scenario vignettes.

In collaboration with the development of route specific fuel consumption estimates, CCDC DAC is developing the HMVCS model. In order to support Army modernization efforts, a tool capable of assessing fuel and energy requirements across various platforms (e.g., ground, air, Soldier) is necessary to supplement existing analytical tools. HVMVS attempts to fill this gap through the utilization of a physics-based, high-fidelity component-level model that can provide route-specific fuel consumption estimates across operationally relevant vignettes.

AP016:
COVID-19 9th Hospital Analytic Support

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Corona Virus Disease 2019 (COVID-19) was declared a pandemic by the World Health Organization on 11 March 2020, prompting mass social distancing and worldwide self-isolation efforts to slow the rate of transmission. The 9th Hospital 1st Medical Brigade deployed to the Javits Convention Center in New York City, NY, to temporarily reduce the anticipated burden of a surge of COVID-19 patients on area hospitals. The Research and Analysis Center (TRAC) was asked to provide analysis to uncover broad/reuseable findings that would aid the mission in New York City and inform future deployments.

TRAC's team created a digital twin model in ProModel to analyze the effects on patient discharge/intake rates by varying the number of intake bays, patient-staff ratios, and addressing supply chain management issues. A linear programming (LP) model was also developed to optimize staff composition and work/rest schedule for the personnel manning the intake process.

This presentation will discuss the insights gained through analysis of simulation output, the study methodology, associated limitations pertaining to modeling results, and subsequent TRAC recommendations to the 9th Hospital for future deployments.

AP017:
Adding Communication Realism into One Semi-Automated Force (OneSAF)

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One Semi-Automated Force (OneSAF) is a computer-generated forces simulation that provides entity-level models and behaviors. Although OneSAF plays the movement of the forces and their operational capability in high detail, it does not represent the realistic capabilities and limits of the network transport systems. OneSAF currently assumes perfect communication between battlefield platforms; however, the actual connectivity between units in the Brigade Combat Team (BCT) is not guaranteed. Dependent on the terrain, distance, unit movement, electronic warfare threats, etc., each communication system has different link tolerance levels and limits that could affects the overall connectivity of the whole network. Soldiers and systems could behave differently based on the percentage of intended communication information is received. Not accounting for communication realism in OneSAF can result in modeling outcomes and decisions that are not based on the performance and capability of the actual communication systems used in the forces.

The U.S. Army Combat Capabilities Development Command Data and Analysis Center (CCDC DAC) is developing a methodology to determine whether platforms that have the need to communicate during a scenario are able to connect across the network and thus exchange information. This ability to connect will be based on a number of factors, which include the terrain; the radio and antenna equipment and receiver capabilities; the network architecture; and routing rules and the presence of jammers. The methodology will also determine a rough estimate of message delay between sources and destinations of information based on capacity of the transport system in use. This new capability will be an extension to OneSAF and implemented as a web service application to allow remote access.

AP018:
Data Collection for a Distributed Capstone Wargame Series

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As part of the Army Futures Command's (AFC) Top-Down Futures Development Process, The Research and Analysis Center (TRAC) is responsible for conducting an annual capstone wargame to analyze the key concepts and modernization capability priorities. The 2020 Capstone Wargames will include two coordinated wargaming efforts: one set in the European Command operational environment and one set in the Indo-Pacific Command operational environment.

TRAC will conduct 2020 Capstone Wargames to assess the effectiveness of key AFC's science and technology investments, and the suitability of the force package designs and calibrated force postures to inform Army modernization efforts. Since wargames rely critically on the interaction between participants, these wargames are historically conducted onsite, in a face-to-face setting. However, due to the Department of Defense's COVID-19 stop movement order, TRAC has planned to conduct these wargames in a distributed setting where some of the participants will be linked in from remote sites. To mitigate data collection challenges presented by the distributed environment, the TRAC team developed a data collection management plan leveraging a suite of tools hosted in a cloud-computing environment. This will enable event participants and observers/analysts to share information, collect data, and establish real-time trends across different geolocation sites. The team will also use a family of data analysis tools to analyze responses of the observed wargame events, and to establish near real-time trends. Finally, the team will build a machine learning model to process the collected text responses. This will help shorten the data analysis time and enable the study team to deliver emerging insights and findings in a timely manner.

This presentation will cover the challenges presented to the data collection team and the innovative approach the team used to overcome the challenges.

AP019:
Applying a Reinforcement Learning Agent to a Combat Simulation

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The Department of Defense makes use of combat simulations of various resolutions to support training and analysis use cases. The development of courses of action in this setting is still a manual process and the analysis of multiple courses of action can be time intensive. This multi-year project by The Research and Analysis Center (TRAC) seeks to integrate a reinforcement learning agent into a combat simulation and to train that agent to develop an optimal policy for creating courses of action given a scenario, friendly assets, and enemy disposition. This presentation will provide a summary of the progress to date to include an overview of reinforcement learning, the selection of an appropriate combat simulation, current progress, integration of reinforcement learning agents with the Versatile Assessment and Simulation Tool (VAST), lessons learned, and future work.

AP020:
Developing New and Practical Skills through the Training With Industry (TWI) Fellowship Program

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An ORSA should be a problem solver first and foremost. We are entrusted with taking on the big / wicked / complex problems that have not been able to get resolved in other ways. A key component to our ability to solve these problems is our training and education. This paper focuses on supplemental techniques to develop skills in new domains, or deepen our skillsets outside the traditional academic environment.

Most of us in the ORSA community did not begin our professional lives as ORSA's. We may have received some of the underlying ORSA-related education during our undergraduate years, but then spent several years doing non-ORSA work. At some point many of us decided to make a career change, and went back to school to earn a Master's or PHD with the intent of learning a new set of skills to prepare for the life of an ORSA. Upon completion of our time in academia many of us went to work in the hopes of applying these newly honed set of skills. For many reasons this process falls short of providing us with the skills we were looking to achieve. Some of these reasons are the curriculum at a particular institution may have obsolete material, the material is not well synchronized in the overall program, the follow-on assignments do not match with the recently attained education, there are limited practical applications given during the instruction, etc. Relying on traditional academic paths may not be enough to equip us to solve problems of today and tomorrow effectively.

I just completed my year-long Training With Industry (TWI) fellowship with Amazon Web Services (AWS), and believe this experience is something that would benefit many ORSA's to improve their set of analytic skills. TWI has been around for a long time, but recent changes to the Army's

promotion process have opened the window for us to take advantage of the opportunity. TWI is one-year where you live and work in a large commercial organization learning new culture and skills, and seeing the practical applications used for decision making, and problem solving. I will share my insights working with AWS, how the Army can benefit from adopting their ways, and opinions on how to enhance the overall experience. Lastly, online learning has been with us for a while, but Amazon's approach to developing their workforce, and their customer's workforce is a model for a future Army hoping to upskill our existing workforce.

AP021:
Modernized Compartment Methodology - A Vulnerability/Analysis Tool for Early Concepts

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A cross functional team consisting of analysts, engineers, target describers, and software developers worked to develop a methodology to conduct vulnerability/lethality (V/L) analyses by using existing Advanced Joint Effectiveness Model (AJEM) V/L results data to predict vehicle loss of function (LOF). In the past, this methodology was referred to as compartment modeling. As opposed to defining individual components, assigning probability of kill (pk) at the component level, and then rolling each component's pk up into a top-level LOF, the compartment methodology separated the target into a handful of compartments and used test data from other vehicle systems to define V/L results of a new or concept vehicle. The compartment methodology has not been used recently and a vast amount of V/L data for various systems has been generated since then. The modernization of the original compartment methodology has led to reduced analysis timelines than a traditional AJEM V/L analysis yields, and does not always require AJEM processing to achieve vulnerability estimates. It provides a method for developing V/L data for concept vehicles and/or vehicles where detailed component-level information is not available. This modernized methodology has been used in the Armored Reconnaissance Vehicle (ARV) analysis of alternatives (AOA) and the Optionally Manned Fighting Vehicle (OMFV) AOA. It will be used to support the Milestone C decision for Mobile Protected Fire (MPF) in FY20.

AP022:
Autonomous Systems Test Capability (ASTC) Verification and Validation (V&V)

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Working Groups: WG2, WG6

Autonomous ground vehicle platforms are a requirement for future combat; however, no holistic capability currently exists to build trust in the battlefield decision-making of these systems. The Army Test and Evaluation Command (ATEC) is leading the development of such a capability: to construct a federation of software platforms that allows a physical copy of an autonomous vehicle's decision-making hardware and software to be connected to a virtual environment, thus allowing thousands or millions of simulation replications under widely varied conditions to be studied in an attempt to build trust. This capability is called the Autonomous Systems Test Capability (ASTC).

The Combat Capabilities Development Command Data and Analysis Center (CCDC DAC) has been asked to verify and validate the ASTC. This presentation will address the challenges of verifying a capability with numerous integrated software components (e.g. environmental model, vehicle dynamics model, numerous sensor models, etc.) with constantly evolving software. This software environment is then coupled to an autonomous decision-making platform which is also dynamically updating itself. This presentation will also detail the approaches and methodologies that DAC and its partners are applying to overcome these challenges. Finally, this presentation introduces the scope of the larger DoD autonomous ground vehicles effort and discusses DAC's role within it.

AP025:
The Vision of the Future: Modern Data Science Techniques for Visualization

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The Vision of the Future: Modern Data Science Techniques for Visualization

Many Data Science methods are far more powerful and accurate than regression. However, they are often not used because they are “black boxes”. That is, they do not allow for an easy interpretation of the impact of each predictor on the outcome. If you would like to go beyond regression, but need to understand the impact of the predictors, this presentation is for you. It turns out, in the past few years, new and powerful ways to visually represent the impact of the predictors on the outcome have been developed. These allow you to use Data Science techniques much more powerful and accurate than regression without losing the ability to visualize and interpret the impact of the predictor variables. This presentation will give a brief introduction to these simple, yet powerful visualization techniques.

Note: All data, concepts, and topics in this presentation will be public domain or simulated.

AP026:
Distinguishing Between User Generated and Automatic Network Flows

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User activity/behavior analysis is an important component in defending Army networks against Insider Threats. Network flow metadata (e.g. Netflow) can be a valuable resource in evaluating network behaviors; it is compact (relative to network packet data), unaffected by data encryption, easily generated and it enables analysis without creating significant user privacy issues. Complicating the evaluation of user behaviors with this resource is the difficulty in distinguishing flows generated by the actions of users from those generated automatically by their computers. Computers automatically create connections to access updates (software, mail, anti-virus signatures, etc.), find network resources and maintain state (time, network connectivity, etc.). We labeled flow meta-data based on scripted computer activities to identify features characteristic of automatic network flows. Using these features we then evaluated flow data extracted from a

campus network, to determine if we could differentiate user generated and automatic flows in unlabeled network traffic.

AP027:
Assessing U.S. Army Formations Enabling Multi-Domain Operations (MDO)

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The MDO capable 2028 force design will either change how units across the Army fight or generate new requirements to provide a full range of capabilities enhancing the Joint Force commander's ability to achieve overmatch in an MDO operational environment. Such unit changes may require adjustments to existing formations, creation or divestment of formations, and/or changes to how formations operate.

The Research and Analysis Center (TRAC) Forward Division, located at Fort Bliss, TX, is in direct support to U.S. Army Joint Modernization Command and is developing a standardized analytic approach to examine new operational concepts, organizational designs and capability sets, (O&O concepts), for formations participating in annual Joint Warfighting Assessment (JWA) events. An O&O concept describes a specific organization (generally brigade-sized and above) and how it functions operationally to achieve the organization's warfighting mission, and also identifies manning and equipment requirements. These O&O concepts, several in near-simultaneous development, will require rapid operational assessments within the scope and limitations of other JWA analytic and event objectives.

This presentation will address the background and development of an assessment framework that can be applied to an O&O concept and how the analysis results will inform Force Design Updates and Total Army Analysis processes as well as support experimentation, wargaming, and other assessments across U.S. Army Futures Command.

AP028:
Challenges and Insights from Developing an Analytical Baseline for Installation-Level Enterprise IT

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This presentation highlights current challenges with developing a comprehensive and coherent baseline of enterprise information technology services at U.S. Army installations. While many monitoring systems and mandatory reporting structures exist at various echelons, these tend to be largely fragmented and desynchronized in the data they contain and the questions they attempt to answer. The diversity of services, functions, and systems across the Army installation ecosystem also creates unique challenges in the ability to form a standard approach. The initiation of the Enterprise IT as a Service (EITaaS) Pilot by U.S. Army Cyber Command (ARCYBER) and Program Executive Office Enterprise Information Systems (PEO-EIS) to explore alternative acquisition models for installation-level IT infrastructure created the requirement to effectively define the baseline for use in future comparisons of effectiveness and cost.

The author provides an overview of the work of the assessments team in identifying existing technical data sources and assessing their value in providing insights to the baseline. The use of non-technical user experience (UX) metrics is also discussed, including the effectiveness of survey instruments to gather data on both system usage and sentiment. The importance of inter-service collaboration is highlighted, along with the challenge of addressing the needs and requirements of a wide variety of stakeholders.

This ongoing work provides insight into challenges faced by the Operations Research community when conducting assessments. It also seeks to inform the efforts of Cyber Communities of Practice as they begin to address the recommendation of the Cyber Solarium Commission to define DoD-wide reporting metrics.

AP029:
Development and Deployment of the ERDC SEIR COVID-19 Model

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The Army Corps of Engineers has been actively deploying scarce resources to combat the spread of the COVID-19 virus and protect the citizens and interests of the United States. Effective allocation of available resources requires accurate forecasting of the pandemic spread. In response to this need, the U.S. Army Corps of Engineers (USACE) Engineer Research and Development Center (ERDC) developed and deployed the ERDC SEIR model. This widely used compartmental model partitions a population into Susceptible, Exposed, Infected, and Removed (SEIR) categories with cross-categories transfer dynamics. Several novel developments were integrated in the model to specifically capture unique features of the COVID-19 outbreak and policy needs. These innovations include the ability to account for both unreported and reported infections, and the movement of portions of the population in and out of isolation in response to changes in both public policy and the outbreak itself. In addition, advanced calibration algorithms were implemented to determine model parameters and allow daily updates for predicting time series for emerging infections. Forecasts from the ERDC SEIR are further improved by the inclusion of parametric uncertainties calculated using Bayesian calibration, an essential capability for assuring confidence in decision makers' ability to use model for policy decision making. The ERDC SEIR takes advantage of the HPC resources housed at ERDC-ITL and a host of automated processes developed by the ERDC modeling team to provide daily forecasts of every U.S. State plus D.C., as well as an increasing selection of U.S. metropolitan areas. These forecasts include projections and uncertainty bounds for reported infections, hospitalizations, and fatalities. Results from the ERDC SEIR are delivered to the USACE Common Operating Platform's Model Ensemble Dashboard, the Reich Lab to be used in the CDC COVID-19 Ensemble Forecast, and the in-house, CAC-enabled ERDC SEIR Viewer website. These results have been further featured as part of the CDC COVID-19 Ensemble Model as well as used by FEMA Region for resource allocation on daily basis.

AP030:
Data Development Process for Modeling, Simulating, and Assessing Competition and Penetration

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Calibrated Force Posture (CFP), one of the least studied tenets of the United States Army Multi-Domain Operations (MDO) concept, describes the need to strategically employ both the capacity and capability of Army forces. Recognizing this knowledge gap, Army Futures Command leaders directed The Research and Analysis Center (TRAC) analysis to identify OPTEMPO implications and potential CFP strategies that expand the competitive space and provide credible deterrence. TRAC explored MDO competition and transition to armed conflict periods over a postulated future 9½ year-period using a supply and demand approach. This approach required TRAC to develop the requisite supply and demand data, largely non-existent prior to the analysis. Anchored on Army AimPoint Force 2035, the supply data defines units and capabilities at appropriate echelons to enable quantitative measurement. Similarly, the corresponding demand data represents projected 2035 demands in USEUCOM, USINDOPACOM, and other global demands that are founded in national, combatant command, and Army strategic guidance documents.

This presentation describes an objective, scalable, repeatable, and flexible data development approach to building model inputs for future studies of continually-evolving force structure and modernization priorities.

AP031:
Uncertainty Quantification and Sensitivity Analysis Methodology for the Advanced Joint Effectiveness Model (AJEM)

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AJEM is a joint forces model developed by the US Army that is used in vulnerability and lethality (V/L) predictions for threat/target interactions. This complex model primarily generates a probability response for various components, scenarios, loss of capabilities, or summary conditions. Sensitivity analysis (SA) and uncertainty quantification (UQ), referred to jointly as SA/UQ, are disciplines that provide the working space for how model estimates changes with respect to changes in input variables.

Emerging results from an anti-tank munition interacting with two armored vehicles will be presented. Full view vulnerability metric sensitivity to various cell sizes and iterations in a cell will be presented. In addition, sensitivity to the threats penetration capability and Behind Armor Debris (BAD) characterizations (number of fragments, fragment mass/shape, and spatial distribution) on full view vulnerability metrics will be presented.

AP032:
Barricaded Shooter/Enemy in Defilade - DOTMLPF-P Considerations

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Barricaded shooters or enemy identified in defilade positions pose a significant risk to Coalition Forces Service Members particularly United States Special Operations Forces (USSOF). USSOF are continuously placed in dynamic kinetic environments where they are exposed to an irregular threat.

A mixed methodology study including a case study methodology of specific casualty producing incidents in 2019 and a qualitative study of DOTMLPF-P analysis was conducted to explore the effectiveness of friendly force's ability to effectively counter the threat associated with dismounted counter-insurgency operations. Amongst the dataset studied, findings provide that accurate and effective targeting cycles subsequently place USSOF in an increased threat environment in which barricaded shooters are encountered within compounds of interest and mosques. Additionally, engagement characteristics such as duration of engagement, range, time of day, and structures typically used has revealed a capabilities gap in correlation to doctrine, training, materiel, and policy.

Recommendations for doctrine, training and material solutions must focus on preventing injuries in the current combat setting while also providing applicability to address near-peer warfare. Apart from identifying a current vulnerability and outcomes, questions related to intelligence value versus risk to force present future research opportunities.

AP033:
Estimating Ground Vehicle Fuel Consumption during Training Events

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The objective of this study was to analyze fuel usage for Army ground vehicle systems during training rotations and develop a methodology for estimating fuel consumption based on mileage during low and high op-tempo segments through traditional OMS/MP calculation methods. By extracting actual individual vehicle platform usage (i.e. vehicle serial number matched to specific miles driven and engine hours), assumptions can be applied relative to vehicle movement time and idle time as well as individual terrain splits to predict total fuel consumption during training events. With this methodology, it is possible to generate estimates of ground vehicle fuel consumption during future training events and identify the magnitude of potential errors.

AP034:
The SEIR Model to Project the Spread of SARS-CoV-2

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This presentation covers the Center for Army Analysis' (CAA's) use of the Susceptible, Exposed, Infected, Removed (SEIR) model to simulate the spread of the SARS-CoV-2 virus (the virus responsible for coronavirus disease (COVID-19)) in the United States and 53 foreign states and territories. The SEIR model is a standard epidemiological compartmental population model. This presentation will cover four topics in the context of the SEIR model. I will discuss how the SEIR model works and its merits and shortcomings relative to other epidemiological models. I will address CAA's decision to make this a deterministic model rather than a stochastic model. I'll explain the unique parameters CAA uses in its SEIR model, namely the initialization of the Exposed compartment. Finally, I will explain how CAA uses the SEIR model results to estimate hospitalizations and fatalities.

AP035:
Capabilities-Based Teaming Analysis

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DAC's emerging CAPability-Based Teaming ANalysis (CAPTAN) methdology is intended to use capability-centered survivability/vulnerability (S/V) methods in the service of assessing teamed systems in realistic mission contexts. CAPTAN's two points of emphasis are addressing the bottom-line effects of threat interactions on mission outcomes--the "so what" question--via DAC's capability-based analysis processes, and considering the team as a holistic unit instead of a simple aggregation of systems. These emphases position CAPTAN as particularly relevant to new areas of research interest such as multi-domain operations.

CAPTAN looks at a teamed system from two perspectives: the S/V perspective, wherein component damage is mapped to system dysfunction and further mapped to capability loss within the team; and the process perspective, wherein capability loss can arise from various mishaps (such as a vehicle moving out-of-range), operator errors, conflicting commands, unintended artificial-intelligence conclusions, or other modalities. These two perspectives are combined into a single model that assesses how teamed systems may perform in the mission context. As a primarily S/V model, CAPTAN is being developed to inform stakeholders where critical capabilities are most vulnerable, where unexpected redundancies (or their lack) might occur on the team level, and where weaknesses in system design or process design might be compensated for in the other domain.

This presentation gives a description of the capability-based analysis paradigm, explains how process analyses are integrated into these analyses, and discusses an example of how CAPTAN can be used throughout the Army acquisition cycle to ensure systems meet mission-completion requirements.

AP036:
Expanding Beyond Active Defense: Broadening the Effects of Program-level Capabilities in Force-on-force Level Modeling

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The 2019 Missile Defense Review (MDR) reaffirmed that active missile defense is on the wrong side of the cost curve, stating the need for a "comprehensive missile defense strategy and increas[ing] the effectiveness of active missile defenses by reducing the number of adversary missiles to be intercepted." As the Army's AMD Enterprise lead, USASMDC is responsible for the development of a long-term holistic approach for Army integrated air and missile defense (AIAMD). USASMDC Space and Missile Defense Center of Excellence (SMD CoE) has developed a process to incorporate additional effects that either cannot be modeled directly, or capture the effects of higher classified programs into military utility assessments (MUA). This process bins capabilities by their ability to deny, disrupt, degrade, deceive, or destroy enemy air and missile operations to more holistically capture the comprehensive impact on missile defense capability and capacity. These effects can then be modeled in Extended Air Defense Simulation (EADSIM) to conduct analysis utilizing a force-on-force simulation. Results can be compared across cases to identify where programs had the highest impact to the effectiveness of active missile defense. This presentation will walk through the methodology that was developed by the SMD CoE to capture the effects of kinetic and non-kinetic capabilities, and how these effects were modeled in EADSIM.

AP037:
Force-on-Force Modeling of High Energy Lasers

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Advances in solid state laser technology and the need to close the intercepor capacity gap are driving the development of battlefield-ready High Energy Laser (HEL) systems. This, in turn, necessitates an increase in HEL modeling, simulation, and analysis and their inclusion in force-on-force assessments. HEL systems present unique challenges to the M&S community as their operations and kill mechanism are significantly different to the kinetic interceptors that have been simulated for decades. Additionally, the analysis of HEL performance is captured in unique metrics that are not directly analogous to kinetic interceptors and are not fully understood throughout the DoD community. The US Army Space and Missile Defense Command (SMDC) Space and Missile Defense Center of Excellence (SMDCoE) is using Extended Air Defense Simulation (EADSIM) and High Energy Laser Consolidated Modeling Engagement Simulation (HELCOMES) to perform force-on-force modeling of HELs and has developed in-house analytic software to generate HEL performance metrics to quantify their performance and compare and contrast it against conventional kinetic interceptors. This briefing will provide an overview of HELs,

a comparison against kinetic defeat systems, the methodology used by SMDC CoE to perform force-on-force HEL simulation, and the metrics used to capture HEL performance.

AP038:
FORGE: The Future of Army Experimentation

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Army Futures Command (AFC) charged The Research and Analysis Center (TRAC) to gain and maintain visibility of all modernization related experimentation activities across the Department of Defense (DOD). From wargames to demonstrations, hundreds of experiments are conducted throughout DOD and results are not being shared across the experimentation enterprise, preventing leaders from making data-driven decisions. TRAC has developed an Experimentation module in the AFC Forge database to synchronize experimentation activities and link results to concepts, capabilities, and leader decisions.

This presentation explores practical applications of the data, pitfalls with developing the database, and the challenges associated with creating structure in unstructured data.

AP039:
Distributed Gap Generation and Assessment

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Bringing a group of experts to consensus remains one of the most challenging aspects of Operations Research. How should an analyst approach this task in a purely distributed environment with no in-person workshops, degraded communication, and a dynamic army structure across the Future Force Modernization Enterprise.

As part of multiagency support to the Synthetic Training Environment-Cross Functional Team (STE-CFT) and Army Capability Manager-Live, TRAC undertook a gap creation, refinement, and prioritization effort for Live training focused STE-Live Increment 1 engagement types (Direct Fire, Indirect Fire, and Counter-defilade) within the context of an ABCT Assault and Breach. This effort supported requirements development via an Abbreviated CDD and informed near term R&D POM estimates. Using a combination of communications tools including surveys for data collection, MS Teams, telephone, and Email, TRAC developed a modified Delphi technique combined with a Rank Order Centroid weighting scheme to generate and rank Live training gaps without ever meeting any of the participants in person. This technique will have continued relevance in future years as budgets continue to constrain travel funding. It will enable inclusion of organizations who might not otherwise be able to participate.

This presentation will discuss how the study team conducted a fully distributed elicitation of subject matter expert input and consolidated that input into weighted gaps to support requirements development and prototyping for the live training environment.

AP042:
Army Officer Assignment: Using a Mixed Integer Program to Maximize Suitability while Minimizing Assignment Cost

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I consider the problem of assigning US Army officers to jobs based on their talent profile or knowledge, skills and behaviors. I analyze this problem by determining how to implement an adequate objective function, then by evaluating the quality of solutions as constraints are introduced to model. Finally, I measure the impact of cost when each Officer moves to their new assignment. The results of this research have the potential to revolutionize how the Army conducts its assignment process. The Army would be able to decide the most important factor for the next assignment cycle (budget reduction or assignment quality) and immediately generate a feasible assignment for decision makers.

AP043:
Assessing Emergency Telecommunication System Resiliency Using MATLAB: An Integrated Value Model Approach

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In order to coordinate and support lifesaving and life-preserving efforts, it is essential that emergency responders have access to resilient emergency telecommunications infrastructure. Since ensuring resiliency is of particular importance for regions with an increased likelihood of natural disasters, this research developed an integrated modeling framework for analyzing and evaluating emergency telecommunications systems using MATLAB. This framework uses performance models to assess communication quality of service (QoS) which calculate performance metrics for a given system architecture. Using the performance metrics, a multiple-objective decision analysis (MODA) value model assesses the value score of a given system. After constructing a life-cycle cost model for emergency telecommunication systems, the research team conducted an illustrative Value versus Cost trade-off analysis using three decision frames and assessed sensitivity of recommendations to changes in the decision frame. This decision analysis framework implements a defensible and transparent, performance-driven methodology for decision-makers to explore the system design tradespace and select the best value, relative to cost, emergency telecommunication system. This presentation provides an overview of the decision analysis framework development as well as sample tradespace and sensitivity analysis output.

AP044:
Bioprotection of Facilities from SARS-CoV-2 (COVID-19)

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The recent COVID-19 pandemic has led to a nearly world-wide shelter-in-place strategy. This raises several natural concerns regarding the safe relaxing of current restrictions. This report focuses on the design and operation of heating ventilation and air conditioning (HVAC) systems. Do HVAC systems have a role in limiting viral spread? During shelter-in-place, can the HVAC system in a dwelling help limit spread of virus? After the shelter-in-place strategy ends, can typical workplace HVAC systems limit spread of virus? What about HVAC systems on public transportation? This paper directly addresses these and other questions, by deriving new results using transform methods first given in Ginsberg & Bui. These new results describe viral spread through an HVAC system and estimate the aggregate dose of virus inhaled by an uninfected building occupant when an infected occupant is present within the same building. Central to these results is the derivation of a quantity called the `protection factor'. Older results that rely upon numerical approximations to these differential equations have long been lab validated. This report gives the exact solutions for the first time. Therefore these solutions retain the same lab validation of the older methods. Further, the exact solutions allow facile evaluation of building safety as a function HVAC adjustments and costs.

AP045:
Using Visualization and Statistics to Shape T&E

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This presentation demonstrates analysis techniques that were applied to a wealth of instrumented test data for a ground vehicle to help identify the root cause of test incidents. The data analyzed included over a terabyte's worth of data streams and hundreds of metrics that could be analyzed. Combat Capabilities Development Command (CCDC) Data and Analysis Center (DAC) set out to investigate these incidents in the data in order to determine the root cause. This presentation shows how the machine learning platform DataRobot was used to create predictive models. The presentation also shows how data visualization was used to quickly narrow down potentially insightful metrics out of the vast amount of data collected. The visualization, conducted in R, incorporated several days' worth of data and produced hundreds of plots for various parameters around the time of an event. This allowed the analysts to identify several anomalies in the data that may have led to a testing incident. Implementing this approach sped up analysis and narrowed down potential failure causes in a short amount of time. This analysis was a collaborative effort between CCDC DAC, the Army Evaluation Center, Aberdeen Test Center, and the Army Research Laboratory.

AP046:
An Investigation of the Appropriateness of the Bhattacharyya Distance in Detecting Data Bias

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The Bhattacharyya Distance has been used for various purposes in statistics, including noise reduction in image processing. This research reports on an investigation of utilizing the Bhattacharyya Distance as a metric for recognition of bias in data that would allow biased data sets to be identified without human intervention. The research reported on here utilized the MNIST data set, calculating the Bhattacharyya Distances between the average distributions of image classes (digits) and one image, arbitrarily chosen, that underwent an image-shift transformation, and then comparing the results. If the Bhattacharyya Distance can be successful adapted to this purpose, it would allow the Bhattacharyya distance to be used as a metric for bias detection, and provide a method to quickly guarantee that statistical models are not built on data sets exhibiting data bias.

AP047:
Exercise VIRTUAL EAGLE: an Armoured Infantry Battlegroup Experiment

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Exercise VIRTUAL EAGLE investigated the effectiveness of a British Armoured Infantry Battle Group in the near future, as part of the Armoured Infantry Battle Group Experiment (AIBGX) study. A three week virtual simulation experiment at scale was delivered by a multi-disciplinary team of 180 personnel from Dstl, the British Army and industry. The experiment used VBS3 which, together with the various communications and analysis functions, was hosted on a bespoke, ad hoc network of over 250 laptops established at the troops' location.

This paper will describe the lessons learnt from designing, running and analysing Ex VIRTUAL EAGLE, identifying with examples the strengths and weaknesses of the approach. It will conclude by demonstrating how these weaknesses can be partially overcome by the use of an integrated experimentation and analysis campaign plan (IEACP), as has been used on AIBGX, which builds on the relative strengths of several methods.

AP048:
Dagger Mission Mapping & Modeling Tool (DM3T) Development for PM PNT

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In order to provide structure and answer questions related to the impact on mission effectiveness of Positioning, Navigation, and Timing (PNT) technologies for various mission threads, the U.S. Army Combat Capabilities Command Data and Analysis Center (CCDC DAC) is building a set of models within the Dagger Mission Mapping and Modeling Tool (DM3T) in support of Program Manager Positioning Navigation and Timing (PM PNT) needs. These models will provide a baseline for assessing PNT technologies in terms of the requirements associated with different Army platform variants, threats and operating environments.

DM3T models are composed of two related but separate pieces: the structural piece of the model and the computational piece. A DM3T model focuses on a specific mission thread and captures all key dependencies between components within that thread that are necessary for mission execution, such as personnel, networks, equipment and software. This web of dependencies is the structural portion of the DM3T model. Underneath the structural portion lies the computational portion, which uses attributes of the components mentioned previously (personnel, networks, equipment, and software); as well as, their dependencies to calculate each component's impact on overall mission effectiveness.

CCDC DAC will use DM3T models to "plug n' play" with various alternative PNT technologies in order to assess whether or not a given technology improves mission performance in various threat environments. CCDC DAC has worked with PM PNT, Centers of Excellence (CoE) and other stakeholders to identify an initial set of mission threads to model within DM3T. At this time, a single DM3T model of an Infantry Brigade Combat Team (IBCT) Call for Fires (CFF) from Forward Observer (FO) has been completed and will be reviewed as part of the presentation. The presentation will also review Dagger, a government off-the-shelf (GOTS) tool developed by Johns Hopkins University Applied Physics Laboratory (JHU APL) that is leveraged by DM3T.

AP049:
Initial Provisioning Analysis - Selected Essential-Item Stock For Availability Method (SESAME)

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This presentation provides an overview of the Selected Essential-Item Stock for Availability Method (SESAME). SESAME is the Army's approved model for conducting initial provisioning analysis. Initial provisioning is the process of determining the range and quantity of Class IX items required to support and maintain an end item for an initial period of service. Army Supply Regulation 700-18 requires the SESAME model to be utilized for Class IX initial provisioning requirements for newly fielded systems. The model determines the optimal range and depth of spares and repair parts at all fielding locations in order to meet either a weapon system/end item

budget constraint or operational performance target. The Combat Capabilities Development Command (CCDC) Data and Analysis Center (DAC) has also developed Visual SESAME (VS), which incorporates a Graphical User Interface around the model. VS allows the user to more easily develop proposed support structures, input parts information with quality checks, and visualize output trade-off curves between cost and readiness. DAC conducts VS training on a per request basis which focuses on the functions, features, and capabilities of the VS software. DAC is also currently in the beginning stages of testing a newer, streamlined, more user friendly version of VS, known as Visual SESAME-LITE, which is on track to be released this year.

AP050:
COVID-19 Analyses within an Organic Industrial Base

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During the first week of March 2020, Indiana received its first confirmed COVID-19 case. Less than three weeks later its Governor issued a 'stay at home' order. In response to this pandemic, Crane Army Ammunition Activity (CAAA), an organic industrial base located in southern Indiana, activated its Crisis Management Team (CMT) and began implementing workforce protective measures such as social distancing and equipment/facility disinfections along with sending increased-risk employees home on weather & safety leave or telework. With its mission to support warfighters, CAAA ships, stores, demilitarizes and produces munitions. With a reduced workforce, non-essential mission activities began to suffer. By mid-April, the White House unveiled a three-phase approach to restoring normal commerce and services; "Opening Up America Again," focused on places that have strong testing and are seeing a decrease in COVID-19 cases. This required trajectory assessments of documented cases and positive test percentage, along with capacity assessments for testing and medical treatment facilities. These assessments required valid data with current information each day. As part of its data retrieval efforts, CAAA considered several online data sources, such as the New York Times, Johns Hopkins University, and the COVID Tracking Project. Though there were some conspicuous discrepancies between them, there contained strong correlations of the data found in these sources. Initially, CAAA developed simple models using Microsoft Excel. After several weeks, more complex models were required, especially with large amounts of data available and the need for reliable data wrangling efforts. Using R programming, CAAA developed scripts to assess trends that supported the CMT's decision-making process. These scripts included rolling averages and simple exponential smoothing forecasting, along with generating PowerPoint files that contained a visual representation of the data for ease of understanding.

AP051:
Analysis of the Effect of Imaging Sensor Configuration on Urban Situational Awareness

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The CCDC Data & Analysis Center (DAC) conducted an analysis of the effect of various Imaging Sensor configurations on Situational Awareness (SA) in an urban setting. The analysis compared the performance of a fixed forward looking sensor, a panning forward looking sensor, a panning omnidirectional sensor, and a contiguous omnidirectional sensor on a vehicle as well as a scanning sensor on an Unmanned Aerial System. The sensor configurations were modeled in the Fusion Oriented C4ISR Utility Simulation (FOCUS), an entity-level, event driven, stochastic, Intelligence, Surveillance, and Reconnaissance (ISR) centric simulation used to rapidly assess the impact of ISR systems on tactical decision making. An urban ambush vignette was developed in FOCUS where a single vehicle traveled down a street and Rocket Propelled Grenade (RPG) gunners were positioned to move out from side streets after the vehicle passed to engage from the rear. The study results highlight the benefits of omnidirectional SA as well as the importance of sufficient observer coverage and/or automation to imagery monitoring.

AP052:
Framework to Analyze Cyber Information Warfare Operations

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Cyberspace operations (activities), which include both offensive and defensive techniques, are often confused with information warfare. While the aim of cyber warfare is to disrupt and/or deny activities of a state, the aim of information warfare is to get a competitive advantage over the opponent using data (information) as a weapon. Models of damage processes, especially for combat induced damage, can be considered time irreversible, moving only forward in time, whereas cyber methods can often be mitigated; hence, are time reversible. In this paper, we begin to develop a framework wherein we can consider both offensive and defensive information warfare operations as time reversible processes with a goal of including these effects in analyses on par with their physical counterpart.

AP053:
APNT CFT Modeling & Simulation Integrated Project Team

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The Army seeks to expand its capabilities in APNT modeling and simulation. Presently, modeling and simulation (M&S) analysis requires a lot of time and resources to execute. Usually, one high level question is answered at a time. As M&S capabilities move forward, the ability to answer multiple, specific questions, gives the Army an analytical and M&S advantage over our adversaries. Having the ability to model and analyze multiple technologies in parallel gives the Army an expedited advantage. Mounted Assured Position, Navigation and Timing System (MAPS) devices are technology of the battlespace that must be modeled, simulated and analyzed.

The demonstration of mission effectiveness in the current, near-term and future GPS-contested environments while simulating and modeling MAPS alternatives within Force-on-Force models, is of great importance as the Army's APNT capabilities expand. Answering the question of

mission operations without GPS and the time needed to complete the mission. is of great importance.

The APNT CFT M&S IPT is implementing a capability for which to model, simulate, and analyze vignettes that look at new and emerging PNT technologies and threats within established and new scenarios. The M&S IPT is working to provide the Army with a M&S quick-turn solution to help facilitate the decision making process for proposed PNT solutions.

AP054:
Army Supply Chain Readiness Posture for Readiness Objectives

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Working Groups: WG3

As Operating Tempo and corresponding demands for repair parts increased from Fiscal Year 2016 to Fiscal Year 2019, the Army made significant investments in Class IX repair part inventory. These investments helped to provide operational readiness to Status of Resources and Training Systems fleets. However, the Army Materiel Command had a need to look ahead towards future readiness requirements and assess how the Army supply chain was postured to support those readiness objectives.

This analysis identified and developed linkages between fleet readiness data and logistics supply chain data such as Customer Wait Time, Requisition Wait Time, Fill Rate, and Supply Availability in order to assess the impact of different levers on readiness.

Impacts of various improvement opportunities were identified in both tactical and national supply processes. These processes were evaluated along with additional Supply Availability inventory investment options in order to determine which courses of action would have the most potential impact on readiness.

The analysis found and demonstrated that process improvements to Customer Wait Time and Requisition Wait Time segments had a much greater potential impact on increasing weapon system readiness rates than did additional Supply Availability inventory investments.

AP055:
Modeling with Noise in the Data – Examples, Effects, and Solutions

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Data scientists commonly deal with the issue of noise within data. Without properly accounting for the noise, the output of the analysis can be uninformative and potentially spread misinformation. When predicting future trends, it is increasingly important to reduce the noise in the data. Recently, leadership from the Center for Army Analysis challenged analysts to model and project the spread of the coronavirus disease (COVID-19) at several geographical levels, including core-based statistical areas, DOD installations, and global regions. Army Senior

Leaders rely on model projections from analysts to implement local and global orders. Given the importance of such a task, it is critical to deal with the noise in the data. COVID-19 projections are only one example of a case where noisy data can interfere with the quality of future projections. Noise within the data also affects several other prediction/projection models.

This presentation communicates examples and definitions of noisy data in time series, forecasting, and clustering models.

AP057:
Resource and Risk Informed Modernization: Analysis to Create the 2028 AimPoint Force

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In FY19, the Army Modernization Enterprise (AME) was rapidly establishing requirements to bring Multi-Domain Operations (MDO) to the force. In guiding future force development, Army Futures Command (AFC) published the MDO Whiteboard Force outlining the units and capabilities resident in the 2028 force. To support accelerated concept development, the MDO Whiteboard Force was developed largely unconstrained. In September 2019, AFC leaders directed that MDO modernization continue on-pace, but with pragmatic resource constraints informed by potential risk. Teamed with the AFC Futures and Concepts Center/Directorate of Concepts, The Research and Analysis Center (TRAC) initiated the Resource and Risk Informed Force Package Analysis to advise resource decision-makers before 1 December 2019. As resource decisions evolved in early 2020, the analysis led AFC to establish the 2028 AimPoint Force as a guide for all future MDO experimentation and modernization. To launch the analysis, TRAC designed accounting methods to describe the total Army force in each of five MDO AimPoint Force courses of action (COA). Concurrently, TRAC designed a series of quick-turn wargames to assess the risk of each COA. Resourcing results describe Active Duty, Reserve and National Guard components that form each unit in an AimPoint Force COA. Operational results show trends in risk as the force composition is changed in each COA.

This presentation describes the analytic methodology used to generate a resource and risk informed AimPoint Force to guide early development of MDO future capabilities.

AP058:
AiTR in Closed Form Simulations: A First Look

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Target acquisition (TA) is a key component of any force-on-force simulation. Detecting the target is the first step in the kill chain and the beginning of the engagement process. TA predictions can have significant effect on battlefield results in any force-on-force simulation. Many of the new TA systems being considered for the future force have aided target recognition systems (AiTR) included. These systems introduce a unique set of challenges from a modeling perspective as limited system performance data is available, they are nontraditional in the sense that there is no human-in-the-loop for initial acquisition, and they present potentially game changing capability with respect to how we fight (Tactics, Techniques and Procedures – TTPs). This paper will describe a first look at a methodology to include the performance estimates of AiTR systems within the construct of the ACQUIRE-TAS (Target Angular Size) and TLS (Time Limited Search) methodologies that are already embedded in many brigade and below force-on-force simulations.

AP059:
Material Identification Research with Target Identification Applications Using Infrared Polarimetric Methods

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An important application for remote sensing is the detection and discrimination of targets of interest. Remote sensing platforms are used to detect targets and discriminate them from countermeasures or decoys that are deployed to degrade the ability of the remote sensing platform to detect these targets. Remote sensors can utilize imaging polarimetry to identify the materials from which targets are made. A fundamental property of a material is its complex index of refraction (CIR), and we describe a technique for estimation of the CIR using modeled and measured polarimetric signatures. Several materials were measured with imaging polarimeters in the mid-wave infrared and long-wave infrared spectral regions and the degree of linear polarization (DoLP) was calculated from the polarimetric data. A model was developed to calculate the DoLP of materials, which includes components to account for the material's polarized self-emission and polarized background reflections from the material. The modeled DoLP is compared with the measured DoLP using a non-linear equation solver to estimate the CIR, which is then used to identify the material. The goal of this work is to use the technique to classify a material as a metal or dielectric, then identify which specific metal or dielectric. We demonstrate the ability to classify a material as a metal or dielectric using the estimated CIR results, then identify the specific material using the ratio of the index of refraction to the extinction coefficient.

AP060:
Achieving the Multi-Domain Operations (MDO) Whiteboard: "Ideal" Force - A Cost Perspective

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The Research and Analysis Center (TRAC) conducted a multi-faceted, quick turn study known as the Army Complementary Analysis, with results provided back to the Chief of Staff of the Army within 90 days. The collective efforts focused on the competition and conflict phases in the Indo-

Pacific Command Theater to accomplish all mission demands required. In particular, the Calibrated Force Posture line of effort dealt with the changes to the optimal Active Component/Reserve Component (AC/RC) mix, which required a review of the Army organizational structural changes, with a comparison of the 2024 programmed force and the MDO Whiteboard "Ideal" Force, from an aggregated cost perspective. The MDO future force was unconstrained and had all three Force Packages as 100 percent AC. As a result, TRAC's team developed the cost methodology and approach to assess the cost and risk trades required across the Army's future force structure.

The TRAC team used two cost models, the Force and Organizational Cost Estimating System (FORCES) cost model and the Army Concept of Operations (CONOPS) cost model, to determine the cost of changes in the organizational structures and an assessment of AC/RC mix and readiness implications. The comparison was organized by warfighting functions and required the identification of 6 associated costs (acquisition of resources, operations and support (O&S) for each component (COMPO) type, movement, and deployment) for each 64 warfighting brigade types. With the Army's total budget request for fiscal year 2020 at $191.4B, the findings highlighted that significant tradeoffs must be made to optimize the Army's organizational redesign and modernization efforts in future Program Objective Memorandum deliberations to achieve the MDO capable force by 2028.

This presentation will focus on the methodology, application, and review the challenges and lessons learned.

AP061:
Developing Outside the Box: Balancing Trade-offs in a Constrained Operational Environment

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The Data Science Directorate (DSD, NETCOM, Ft. Huachuca) shares DevSecOps lessons learned from problem-solving in a dynamic operational environment. The case study involves improving time to completion (TTC) of time-intensive manual analyses of pre-collected PCAP files in support of NETCOM partners for identifying the cause of network latency. Challenges were overcome in many areas including process management, data spillage, automation, and complexity reduction. DSD discusses tradeoffs in those areas among various approaches.

AP062:
Condition Assessment of Micro Nuclear Reactors Performance in Grid Disruption Scenarios

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Micro Nuclear Reactors (MNRs) are the emerging innovation in nuclear technology as small, portable, and self-sufficient reactor units in the size of a standard 40-foot shipping container. An MNR functions as a "nuclear battery", where each unit can power load capacities from 500 kWs to 5 MWs over the lifetime of 1 to 1 0 years. The expected deployment date of this technology is around 2025, but preparations for operational usage of these units have been considered by the DoD to increase energy resilience on domestic instillations. In addition to growing grid disruption events from natural threats, cyber and physical threats challenge the dependence of domestic instillations on traditional grids from surrounding utility providers. This research seeks to analyze the performance of MNRs in different implementation strategies for emergency grid disruption scenarios. First, this research investigates the trade-offs between time and cost of response to a reduced grid capacity from a grid disruption event. This research also explores capacities and operation conditions necessary for MN Rs in a microgrid response to grid disruption events. A series of models were developed for the transportation network and the MNR-based microgrid response to grid disruption to represent different deployment strategies for this technology. The point-to-point truck-load model required standard freight shipment rates for the U.S. road network. The specialized power systems library for Simscape was used to develop an MNR-based microgrid that received power demand data from natural disaster-based grid disruption events.

AP063:
Implementing Scrum Project Management Methodology to Manage COVID-19 Modeling

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To meet the demand from Army Senior Leaders (ASL) for a cohesive analytic response to the spread of the coronavirus disease (COVID-19) in the United States, the Center for Army Analysis (CAA) consolidated several smaller COVID-19 modeling efforts into one team within the Operations Analysis Division. The pace and urgency of the COVID-19 modeling work quickly revealed the shortcomings of traditional project management that prefers to identify and enumerate all requirements at the start of a project. To remain relevant and responsive, CAA's Operations Analysis Division adopted an agile project management style called Scrum. Within this agile framework, CAA executes a Scrum of Scrums, in which two Scrum teams execute parallel 3-day sprints. Using Scrum, CAA dramatically improved its ability to contribute to a dynamic analytic environment that includes other government and academic organizations. Perhaps most importantly, CAA's flexibility in allowing emergent requirements to inform the project path led to a successful partnership with Lawrence Livermore National Laboratories and the Army Public Health Center that informs Headquarters, Department of the Army COVID-19 policies.

AP064:
A Comparison of the Effectiveness of Deep Learning Models in Predicting Network Performance

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Deep Learning and other unsupervised machine learning methods are applicable to various problem domains. This presentation reports on the results of comparing the effectiveness of machine learning models for the task of predicting time-series network performance data. The models analyzed include LSTM Neural Networks, Convolutional Neural Networks, and XgBoost. Comparisons of the performance of these models on real network circuit data will be presented along with other factors and trade-offs to consider.

AP065:
Self-equity as a Trustworthiness Measure: The Relationship Between Self-equity and Discharge Characterizations in U.S. Army Recruits

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This work tests self-equity based trustworthiness as a risk mitigating construct for United States Army recruits as informed by informal social control theory. Logistic regression analysis predicts the category of discharge and partially replicates the relationship among self-equity factors measured in terms of qualification test percentile, rank, service years, education level, marriage, and children as it relates to trustworthiness as measured in terms of 231,886 Army recruit discharge characterizations within the first five years of service. The results reveal that self-equity measures negatively relate to unfavorable discharge characterization outcomes with the exception of marriage and children, which must occur together in order to produce beneficial effects. Thus, self-equity factors predict discharge characterizations among recruits, and marriage and children interact to produce various discharge outcomes. These findings demonstrate that self-equity is as a scientifically valid trustworthiness measure for Army recruits that may be applied to reduce false positives inherent to risk measures.

AP066:
Army Cyberspace and Information Warfare

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Abstract not for public release.

AP067:
Human Anatomy Representations for US Army M&S

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The U.S. Army Data and Analysis Center is working to improve casualty assessment by improving the Operational Requirements-based Casualty Assessment (ORCA) model's embedded human anatomy. ORCA modeling provides a standardized methodology for assessing weapon-induced injuries. In its current state the ORCA model simulates tissue damage and its effects on individual

performance using a 5x5mm voxel representation of various tissues for one medium male of 50th-percentile stature. We intend to make the embedded human geometry configurable and representative of the distribution of anthropometries for male and female Soldiers. The development of these anatomical geometries is based on medical data previously collected in a collaboration with Wake Forest University. Data was collected from participants that represent morphologies within the U.S. Army population using selection criteria derived from the US Army CCDC Soldier Center's Anthropometric Survey of US Army Personnel (ANSUR) study comprising small, medium, large, wide-shoulder, long-limb and long-torso male and female anatomies. DAC's new ORCA human representations will eventually include that entire dataset. This presentation will discuss DAC's short term and long term plan for replacing the ORCA ComputerMan geometry, detail how we are using the medical data to create a representative population of human anatomies, and list benefits of having a set of anatomies prepared for future Soldier Lethality M&S needs.

AP068:
The Accountability Paradox Examined: Evaluating the Effects of Accountability on Improvement in U.S. Federal Agencies

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Public organizations are expected to use performance information to improve their programs and to give account to the public. However, a large and growing body of research suggests that using performance information for accountability decreases the likelihood of public managers using performance information to improve their programs -- a so-called 'accountability paradox.' The US Government Accountability Office conducts periodic surveys of US federal managers, examining their performance measurement and management practices, yet almost no research has examined the effects of accountability on managerial use of performance information. This study seeks to fill that gap by examining the GAO's 2017 survey data and drawing conclusions regarding the types of account-giving activities that promote or discourage federal managers' use of performance information in decision-making.

AP070:
U.S. Army Performance Analytics in a Deployed Environment

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The current Unmanned Aerial Surveillance (UAS) Fighter Management Program (FMP) Standard Operating Procedures (SOP) in the 160th Special Operations Aviation Regiment (SOAR) may contribute to sub-optimal work-rest cycles and ultimately sub-optimal operational effectiveness while deployed.
The primary purpose of this research is to determine how and when UAS Operators experience cognitive decline while operating in a deployed environment under the current FMP SOP. The secondary purpose of this research is to enable commanders to anticipate cognitive decline and

make improved policy decisions in order to intervene and limit the risk associated with deteriorating cognitive performance in their UAS Operators. I began with a descriptive statistical analysis of the individual data collected throughout the deployment, to include sleep, physiological, and cognitive performance. After analyzing the data individually, I conducted a trend analysis using normalized cognitive data to determine when cognitive function begins to deteriorate and analyze how sleep and physiological data may impact overall cognitive performance.

AP071:
A semi-qualitative Methodology for Optimising Wide Wet Gap Crossing Fleets

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Wide Wet Gaps (WWG) can pose major challenges in optimising British Army land manoeuvre operations. It is therefore imperative to gain an understanding of potential gap crossing solutions and the factors that most affect their performance. To address this issue a multi-criteria decision analysis (MCDA) was developed used to generate a performance score for a range of WWG crossing bridging platforms. This then informed a linear programming (LP) model developed to estimate the size and composition of an optimal WWG crossing fleet under a range of constraints including equipment costs and manpower limits.

The MCDA procedure enabled a subject matter expert assessment of platform performance against a range of gaps, across several routes, and crossing under different contexts (humanitarian, under fire etc.) to be evaluated into a set of transparent quantitative measures. Using this data in the LP model, a fleet composed of mostly motorised pontoon platforms, augmented with a few amphibious platforms, provided the optimal cost-effective solution, satisfying British Army requirements.

AP072:
A Framework to Assess Detection and Defeat Capabilities Against UAS Intrusions

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An operational scenario-based framework is being developed to detect and interdict adversarial intrusions near geographic areas of interest, by simulating concurrently the behaviors of intruders, interdicting agents, and sensors. This framework supports a specific model for sensor and defeater selection and placement to interdict intruding Group 1 and Group 2 Unmanned Aerial Systems (UAS). The approach entails determining intruders' preferred paths of travel to their respective destinations, actions required to interdict intruding UAS, and sensing capabilities that form the basis of detection. The sensing component of the model includes high-fidelity sensing of

intruders using a myriad of sensing modalities in both existent and notional sections of geospecific terrain, with fixed-site infrastructure as the target of the UAS. Furthermore, the intruder-path architecture takes into account any obstacles in the terrain under study. Model outputs include visualizations displayed in a dynamic dashboard framework that is designed to update automatically as the capabilities of intruders, interdicting agents, and sensors change. As development continues, this model could inform stakeholders' future efforts to assess intruder-detection capabilities near fixed-site areas of interest and identify gaps associated with a plethora of intrusion, defense, and sensing methods. This presentation provides an overview of the overall model and discusses the functionality required to analyze gaps associated with UAS detection and defense capabilities for areas of interest within an operational scenario-based framework.

AP073:
Likelihood Ratio Test on V50 with Multiple Factors

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Ballistic limit testing is a type of sensitivity testing where the velocity at which a kinetic energy threat impacts an armor sample is varied and the binary penetration result (partial or complete) is recorded. The data is then analyzed to estimate the probability of penetration as a function of threat velocity assuming some probability distribution using a generalized linear model. Typical protection levels of interest include the V50 (velocity at which there is a 50% probability of complete penetration). Methods have been presented to conduct a likelihood ratio test on the V50 for two-samples. This work extends that method to multiple factors. Since proper test planning involves sample size determination, Monte Carlo simulations may be used to estimate power for a given sample size and test method. A case study is investigated.

AP074:
Using Machine Learning to Automate the Classification of Geospatial Data from Multi-Spectral Imagery

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The lack of availability of geospatial data at the correct resolution can drastically increase the risk associated with the Combat Capabilities Development Command (CCDC) Data and Analysis Center's (DAC) ability to perform analysis in support of Army studies. With the current need for analysis to be operationally relevant, the CCDC DAC Geospatial Analysis (GA) team regularly develops data in-house to close data gaps in operationally relevant regions where data is not currently available. To improve efficiencies in data production, the GA team has recently made advancements in automating the delineation of geospatial data types like landuse, soil types, and various other features by utilizing machine/deep learning algorithms to automate the previously manual process. This will allow CCDC DAC to respond rapidly to answer questions for any Area of Interest (AOI) where high resolution multi-spectral imagery is available. It also drastically reduces the amount of time it currently takes to produce these datasets at the resolutions necessary to illustrate operational system performance.

AP075:
Tactical Vehicle Solar Recharging

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The Army's fleet of low-usage tactical wheeled vehicles (TWVs) suffers high rates of discharged and unbalanced 6T AGM batteries. This affects unit readiness, maintenance costs, logistics, disposal, and has a negative environmental impact. The Army spent over $338 million on vehicle batteries from FY12 to FY18, with 6T AGM batteries being the number one parts driver in frequency for all TWV non-mission capable (NMC) work orders. CCDC DAC examined potential solutions to the battery issue and proposed solar chargers to improve the readiness of the TWVs. Implementing solar systems on TWVs is estimated to result in 7 to 8 million dollars yearly in cost savings and a decrease in yearly maintenance man hours by 32 to 36 thousand hours.

CCDC DAC solar system analysis addressed both the ability to maintain and recharge 6T AGM batteries. Initial studies successfully showed that solar systems can be used to maintain 6T AGM batteries for tactical vehicles. The collection of solar panels examined possessed enough power and reliability to keep vehicle batteries charged while using only limited space on the vehicle. CCDC DAC is now investigating if these same solar panels possess enough power to fully recharge tactical vehicle batteries in a timely and reliable manner. Modeling the expected recharge times for various environmental conditions gives an estimate for solar system recharge times. Data collected during test events conducted at Aberdeen Test Center will be compared to the estimated times to determine if the solar systems examined will meet expectations in the field.

AP076:
How Long is a Person Contagious with COVID-19?

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The receipt of a positive COVID-19 test result is jarring. Reactions include fear, guilt, and concern. In addition to these emotional reactions, one of the first things that someone might think of is how their life will change logistically in the near future. Do they have to cancel social plans? Does the person have to arrange for alternative child care? Perhaps the most common question is how long they must be absent from work. This question is crucially important for Soldiers. Being present for training is necessary to maintain readiness, especially for Soldiers in units in a deployment cycle. Decisions regarding when it is safe to return to training are ones that many Commanders and Soldiers across the Army must make. This presentation explores the states of academic literature regarding how long a person is contagious and attempts to provide a more rigorous framework for determining a distribution for this random variable in order to help better balance the risk of infecting others with the risk of degraded readiness.

AP077:
Using NLP to Improve Situational Awareness of Tactical Communications

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The US Army Robotic and Autonomous Systems Strategy notes that AI can "facilitate mission command by collecting, organizing, and prioritizing data to facilitate decision-making." As the organization responsible for acquisition of Army mission command systems, the Project Manager for Mission Command is engaged in reducing the risk associated with enabling artificial intelligence in mission command applications. One key aspect of this role is ensuring echelon-appropriate command awareness of communications, including text chat, voice, and even network operations. The ability to identify, highlight, and make sense of pertinent communications is overwhelmed by the volume of traffic.

PM Mission Command has partnered with MITRE to develop tools to provide real-time or near real-time insight into communications, including topic analysis, key word alerts, and development of use cases for further enhancing communications, such as named entity recognition and plotting named coordinates.

The prevalence of communications technology in the tactical setting is a significant source of cognitive burden for warfighters, as it can be overwhelming to monitor multiple modes of communication and warfighter fatigue can cause critical information to be missed, impacting the value of situational awareness in providing context for decision-making. Warfighters have issued need statements for cognitive assistant capabilities that enable improved situational awareness and coordination, citing the exponentially increasing volume of relevant data that exceeds the cognitive capacity of personnel. To build these cognitive assistant capabilities, researchers require high quality labeled datasets, an environment to work on those datasets with the proper authority, and requirements informed by the operational perspective.

PM Mission Command and MITRE are developing prototype software applications for the Mission Command Support Center and Common Operating Environment that aim to lessen the cognitive load of the warfighter, automate coordination, alert on critical information, and identify relationships in data through disparate means of communication. To accomplish this, MITRE is leveraging ML techniques in NLP to "understand" the content of chat messages and developing ML classification, entity extraction, entity linking, co-reference resolution capabilities.

The approach is to build an NLP framework to address the challenge with data and requirements by using a pipeline approach to parse data, extract entities, visualize that data, persist and access that data, develop use cases using hands-on experience with the data, label the data, and ultimately train ML models that will enable cognitive assistant capabilities.

This talk will explore these challenges in more detail and demonstrate these NLP framework capabilities that allow for visualizing data trends, spotting anomalies, identifying impactful use-cases, and ultimately gain a richer understanding of the data to inform requirements and enable capability development.

AP078:
DIY Dashboads

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Show of hands. How many of you have seen high speed dashboards created in Python, R, Tableau, etc.? Probably most of you. Ok, how many of you actually know enough about coding and scripting to make your own dashboards? Probably a few of you. How many of you have the hours it would take in order to learn to code/script your own dashboards?

What if I told you that you could easily catch up with your high-speed coding peers in a matter of minutes? What if I told that you could make your own high speed dashboards without coding or scripting? What if I told you that the tools have been posted all over YouTube for the last decade?

How fast can you make a dashboard? If you have a decent data source, you can make a clean and working dashboard in 10 minutes. If you have to scrub your data because dates are stored as text or numbers have decimals, it might take you all of 30 minutes.

But wait, there's more. Using common spreadsheet technology such as Excel or Google Sheets, it is practically free. Furthermore, spreadsheets are the "lingua franca" of data analytics so your dashboard is accessible to anybody with either the Microsoft Office Suite or an Internet connection.

No coding. No Scripting. Low cost. Easy to learn. Drag and Drop. DIY Dashboards.

AP079:
Cost Benefit Analysis and Linear Optimization for Army Modernization Analysis

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The Army Modernization Analysis (AMA) is an analytic approach led by The Research and Analysis Center (TRAC) to integrate modernization analysis across concept development, future force designs, and program investments to inform critical modernization decision forums. Recognizing the challenging fiscal environment facing Army Senior Leaders, the AMA focused on developing a Trade-Space and Decision Exploration System (TRADES) to make informed, cross-portfolio investment trades.
The TRADES tool implements a mathematical series of algorithms to formulate cost over the Future Years Defense Program (FYDP) and beyond to Fiscal Year (FY) 2035. Cost is analyzed with program operational benefit and risk across two theaters to provide descriptive statistics and data visualization to Army Senior Leaders. Furthermore, linear optimization is implemented to maximize operational benefit to the future force under a constrained fiscal budget and recommend program prioritization across multiple analytic approaches and input data. This presentation provides an overview of the methods implemented and example results obtained through cost-benefit analysis and linear optimization within the Army Modernization Analysis TRADES Tool.

AP080:
Expanding Your Aperture to Explore and Leverage Emerging Technologies

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Title: Expanding Your Aperture to Explore and Leverage Emerging Technologies

Today both our adversaries and our technologies are changing rapidly. In 2020, we are facing challenges both typical and extraordinary, and as such, we are being called upon to employ emerging technologies in new and creative ways. While the daily business of maintaining and equipping the Army to keep the peace through strength by building on our military advantage and maintaining important regional balances of power continues, the how and where we do business has changed. It is only through our imagination and adaptability that we have employed these new technologies to address all challenges, anticipated and unanticipated.

Current technology advancements are not based on (or influenced by) the current state of Department of Defense (DoD) Modeling and Simulation (M&S) and its programs. Our job as analysts is to be smart in evaluating how to best adopt these advances to the benefit our military stakeholders, while considering interoperability with existing tools, data reuse, and standardization.

In order to expand your personal aperture and 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 military analysts as we employ M&S as a tool.

This presentation will discuss relevant findings from the ENGTAM SSG and what they mean to the military Analytical Community in the development and use of cutting-edge tools, techniques, and best practices. It will also provide an opportunity to discuss these emerging technologies and how they benefit the military analyst in their mission to inform the achievement of the "continuum of strategic direction."

AP081:
Assessing Project Convergence: AFC's Integrated Data Analysis Effort of an Artificial Intelligence (AI)-enabled Battlespace

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Adversaries will seek to achieve physical stand-off by employing layers of anti-access and area denial systems in order to deny U.S. and Partner forces the ability to achieve our campaign objectives. Future armed conflicts with near-peer adversaries require faster coordinated effects, near-real time decision-making, and on-demand accessibility to multiple domains – space, cyber, air, sea, and land – to maximize effect during the window of parity. This will require exponential growth in computing power; network resilience; and artificial intelligence, as well as changes to how we fight future wars.

Project Convergence (PC) is the Army Futures Command (AFC) initiative to integrate the necessary capabilities to achieve autonomous battlefield effects by connecting all sensors, to the right shooter, to the right command and control nodes with the right authorities at the right time. PC Evolution I, conducted June-September 2020, is a series of experimentation activities culminating in a 1 day demonstration that brings together multiple AFC Cross-Functional Teams' and Task Forces' modernization efforts. The event's purpose is to understand the current state of the Army's ability to operate in an AI-enabled battlefield and inform the Future Force Modernization Enterprise.

PC Evolution I requires an integrating analytic framework to focus experimentation efforts and provide Army senior leaders with an understanding of the progress towards achieving networked lethality and AI-enabled operations. AFC tasked The Research and Analysis Center and the Data and Analysis Center to lead the development and execution of this overarching analysis plan.

This presentation will provide an overview of the study approach and data collection management plan to deliver an integrated analysis product for Evolution I and will describe how the findings from this event can contribute to the AFC's campaign of learning initiative. In addition, it will address the impacts of working within a distributed environment due to current operating conditions.

AP082:
RCS Averaged Values

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RCS Averaged Values RCS, Radar Cross Section, in square meters, is a quantitative measurement or estimate of the reflective area of a target for a given frequency/polarity at a given viewing angle, or it may be averaged over a set of views, and a time frame. DAC uses EM, electromagnetic simulators like Xpatch to estimate the RCS of targets, and we maintain data bases and access to accounts of measured data for checking.

Because there are potentially infinite views with widely varying RCS values, either the specific view or the averaging interval needs to be understood, specified and documented. DAC has been providing consistent, grossly averaged RCS data to long term combat simulation customers for hundreds of targets over the past few years, allowing for interchange of target values.

Advances in electronics allow modern radar to capture and process reflection signals on the order of nanoseconds, allowing them to see and record brief high level transients, or flash. To better support modeling modern radar, we may have to both increase the number of view angles, including the exponential growth required for dynamic analysis, and change the way we process and average RCS simulation predicted values to capture these spikes.

AP083:
An Interactive Visualisation Platform for Exploring Defence Workforce Transition Scheduling Solutions

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Scheduling problems can be quite complex, with many constraints, parameters and complex interactions. Strategies to effectively represent these problems using modelling and simulation approaches rely on accurate inputs and assumptions from Subject Matter Experts (SMEs). However, there are challenges in extracting this information and there can often be a disconnect between SMEs and the scientists developing scheduling solutions. SMEs often find it difficult to clearly describe what their needs or priorities are, what constraints apply, how they interact and select important initial parameter bounds and related constraints. Conversely, scientists don't always effectively communicate results and how various parameters and constraints can affect the system's performance. This leads to solutions that are often not fully exploited in practice.
To address these challenges, we have developed a highly interactive interface to help SMEs explore scheduling rules and discover what the key variables of interest are and their corresponding effect on the system's performance. At each iteration of a complete schedule simulation the interface allows the user to set constraints and parameters of the underlying Discrete Event Simulation (DES) and observe how these settings affect the system. Simulation parameters and constraints are set by the SME using levers. The effect of changing these parameters are shown on a 'bullseye' map, where a total cost per simulation is displayed as a point on the bullseye. The closer the point is to the centre of the bullseye map, the lower the cost. Running a new simulation also produces a time based heatmap and bar chart, allowing the SME to observe a more detailed analysis of each simulation run providing them with crucial insights in their scheduling problem.
To illustrate these exploratory and planning processes we have used a Defence workforce transition example. Workforce transitions can be difficult to plan for due to a large number of unknown variables, such as future personnel inflow, unanticipated attrition, and workforce availability. This task is made especially difficult in a Defence setting, where the workforce is complex and relies on a hierarchical structure based on proficiencies gained through years of experience and training by the SME. There is also often a requirement to maintain a level of capability throughout the transition process, which adds to the complexity of scheduling transition training. By using the interactive visualisation platform, unknown variables and constraints are exposed to the SMEs. This allows for effective exploration of the problem space with realistic

options and gives SMEs the ability to understand how the different variables affect the workforce transition. This exposes various workforce risks that may have not been understood otherwise, and allows for the formulation of plans to mitigate these risks, leading to a more robust workforce transition.

AP084:
Development of the Next-Generation Off-Road Mobility Performance Models

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Off-road mobility modeling of Army ground vehicles enables performance, supports acquisition decisions, shortens testing requirements - saving time and money, and supplements testing (i.e. when conditions exceed the limits for safe occupant/driver testing). This presentation will discuss multiple efforts conducted by the Combat Capabilities Development Command Data and Analysis Center (CCDC DAC) in 2020 to develop a Next-Generation NATO Reference Mobility Model (NRMM) - the DoD and NATO standard for off-road mobility modeling for the last 40+ yrs; and how these efforts support Army operational and acquisition decisions.

CCDC DAC is collaborating with the US Army Corps of Engineers Engineer Research Development Command Cold Regions Research and Engineering Laboratory (USACE ERDC CRREL) to update the vehicle-terrain modeling capabilities and physics-based algorithms in NRMM 3.1. As part of this modernization effort, CCDC DAC has developed the System Level Analysis Mobility Dashboard (SLAMD) - a tool that eliminates the steep "learning curve" associated with traditional NRMM. Additionally, the SLAMD interface enables operators to complete far more model runs and analyses than traditional methods of running NRMM, allowing for broader sensitivity analysis. CCDC DAC is leading the verification and validation of NRMM 3.1. In conjunction with these efforts, CCDC DAC is constructing new NRMM terrains in geospecific locations that are operationally-relevant to Army senior leaders. And all of these capabilities are contributing to prepare Army for the next big challenge in ground vehicle mobility performance modeling: unmanned vehicles.

AP086:
Combinatorics Approach using Predictive Intervals (CAPI) for Forecasting Demand Boundaries

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A top priority for the U.S. Army is to make informed decisions regarding parts demand forecasts. Providing an accurate parts forecast can help item and supply chain managers with the Logistics Modernization Program (LMP) to make important decisions such as making parts purchases to meet demand of future sustainment needs. Having parts available to soldiers when they need them is a vital component of readiness and success of U.S. Army missions.

The Data and Analysis Center (DAC) has been forecasting the corrected historical demand for parts (the main component of the overall forecast) using a one year average of past parts history

for many years. In 2012, AMSAA (prior to creation of DAC in 2/2019) explored many COTS forecasting methods (ARIMA models, etc.) and compared them to the one year average. Results of this study showed no reason to change the one year average method.

DAC created a methodology to place boundaries for the one year average forecast to improve. Validation has shown that this improves it's accuracy. This improvement methodology to the one year average is called "Combinatorics Approach using Predictive Intervals (CAPI) for Forecasting Demand Boundaries". This AORS presentation focuses on the development, validation, and application of this enhancement methodology to the one year average forecast. DAC has not applied this enhancement yet and are in the process of vetting this with the TACOM and CECOM item and supply chain managers.

DAC envisions that the CAPI approach will applied to other analytic efforts.

AP087:
Recipe for Using R Products to Produce Ad-Hoc Tables/Reports from Ad-Hoc Data

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During the discovery phase of an analysis of alternatives (AoA), alternatives and data describing them are in flux, yet the customer wants reports, whose content frequently changes as what is deemed important continues to emerge.

This paper provides a recipe for using R tools to automate the generation of these ad-hoc reports based on ad-hoc data collection. In particular, this paper explores the case of storing data of dozens of alternatives in multiple spreadsheets and creating tables summarizing certain qualities of each alternative by category. Also explored is using the same data set to produce a synopsis of each alternative. The technique uses R Markdown page that includes R scripts to read, join, and filter data and then create formatted tables and documents.

The advantage of this technique is the creation of these dozens of products by only changing several portions of the RMarkdown page and R scripts. The paper then suggests how one might facilitate those changes from a spreadsheet leaving the Rmarkdown page and R scripts untouched.

AP090:
Modeling, Simulating, and Assessing Competition and Penetration

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The United States Army Multi-Domain Operations (MDO) concept requires a calibrated force posture (CFP) -- the appropriate units and capabilities at the desired time and place -- to enable achievement of United States national security objectives. Much quantitative-based analysis of armed conflict exists; however, there is a dearth of quantitative-based analysis examining the

competition period. Army Futures Command leaders directed The Research and Analysis Center (TRAC) analysis to identify OPTEMPO implications and potential CFP strategies that expand the competitive space and provide credible deterrence. Utilizing a supply and demand approach within a discrete event simulation, TRAC assessed the sufficiency of the established 2035 AimPoint Force structure to fulfill the capacity and capability demands throughout MDO competition and the transition to armed conflict periods. The assessment explored assumptions, mission demand satisfaction across time and unit preference, and unit utilization to inform CFP strategy options and resourcing decisions.

This presentation describes the objective, scalable, repeatable, and flexible analytic methodology used to inform CFP trade-space and win in competition.

AP091:
Operational Impacts of Modernization Decisions

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The Army Modernization Analysis (AMA) is an analytic approach led by The Research and Analysis Center (TRAC) to integrate modernization analysis across concept development, future force designs, and program investments to inform critical modernization decision forums. Recognizing the challenging fiscal environment facing Army Senior Leaders, the AMA focused on developing a Trade-Space and Decision Exploration System (TRADES) to make informed, cross-portfolio investment trades.

The TRADES tools compares multiple, dissimilar programs through an assessment of the operational benefit of a given program and its relationship to a set of operational measures. Operational benefit is defined as the contribution the formations provide to the force in future armed conflict, when equipped with a given capability. Benefit is measured along several metrics, aligning closely to warfighting function at echelon. This enables the comparison of programs across different operational areas. The team drew data from completed and on-going studies, analysis, and wargames to inform operational benefit to the future force for each program at various fielding levels and in two theaters. This presentation provides an overview of the approach used to define, measure, collect, and assess operational benefit for the Army Modernization Analysis TRADES Tool.

AP092:
Incorporating a Fault Prediction Model into Maintenance Planning

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In a military aviation unit, the efficient and intelligent use of maintenance resources drives the availability of aircraft for missions. Even with good planning, unscheduled maintenance can disrupt schedules for flights and maintenance. To minimize downtime from unscheduled maintenance, the Department of Defense (DoD) is investing in predictive maintenance research, which includes the development of component-level fault prediction models. We focus on two

questions related to these prediction models: 1) "What do units do with the predictions?" and 2) "How good do the prediction models have to be?"

Units will need to adjust existing maintenance processes when they begin fielding component-level fault prediction models. The best use of these models for minimizing downtime might not be to execute a repair every time the model predicts an impending failure. In some cases, it could be advantageous to embed the repair in the existing preventive maintenance schedule, either by waiting to repair the failing component until preventive maintenance is due, or by executing preventive maintenance early.

This paper develops a framework for integrating a fault prediction model into a military aviation unit's existing maintenance decision process. We then leverage this decision framework for determining the characteristics of components where a fault prediction model could be most beneficial. Additionally, we develop a method for determining the minimum required performance of a fault prediction model for it to impact the decision process. A better understanding of these aspects can inform enterprise-level research and development investments for future component-level fault prediction models.

AP093:
Combating the Impact of Operating in Resource Constrained Environments with Data Analytics: A Fiscal Management Case Study

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Abstract: Resource constrained environments challenge the Finance & Comptroller Branch to better maximize the impact of available funds while coping with a reduction in manpower to perform budget execution. This presentation details how the Combined Security Transition Command-Afghanistan (CSTC-A) Resource Management (RM) Section altered daily operations to more efficiently compile actionable information for senior leaders by employing systems analysis and data analytics. CSTC-A budgets, requests, and executes the Afghan Security Forces Fund (ASFF). The appropriation is historically a $4 billion dollar Operations and Maintenance (O&M) fund that supports the sustainment of the Afghan Security Defense Force. CSTC-A's RM Section runs a completely integrated financial operation. It is responsible for programming future years' requirements, submitting an annual Congressional Justification Book (J-Book), executing two concurrently available years of O&M funds, and accounting for prior year balances. Daily monitoring of ASFF execution and account balances requires Resource Managers to ingest and process data from three Financial Systems – the Army's General Funds Enterprise Business System (GFEBS), DSCA's Security Cooperation Information Portal (SCIP) and the Afghan Government's Afghan Financial Management Information System (AFMIS). Over a one year period, the CSTC-A RM-R office employed efficiencies to reduce manpower needs by using Power BI to compile and consolidate reports from various financial systems. The goal was to provide key senior leaders with a common, accurate picture of the fiscal trade space. Within 11 months the effort saved the command over 2000 man hours and $54M in savings.

AP094:
Distributed Low-Energy Wastewater Treatment

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ERDC-CERL's Distributed Low Energy Wastewater Treatment (DLEWT) team developed and built the world's first containerized wastewater treatment system revolutionizing wastewater treatment and DOD energy resiliency and security. DLEWT transforms wastewater into two harvestable fuels, methane and hydrogen, and creates reusable water while using approximately 80% less energy than traditional treatment methods. DLEWT technology has significant potential to reduce energy consumption, sludge production, and maintenance requirements in comparison to traditional wastewater treatment methods, in addition to generating usable fuels and water for reuse applications. Development of the DLEWT system has resulted in one patent being awarded to ERDC-CERL for the ammonia sequestering system, and a second patent discovery for the entire system design is currently underway. The DLEWT system converts the DoD's wastewater treatment from a liability into an untapped resource, generating fuel onsite and supporting the Army's 14-day resiliency requirement with the potential of saving the DoD billions of dollars in annual wastewater treatment costs. DLEWT represents cutting edge advancements in wastewater treatment technology that address critical Department of Defense (DoD) needs and requirements to reduce water and energy use across its sites. The Department of Defense (DoD) spends millions of dollars each year treating wastewater using conventional wastewater treatment methods that are energy intensive, do not specifically produce reusable quality water, or harvest byproducts for energy production. An energy efficient wastewater treatment system is needed to meet ongoing sustainability goals. The team designed and developed the DLEWT system starting with a concept, researching the basic science, building and testing a bench scale version, and culminating the effort into a 1000 gallon/day field system. The DLEWT technology harnesses the benefits of anaerobic digestion while treating ammonia as a resource. The innovative approach symbiotically integrates technologies to treat wastewater in a manner that reduces energy consumption and generates useful fuels. The system is made up of three major subsystems (1) Anaerobic Membrane Bioreactor (AnMBR), (2) clinoptilolite ion-exchange and (3) ammonia electrolysis. This modular treatment technology is designed for distributed requirements at fixed sites, serving remote training areas, contingency bases, and disaster relief efforts.

AP095:
A Model for Optimising Personnel Allocation under Uncertainty

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We describe a generic approach using stochastic programming and network flow principles, that has been developed to address some typical recruitment and training challenges in Australian Defence. Specifically our methods apply to answer questions like: how many people to recruit, how many to promote, and how to allocate personnel to postings. Our aim is to allocate the right number of people with the right skills at the right time to maintain operational capability across

units at minimal cost. An important issue handled by our approach is the uncertainty of parameters such as course pass/fail rates and attrition.

These methods apply to both promotion structures and training schedules. Their structures are modelled as directed graphs and the control variables in the optimization problem are represented in terms of so-called 'Delta Matrices'. These are decision operators for the allocation of personnel from one node in the graph to another to which it is linked. The objective is to minimise the number of new recruits while attempting to meet the required numbers of personnel in different units subject to a given risk of failure to achieve that capability. The algorithm described here finds good solutions yet is significantly faster when compared with MDP and MIP techniques. The method has been successfully applied in a practical context in Australian Defence pilot training, submarine officer career progression and Army helicopter pilot transition studies.

In the case of training, for instance, nodes in the graph correspond to courses and arcs between nodes that provide a model for prerequisite structures. Failure rates in some courses are high and are highly variable, as can be attrition rates in units. Uncertainties of this kind are modelled by probability distributions that can be generated from historical data. In this context, it is impossible to achieve a required number of personnel in any unit with certainty, at least within reasonable costs. Instead we pose these constraints in terms of risk; that is, the probability of achieving the required number of personnel based on the pass/fail and wastage distributions provided for each of the arcs.

In order to optimise the personnel allocation and recruitment in the workforce structure described by this directed graph, we utilise a technique from the area of Network Flow, specifically, a Push-Relabel Min-Cost Flow algorithm. We first solve a simplified subproblem where, for each arc in the directed graph, we apply a cost equal to the average attrition rate or course pass rate, and solve the resulting Minimum Cost Flow problem for the required number of personnel in the unit nodes. This generates a solution that describes which paths from our recruitment source node to unit nodes have the lowest losses when taking into account attrition, course failures, and capacity constraints. From this, we generate Delta Matrices that divert flows of personnel from each node in the same loss-minimising way, but considering all possible outcomes of inflows into the node. The risk constraints at the unit nodes are achieved by backpropagating the risk targets back through the graph with the defined attrition and course failure transition matrices, as well as Delta Matrices, to obtain a necessary level of recruitment.

We will present the results of some small simulations for the Australian Army pilot training programme. These demonstrate that the algorithm achieves close to optimal results when compared to MILP, yet it is able to reach this solution in significantly less time than MILP on a similar machine.

AP097:
Strategic Fires Study (SFS): Fast-track Toward Army Modernization

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Since the United States' (U.S.) withdrawal from the Intermediate-Range Nuclear Forces Agreement in August 2019, the U.S. Army has focused on rapidly developing its surface-to-

surface fires capability at ranges beyond 500 kilometers. The Army is currently investing in emerging strategic and operational fires capabilities that require analytic comparison to enable Army senior leaders to understand the risks and trade-offs between multiple technologies that will overmatch future threats. SFS was a 4 month effort to rapidly explore the performance, cost, and schedule of intermediate and long range fires capabilities that enable multi-domain operations and support the Joint Force by 2028. The study team identified high payoff science and technologies and requirements which served as input to the fires portion of the Army Fiscal Year 22-26 Program Objective Memorandum development.

This presentation will describe the unique challenges the SFS overcame to inform Secretary of the Army and Army Futures Command decision points as well as the processes, methods, models, and tools employed that enabled the on-time delivery of this critical analysis.

AP098:
Continuous Autonomy Simulation Test Laboratory Environment (CASTLE) Verification and Validation (V&V)

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Autonomous systems incorporate multi-disciplinary technologies including artificial intelligence, sensors, actuations, controls and controlled vehicles. The complexity of autonomous systems and their development makes credible evaluation of the systems impossible without aiding technologies such as modeling and simulation (M&S). The Continuous Autonomy Simulation Test Laboratory Environment (CASTLE) was developed by CCDC GVSC to fill this gap so that the performance of the autonomous systems could be predicted and evaluated in a timely and cost-effective manner.

CASTLE employs state-of-art technologies and integrates many subsystems and components with a wide array of physical representations and interactions. This complexity, along with the cutting-edge purpose of assessing autonomous vehicle software by connecting physical vehicle hardware and software into a simulated environment, makes the Verification and Validation (V&V) of CASTLE a complicated and novel effort. This presentation will present the challenges, applied methodologies, and emerging results of the Combat Capabilities Development Command Data and Analysis Center's (CCDC DAC) verification and validation of CASTLE.

AP099:
Simulation System Requirements and Assessment Tools for Software in Loop Testing of Autonomous Systems

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System design informed by simulation offers the opportunity to increase development speed and decrease the cost of physical testing. Additionally, simulation offers the capability to test systems under conditions that would be difficult, risky, or impossible to perform during physical testing.

The Combat Vehicle Robotics (CoVeR) is researching autonomous tactical capabilities needed by the military to succeed on modern and future battlefields. Autonomous vehicle operation represents a significant increase in the complexity of combat vehicles and weapon systems with uncharted pathways for undesired emergent behavior. This research identifies a set of high level simulation system requirements that can be used to inform Software in the Loop (SIL) development. Additionally, it proposes specific derived requirements for SIL simulation and the development for such a computation environment applied to the CoVeR programs Engineering, Evaluation and Test (virtual EET). Finally, this research proposes SIL assessment criteria and apply these to the Simulation Tools for CoVeR SIL during the FY20 EET. This system assessment is focused on providing the Simulation Tools for CoVeR team with actionable feedback to focus future research and development using a modified Tradespace Methodology approach. The SIL is assessed for technical, usability, and logistics attributes.

AP100:
Human Dynamics Analysis: Using Modeling to Build Resilience in Planning and Operations

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"The enemy gets a vote." We've all heard the phrase; it echoes across history from luminaries as far back as SunTzu and Polybius (as he discussed Hannibal) to modern uses by leaders such as James Mattis. But how do we gain insight on what 'vote' the enemy is casting? What will our adversaries—or allies and partners for that matter—decide to do, or how will they react to outside influences, especially in response to military operations? Through modeling and simulation and/or war gaming we've greatly improved our ability to analyze campaigns and combat operations, but who models the adversary's decisions? Usually, it's that really smart, well-studied intel analyst or planner who provides their subjective assessment. However, that assessment often is tinted by a biased lens or shrouded in mirror-imaging (i.e. reflecting our own decision if we were placed in the same situation).

As we seek to build greater resilience, we need organizations that recognize complexity, identify risks, and prepare for uncertainty in potential outcomes through adapting and planning. We need to find a better way to understand the humans making decisions within our sphere of influence. U.S. Central Command is investing in the on-going development of a Human Dynamics Analysis capability. It takes multiple, sometimes varied, inputs from subject matter experts and builds simulations that model stakeholder influences, group interactions and dynamics, and provides predicted outcomes for a given situation. The selected software takes the subjective assessments of our best planners and analysts and models them through social science-validated algorithms that allow testing of the simulation for robustness in the face of varied opinions. Ultimately, these models produce repeatable, reliable and objective simulations of stakeholder behavior in a negotiation space which allow analysts to develop both predictive and prescriptive analysis.

In the next crises, predictive Human Dynamics analysis builds unit resilience through an understanding of how key stakeholders (friendly, neutral and adversarial) view risks, opportunities, and possible leading indicators. This deeper understanding of personalities and

groups allows commanders to adapt operations and cue their messaging and engagements, and it allows planners insight to develop critical branches and sequels to near-term operations. In the more deliberate process, prescriptive Human Dynamics analysis shows the power of repeatable, reliable, objective simulations, and develops the ability for commanders and planners to strengthen their design and planning processes by understanding how personality influences can be leveraged side-by-side with the kinetic and non-kinetic operations to achieve desired outcomes.

AP101:
Development of Geo-Typical Urban Terrain Templates for Network Analysis

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The U.S. Army lacks an efficient method to model diverse urban environments for use within Network and Communications analysis and across other cross-functional team (CFT) disciplines. Operationally-relevant urban data is not available in many regions or may not be in a form that can be rapidly ingested by existing modeling and simulation (M&S) tools. This lack of appropriate urban models greatly reduces the Army's ability to perform quick-turn analysis in urban environments.

To combat this limitation, the U.S. Army Combat Capabilities Development Command Data and Analysis Center (CCDC DAC) has created an Urban Terrain Template (UTT) development methodology and utilizes robust RF propagation models, particularly Vertical Plane Launch (VPL), for network analysis in urban environments. The UTT methodology has been established in order to quickly generate realistic, 3-D terrain and building data in a form that can be readily used by VPL for quick-turn analysis. To organize, store and make urban products available to the wider analysis community, a repository of urban terrain templates has been established, which holds all urban templates and associated analysis results.

The UTT methodology and repository provides the Army with an expanding collection of urban environment data for use by M&S urban analysis tools. Realization of this capability allows the Army to access and analyze the performance of innovative technologies and deployments, such as new network architectures, more quickly against a diverse set of urban conditions. The UTT methodology and its data products enable comparative studies of systems across the Army's CFTs to be performed early in the acquisition cycle, which greatly reduces response time to confidently respond to questions from Army Leadership. With the Army's increasing interest in modeling and analyzing military operations in urban settings, CCDC DAC will continue to provide the Army and wider analysis communities with representative urban models and collect requirements to develop additional urban areas of interest.

AP102:
Rapid Development of New Model to Quickly Evaluate Air Defense Battery Effectiveness. (Air Defense Raid Analysis Tool (ADRAT) Development, Using Python, and Employment)

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Air Defense (AD) systems are typically deployed as batteries or platoons. Therefore battery or platoon effectiveness is the desired measure of AD effectiveness in Army studies. Traditionally AD battery effectiveness is modeled using force-on-force models like the Extended Air Defense Simulation (EADSIM) and more recently the Advanced Framework for Simulation, Integration and Modeling (AFSIM). Both EADSIM and AFSIM require extremely detailed scenario inputs, item level performance data, long set-up times and a steep learning curve. CCDC DAC did not have a tool that could support quick-turn AD battery effectiveness analyses. In May 2019, DAC developed the Air Defense Raid Analysis Tool (ADRAT) in Python to support an AMD CFT quick turn analysis of Complementary Analysis S&T enablers. The model has been updated several times and used to support both Air and Missile Defense CFT and Long Range Precision Fires CFT studies. This presentation details the unique software development and review process that allowed for rapid coding of the initial version in under two weeks and a high level summary of the types of analysis conducted with ADRAT and decisions supported.

AP105:
Component Error Representation of Sensor Target Location Errors (TLEs)

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Currently, when the CCDC (Combat Capabilities Development Command) Data and Analysis Center (DAC) supplies the Target Location Error (TLE) for various sensors so that the Modeling and Simulation (M&S) community can represent the uncertainty inherent in measuring the location of an object, we supply a single 50% Circular Error Probability (CEP50) value as a function of range. CEP50 is not an ideal metric because a sensor's TLE is often not circular in nature. Further, users cannot remove the component of the TLE that is due to self-location error -- this makes it difficult for the M&S community to model the effects of a loss in GPS capability. In addition to CEP50, we have expanded our models so that we can now estimate the downrange, cross range, and vertical TLE for various sensors including: GMTI and SAR RADAR, Laser Range Finders and EO/IR sensors, as well as SIGINT systems. By including these additional parameters, the M&S community will be able to more accurately represent the TLE of a sensor and will be able to expand their efforts to play scenarios that they were not previously able to simulate.

AP106:
Insider Threat Anomaly Detection on Network Traffic

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Insider threats are a constant worry for any network, but are especially egregious for the Army network because of the potential sensitivity of the data stored on the network. Because of this, it is essential for the Army to develop some technique for identifying insider threats before these threats can cause harm to national security. The complexity of this task increases exponentially because of the sheer volume of data moving over the Army network at any time.
This project focuses on network traffic clustering using machine learning techniques and characterization of clusters to identify the sources of data that form individual clusters. Characterization of clusters may be based on the nature of activity performed (such as video conferencing, web access, and email) and can help us identify associated types of devices (such as printers, surveillance cameras and other machinery) and types of activity (such as voice over IP, email and web access). Further, such characterization could be useful for identifying users on the network and the type of work they may be engaged in.
The clustering and identification techniques developed will help to identify anomalous activity on the network and will set a baseline for what is acceptable activity on the network. The goal of this project is to create a dashboard for continual monitoring of the network enabling network administrators to rapidly detection and neutralize insider threats on Army networks.

AP107:
Analytic Application Development, Delivery, and Sustainment Considerations

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Applied research conducted by The Research and Analysis Center (TRAC) often results in the creation of analytic applications deliverable to the customer or research sponsor. TRAC commonly uses robust, open-source platforms such as R Shiny and Python's Dash for application builds, but this software is difficult to deploy on government networks and is susceptible to brittleness and degradation, especially in the hands of non-technical customers. TRAC's experience in packaging, deploying, and sustaining a diverse suite of analytic applications for various customers has inspired innovative methods such as packaging applications as executable Windows programs and employing elegant design techniques to refactoring applications with lower sustainment requirements. This presentation provides an overview of the common challenges encountered as well as techniques and processes for analytical organizations to mitigate the pitfalls so as to aid other organizations in designing and delivering analytic applications to stakeholders of varying technical expertise.

AP108:
Using Data Science to Increase Recruitment at the Defense Language Institute

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The Defense Language Institute Foreign Language Center's (DLIFLC) mission is to provide the highest quality culturally based foreign language education, training and evaluation to enhance the national security of the United States. The linguists trained at DLIFLC are crucial at the tactical through strategic level in understanding foreign language communications. Recently, senior leaders have mandated that DLIFLC increase their already high graduation requirements to meet operational requirements. As such, admission standards for DLIFLC are high. Currently the Army uses the Armed Services Vocational Aptitude Battery test (ASVAB) and the Defense Language Aptitude Battery (DLAB)to evaluate a recruit's ability to become a linguist and attend DLIFLC. However, the numbers of DLAB testing centers are few and only about 3% of recruits are able to take the DLAB. As a result, in recent years the Army has failed to meet its linguist recruitment goals by 40%. Therefore, the Army is interested in using ASVAB scores and other relevant metrics to predict a recruits potential for success at DLIFLC in lieu of taking the DLAB. The overall intent is to increase the pool of qualified recruits. TRAC assisted DLIFLC leadership in creating statistical models to assess the worthiness of using these alternative metrics in predicting student success at DLI.

AP109:
Closing the Gap Between Materiel, Information and Payment Flows

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Companies spend significant resources on digital transformation projects that do not always meet expectations. This thesis contends that these projects fail or fall short because organizations do not consider the three fundamental flows of a supply chain; materiel, information, and payment. To address the issue, this thesis develops a lens to identify mismatches between materiel, information, and payment flows, and applies this lens to putaways and the post goods receipt process in the US Army's supply chain. The thesis identifies an increased risk of loss for putaways confirmed before physical movement could take place, and confirmations that occurred after seven days. The thesis recommends measuring putaway time as a key performance indicator and establishing a two duty-day key performance standard, which would hypothetically lead to a reduced rate of loss. With respect to the post goods receipt process, it was found that a failure to confirm goods receipt led to the creation of millions of dollars in phantom inventory and late payments. This thesis recommends allowing customers to pay for materiel even if intermediate digitized information flows were not confirmed. It also recommends monitoring materiel available to be received so that leaders can spot and address errors. By considering the three fundamental flows of a supply chain, digital transformation practitioners can achieve better results.

NOTES:

I am submitting my thesis prepared in partial fulfillment of the requirements for the Degree of Master of Engineering in Supply Chain Management from the Massachusetts Institute of Technology.

I submitted and received approval for my research to be published from the Defense Office of Prepublication and Security Review on 11 June 2020. Their approval is annotated on the attached dd1910.

AP110:
Introduction to Artificial Intelligence

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The Army has made it clear that its future includes autonomy and artificial intelligence (AI). But what is AI? How do its practitioners think about the systems they build and the environments in which they operate? What tools are in their toolbox? This tutorial gives a high-level introduction to AI based on the University of Delaware's "Introduction to Artificial Intelligence" course and the text, "Artificial Intelligence – A Modern Approach" (3rd ed.) by Stuart Russell and Peter Norvig. It presents the most common concept of AI, explains how problems and systems are described, and reviews different ways of implementing "intelligence." It will give you the basic tools to start exploring the more accessible AI literature.

AP113:
The Future of Data Standardization and Repository: Squad Performance Model

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Working Groups: WG2, WG5

Historically, objective and subjective data are collected to investigate questions of interest, used for a short term analysis, and then stored in a variety of ways, including external hard drives, hard copies, delimited files, etc. To date, the Army has not had a repository to store this type of experimentation data. With the recent advent of the Army Experimentation Resource Data Repository (AERDR), this is about to change. Here we present a representative study, traditional outcomes, and novel subsequent use and storage of the data for future use in acquisition decisions or future research.

Squad Performance Metrics Line of Effort (LOE) within the Soldier Lethality Cross-Functional Team identified the need for a Squad Performance Metric Framework to develop a decision support tool and produce a Squad Lethality Rating. Battle Drill 1, 2, 2A, and 6, and expressed tasks of Soldier/squad lethality, including variables such as mobility, navigation, survivability, and training performance were evaluated. A squad's ability to shoot, move, navigate, communicate, protect and sustain was evaluated including tasks such as physical fitness, a 6 to 12-mile road march, individual and team/squad obstacle course, squad build movement, casualty care and evacuation, marksmanship, and land navigation assessments. Additional data included objective

input from cadre through a grade-book and subjective input from squads through questionnaires and after action reviews.

While the analysis and report of the outcomes to the LOE would have been the traditional 'end point' for this effort, the recent development of the AERDR provides a means to store the data for additional analysis and connect it to other systems that would also make use of it such as FORGE. This presentation will include the background for a Squad Performance Metric Framework, an overview of field experiments and a summary of the AERDR which will house, preserve and make the data available to the Army analytical community for future use.

AP114:
Air and Missile Defense Beyond 2035, Air and Missile Defense Concept Development and Assessment

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"What is the next Army layered air and missile defense concept that contributes to Joint defensive counterair beyond 2035?"

Gen. Murray CG, AFC, directed The Research and Analyst Center (TRAC) to execute a three-month sprint focused on future (beyond 2035) layered air and missile defense (AMD). The sprint's deliverables are a set of future layered AMD frameworks comprising relevant research topics and future technologies with associated how-to-fight concepts. The sprint team received input from future operational environment experts and technologists to develop research and technology driven AMD concepts, which science and technology investments informed. The scope of this analysis encompassed theater and below Army defensive counterair and accounted for Army AMD interactions across all domains, with the priority theater being the Indo-Pacific region followed by the European theater.

This presentation will discuss the sprint's lines of effort specifically addressing the methodology and techniques applied to develop future AMD layered concepts.

AP115:
Analytical Support to the Commanding General's COVID Messaging

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Working Groups: WG10

In the spring of 2020, the rise of COVID-19 became a major challenge for organizations across the Army to contend with. Army commands quickly organized in ways that sought to create the best response to mitigate the growing medical threat. The Commanding General of I Corps at Joint Base Lewis-McChord held weekly Facebook Live Town Hall events, in which any person

watching could ask a question pertaining to COVID response and policy adjustments. In order to fully understand the themes of the audience's issues, a cross-functional team was formed, consisting of the I Corps Public Affairs, G39 Information Operations, and Operations Research / Systems Analysis (ORSA) officers. The purpose of this team was to develop recurring messages for the Commanding General (CG) to inform the public on concerning I Corps and JBLM's response to COVID-19. This methodology for this response began with an an Excel-based key word data binning methodology, and resulted in a machine-learning algorithm in the Python coding language. Other Army commands could benefit from this innovative process, in order to gain insight to audience cares and concerns during a key leader town hall event.

AP116:
The Impact of Two versus Three Soldier Crews in the Next Generation Combat Vehicle

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The Army Modernization Plan spans eight cross functional teams to address critical needs, one of which is the Next Generation Combat Vehicles (NGCV) , with the Optionally Manned Fighting Vehicle (OMFV) as one of the major components of the NGCV effort.

One of the options being considered for the OMFV is reduction of the crew from three (driver, gunner, commander) to two crewmen.

This paper used existing literature to evaluate the probable effect of going from a three person crew to a two person crew in terms of workload, task distribution, cognitive overload conditions, and conditions that may exceed the knowledge skills and abilities of the crew. Studies and IMPRINT based workload models from the Future Combat System and from work supporting the NGCV program were used to demonstrate that a 2 Soldier crew would probably lead to reduced mobility and lethality due to workload and task conflicts.

The paper includes a brief review of emerging technologies which might be used to mitigate the performance loss associated with reducing the OMFV crew to 2 Soldiers.

AP117:
A Distributed Intelligence Framework for Cyber and Electromagnetic Technologies to Support Expeditionary Cyber as a Sociotechnical Challenge

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This paper is a preliminary study for a larger scale phase two effort. It establishes a preliminary concept for a distributed intelligence framework for Expeditionary Cyber. The general concept will serve as a foundation for critical new forms of Analysis and Assessment. The knowledge elements will serve as a cognitive framework for smart radio and network platforms critical to realizing cognitive radio capability. The era of 5G deployment is giving way to research in the 6G era that will make cognitive radio a reality. Joseph Mitola coined the term "cognitive radio" and his concepts on cognitive radio and cognitive networks are the inspiration for this research. The technical feasibility of cognitive systems is due to advances in network and data science, in addition to technical advances in Artificial Intelligence and Machine Learning. The work described in this paper presents a soldier-partnered research initiative driven by West Point and the University of Arizona in collaboration with the CCDC Army Research Lab and CCDC Data and Analysis Center's Cyber Experimentation and Analysis Division. The operational environment for deployment of this research is the future envisioned in a white paper by Army and the Marines called Multi-Domain Battle (MDB). MDB concepts have moved forward into the current Army operating concept called Multi-Domain Operations (MDO).

AP118:
Modeling Army Layered Air and Missile Defense (AMD)

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The Extended Air Defense Simulation's (EADSIM) significant capability to model highly integrated interoperability between sensors, shooters, and command and control in a layered air and missile defense environment has evolved over the years. EADSIM has the ability to model levels of interoperability between multiple systems ranging from totally independent operations to fully cooperative weapon allocation and decision making required to realize full potential in the multi-domain environment. EADSIM includes extensive coverage for a wide range of sensor technologies integrated into any system on the battlefield, as well as addressing contributions to the situational awareness and fire control from a fully networked architecture of sensors. Furthermore, EADSIM can quite comfortably model a mixed air and missile defense deployment, whether that be consideration of longer range threats handled with similar technologies or layers of disparate technology for shorter range or possibly close in threats, such as UAS, cruise missiles, and Rockets, Artillery, and Mortars (RAM). EADSIM has been used extensively not only in evaluation of conventional kinetic kill capability, but also with directed energy capabilities, e.g., High Energy Lasers (HEL). This is not just the deployment of the different weapon systems, but also the networking capabilities and the requisite command and control flexibility to allow preferential usage of the available technologies to efficiently counter the perceived threat as these systems simultaneously operate within a multi-domain environment.
This presentation will highlight capabilities specifically focused on layered AMD operations.

AP120:
Modeling Timing Error Impacts on Operational Capability

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The Extended Air Defense Simulation (EADSIM) Development Team was approached on the potential to evaluate and demonstrate impacts of Position, Navigation, and Timing (PNT), specifically timing errors, upon a multiple sensor kill chain. EADSIM is a many-on-many simulation of air, missile and space warfare. It provides modeling capability for all of the relevant players for this evaluation. Fully operating on each player's perception, detailed algorithmic models would be directly impacted if timing errors were injected. In fact, the team had firsthand experience with timing errors. The EADSIM framework supports running much faster than real time for constructive analytical simulation. In addition, it is frequently slowed down to real time to communicate directly with other systems using an array of mechanisms: Distributed Interactive Simulation (DIS), High Level Architecture (HLA), and direct tactical communications. We had experienced issues in these real time venues whenever computers were not synchronized, and had experienced issues when another system was not correctly accounting for the timing delta between Global Positioning System (GPS) time and Universal Time Coordinated (UTC) time. An unmodified EADSIM Version 19 could have been used to evaluate this problem by creating real timing errors; however, it would have required multiple computers, been limited to real time, and been marginally repeatable.
This presentation will illustrate the class of problem that was investigated and the minor modification that was made to allow modeling of the timing error in a faster than real time, repeatable, analytic construct.

AP121:
A Hybrid Approach to COVID-19 Prediction Using Machine Learning and Poisson Regression

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The United States is facing one of its most difficult challenges in history as it tries to mitigate the impacts of the COVID-19 virus. Reporting lag/error, differing policy implementation from state-to-state, and a general lack of knowledge regarding the virus' transmission and treatment creates challenges when trying to predict these impacts on the population and readiness of the U.S. Army. When knowledge is limited and cause and effects are not available, Machine Learning is one of the best candidates to analyze and predict outcomes of interest. This analysis proposes a hybrid approach of Machine Learning and traditional Poisson model to predict cumulative deaths for each US County for 30 days and identify hot-spot clusters using late March and early April data, as the Poisson distribution is among the commonly applied modeling distribution for disease outbreaks and can be used to project cumulative deaths. Using Principle Component Analysis, new variables can be ascertained to reduce codependency and input into K-Means Machine Learning algorithm to form relative hot-spots. These hot-spot identifiers were then applied as a

predictor to the Poisson Regression model for cumulative deaths prediction. The validation for a 1-week prediction for early April data came back with an R2 of 0.7, which is relatively accurate given the many challenges in the data. Given more information as time has passed, this model could be very useful for predicting risk of U.S. Army Installation re-openings in support of readiness across the United States.

AP122:
COVID Modeling at Center for Army Analysis and Estimating the Effective Basic Reproduction Rate (R0)

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In epidemiological models, the basic reproduction rate, R0, is the average number of infected contacts per infected individual. This number is important in an SEIR (Susceptible, Exposed, Infected, Recovered) model as it controls the rate of spread of a disease throughout the population. With an R0 greater than 1, the virus will eventually spread to the entire population. With an R0 less than one, it will die out over time. This number is influenced by characteristics of the disease, external factors including population density and social attitudes and norms, as well as many other factors. In the Center for Army Analysis' efforts to model the coronavirus disease (COVID-19) for the United States Army, we used several machine learning techniques to best capture the viruses past basic reproduction rate as well as make projections into the future to model the spread of the disease as it moved sporadically and unpredictably across the country. We'll talk about what worked, what did not work, and ongoing efforts to model this epidemiological rate.

AP123:
Numerical Modeling of Vehicle Barriers to Develop Calculation Analysis Methods

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The reoccurring hostile vehicle ramming attacks in Europe and USA require protective solutions for civilian and military infrastructure. There is a need for new assessment methods of passive protective elements to counteract these persistent threats. Current standardization and certification of vehicle barriers relies only on physical testing which is laborsome, expensive, and limited. Calculation methods must be developed to evaluate existing and new passive protection elements to expand and improve protective options. This study will use numerical simulations to develop alternative test methods. These alternative test methods will be evaluated and used to develop accurate computational methods for evaluating vehicle barrier performance against vehicle impacts. The new analysis capability will allow for optimal planning and design of protective elements that accurately account for unique individual case scenario variables.

AP124:
Effects of Weaponized Commercial Unmanned Aerial Vehicles (UAVs) on Structures, Experimental Testing Comparison to Numerical Models

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Abstract for wUAV Part 1 (research completed OCT2019 for ISIEMS):
We explore the effects commercial unmanned aerial vehicles (UAVs) weaponized with explosives have on reinforced concrete roof slabs to understand the criticality of this emergent threat tactic to at-risk buildings. This study utilized Vulnerability Assessment and Protection Option (VAPO) software and more sophisticated finite element analysis (FEA) methods to predict structural damage and human occupant injuries. Comparison of analysis method results suggest that engineers can use VAPO to assess the effects of contact bursts of relatively small explosives on buildings from weaponized UAVs (wUAVs). Typical reinforced concrete roofs will protect building occupants from injury from the most prevalent wUAV munition, a 40 millimeter (mm) high explosive (HE) grenade. A commercial UAV weaponized with explosives to a maximum payload of "Explosive 2" will breach the roof slab, and cause casualties and/or fatalities to building occupants directly under the contact burst location. The criticality of this threat tactic will increase in future years as UAV technologies continue to progress and provide higher payload UAVs and lower prices. Since new buildings typically have design lives of 25-50+ years, protective design engineers should already start accounting for wUAV threat tactics with adequate building materials and mitigating features.

Abstract for wUAV Part 2 (research planned for summer 2020 pending COVID-19 restrictions):
We propose researching the effects that commercial unmanned aerial vehicles (UAVs) weaponized with explosives have on reinforced concrete roof slabs. This research is required to understand the criticality of this emergent threat tactic to at-risk buildings. Previous research by Turygan utilized Vulnerability Assessment and Protection Option (VAPO) software and more sophisticated finite element analysis (FEA) methods to predict structural damage and human occupant injuries. Recent research by Sielicki performed experimental testing of weaponized UAVs (wUAVs) to study the fragmentation distribution and energy. We will now collaborate to perform experimental testing and additional corresponding numerical modeling of wUAVs in order to more accurately understand the structural loading and effects of this threat tactic.

AP125:
Retention and Recruiting Data Analysis

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A recent study by the Government Accountability Office found that more than 60% of recent federal employee hires left within two years. With the changing multi-generational workforce and the increasing benefits offered by industry, the federal government must adapt if it wishes to retain

employees. Before determining policies, however, a federal organization must understand its current state of retention and the factors impacting that retention.

To achieve this goal, The Research and Analysis Center (TRAC) embarked on a comprehensive data collection and analysis effort to develop an organizational employee database that provides richer and more timely information than is accessible from current Department of Defense HR systems. The study team analyzed this data using industry-standard retention metrics, as well as longitudinal trends and cohort survival curves. The study results give organizational leaders a quantified look at how the employee population changed in the last 10 years, highlight the impacts of those changes on retention, and provide a tool for continuous analysis for years to come. Insights from this analysis inform workforce planning initiatives including recruitment, hiring, and professional development reform.

This presentation will share insights from the retention study, the analysis approach, and the R Markdown document used to present the analysis.

AP126:
Tactical Intelligence Targeting Access Node: Analysis of Alternatives

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Current Army ground stations lack the technical architectures required to support Long Range Precision Fires targeting in Joint All Domain Operations. They also lack the ability to rapidly incorporate new technologies, data processing advances, sensor innovations, machine learning, and artificial intelligence (AI). An envisioned future Tactical Intelligence Targeting Access Node (TITAN) ground station capability would enable deep sensing and targeting by providing near-real time access to space, aerial, and terrestrial layer sensors and by utilizing AI to expedite sensor-to-shooter kill chains. Army senior leaders requested The Research and Analysis Center (TRAC) lead a cross-functional, multi-agency team to complete an analysis of ground station alternatives (AoA) by December 2020.

TRAC will examine how experimental AI technologies impact the operational benefits each alternative offers by echelon. The analysis will also determine the implications of these AI technologies on cost, schedule, and doctrine, organization, training, leadership, personnel, facilities, and policy. These analytic results lay the foundation for identifying resource-informed trade space in order to inform an affordable and achievable set of TITAN requirements and investment options.

This presentation describes the study scope, methodology, and techniques used to evaluate trade-offs between alternatives across echelons. It will also illustrate challenges and lessons learned when analyzing new and experimental AI technologies.

AP127:
Implementing a Data Science Capability in an Operational Command

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Data science offers enormous potential to benefit organizations in a wide variety of undertakings. In order to achieve that benefit, organizations should plan and execute activities to transform the enterprise to support the successful implementation of data science. For operational commands, commanders should also be willing and able to transform their organizations and processes as a result of data science. This presentation examines the relevant factors, maturity models, failure modes, and potential strategies relevant for successful implementation of data science capabilities within US Army operational commands.

AP128:
Data Analytics to Improve Operationally Relevant Fuel Consumption Estimates

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CCDC DAC is applying 'Big Data' analytics to address operational fuel consumption estimation limitations. Data collection from CCDC DAC's extensive Condition Based Maintenance resource were used to support a quantitative assessment of the fuel estimation capability gap. Subsequent efforts have leveraged big data analytics to mitigate the fuel estimation gap by improving fuel prediction methods for fleet-level fuel requirements during counter-insurgency (COIN) operations. Developing estimates based on data collected during COIN operations is a sensible approach for predicting fuel consumption in continued COIN environments; however, for Multi-Domain Operations (MDO), the Joint Services need improved techniques to estimate fuel consumption in operating environments for which no data have been collected.

In an effort to address this limitation, CCDC DAC is leveraging a combination of 'Deep Machine Learning' and Artificial Intelligence (AI) techniques to support the future fight. Preliminary development / validation efforts indicate the AI-based approach, relating commercial satellite image terrain profile information to Army Test and Evaluation Command (ATEC) test course profiles, is well suited to address field data collection limitations. CCDC DAC validation efforts using ATEC test courses as ground truth is underway. The ultimate goal is to estimate operationally relevant fuel consumption (and range) for US military ground vehicles operating in contested environments around the world.

AP129:
Building Tools for a Flexible and Scalable COVID Model in R

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Early in the development of the Center for Army Analysis' coronavirus disease (COVID-19) forecasting model, the modeling team faced a high degree of uncertainty regarding the needs of forecast users and the ideal model methodology. To react quickly to changes along these dimensions, the team built a set of scalable, flexible modeling tools in R, which allowed them to run the model for arbitrary collections of U.S. counties and territories, take advantage of parallel processing in R with minimal extra coding, and track and compare the accuracy of different model specifications.

AP130:
Applications of DoD Supercomputers

James Way - DAC
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Working Groups: WG4

This presentation will highlight applications of Department of Defense (DoD) supercomputers, including combat simulation, aerial imagery, machine learning, and the modeling of fragmenting munitions and body armor. Examples will be presented in which DoD supercomputers reduced program runtimes dramatically, in one case by a factor of 18,500. These speedups made it possible to perform new types of analysis. However, it can be challenging to write code that makes good use of supercomputer hardware. Therefore, parallelization techniques will be discussed as well as useful tools such as Jupyter notebook servers, GNU parallel, Linux containers, and upcoming GPU hardware.

AP131:
Using Neural Networks to Compress Grenade Lethality Data in the Infantry Warrior Simulation (IWARS)

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Working Groups: WG4

The Infantry Warrior Simulation (IWARS) is an entity-level combat simulation that is typically used to estimate differences in operational effectiveness caused by using different equipment, including grenades and grenade launchers. When a simulated grenade explodes in IWARS, the effect on nearby personnel is determined by looking up a probability of incapacitation value that was precomputed by a high-resolution model. This value depends on many factors, creating the need for a large lookup table that may exceed the maximum database size. To solve this problem, a neural network input option was created, giving analysts the opportunity to use highly compressed data without sacrificing accuracy or runtime. Previous compression techniques are either less accurate or offer a lower compression ratio. This research was funded by the Army Study Program Management Office in fiscal year 2019 as part of the study titled "Machine Learning Techniques to Aid in Generating Item-Level Performance Estimates for use in Squad and Soldier Level Operational Assessments". The other half of that study will also be discussed, in which gradient-boosted decision trees were used to predict the surrogation decisions of human subject-matter experts.

AP132:
Measuring and Predicting Soldier Performance, Lethality, and Resilience Through Soldier-Systems Modeling

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Measuring and predicting Soldier performance and overall lethality are a priority for the US Army. Performance predictions can be used to help define requirements, identify where to prioritize performance improvements, and ultimately overall Soldier-systems performance or lethality. What is needed is an integrated systems approach to performance modelling and prediction to merge both soldier and equipment performance in the context of operating environments. To meet future challenges of complex and demanding operational environments, the performance of Soldiers, their supporting systems and integrated Soldier teams need to be measured and optimized to maximize the overall potential for needed Soldier-systems performance.
Techniques to apply systems performance have been developed in the systems engineering, reliability engineering and safety communities. These techniques can be adapted to support the Army's needs for measuring and predicting performance and lethality.
This paper will provide an initial analytical framework to measure and predict performance through the use of event trees and success trees pulling together both inductive and deductive logic of task performance (physical & cognitive), system functional performance and overall mission performance leading to lethality. This model can then be examined by sensitivity analysis to determine the most important elements of Soldier-systems for overall performance. These elements can then be prioritized for more detailed modelling & simulation and data collection efforts to measure and predict lethality.
This approach can be used to help inform current performance modelling efforts of the US Army's MASTRE (Measuring and Advancing Soldier Tactical Readiness and Effectiveness) Program lead by the CCDC Soldier Center and the Squad Performance Model lead by PEO Soldier.
While the proposed approach to modelling and simulation provides an initial framework, the ability for a more comprehensive analysis of performance in real-time will require data and more detailed model elements to represent the real-world complexities (where needed).

AP133:
From the Crescent City to the Fertile Crescent: Contingency Engineering and Base Development

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The process of engineering from the comforts of New Orleans is great when you have unlimited time and resources, but how does one efficiently design Life Support Area's (LSAs) in a contingency environment, under fire, and with limited resources? The author learned the differences first hand working in CONUS, EUCOM, and CENTCOM. In the wake of Russia's annexation of the Crimea and it's aggression towards Eastern Europe, the US Army has responded to the threat through the European Defense Initiative to reassure it's NATO allies and

partners. New Forward Operating Sites (FOS) in Eastern Europe have been explored and developed. Likewise, FOS's in Iraq were constructed from the ground up after they were completely destroyed by ISIS. However, the path to building a mature FOS is not straightforward. What is the most effective way to conduct a base master plan and determine the requirements for immediate military occupation and future expansion? With the end state in mind, developing interim steps for the area development plan is a necessity for base development.

Military commanders view their operation and the base camps which will be used during the operation in terms of the six war fighting functions defined in ADP 3-0. Military engineers view the base camp through the acronym SWEAT-MSO, outlined in ATP 3-34.81. Master planners are trained to utilize the master planning process and "Base Camp Development Planning Process" outlined in EP 1105-3-1.
This article proposes a new framework, "MOS-LIFE", which aligns these three perspectives. "MOS-LIFE" stands for: Mission Command Facilities, Operational Facilities, Sustainment Facilities, Life Support Facilities, Infrastructure, Force Protection Facilities, and Environmental.

AP134:
Challenges Executing Verification and Validation for COVID-19 Modeling

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Verifying and validating model results are important components of assessing model performance. Proper verification and validation allows model consumers to have confidence in decisions based on model output. Often the best way to validate model performance is to measure the difference between model predictions and actual observations of the model's dependent variable. While executing verification and validation may seem relatively straightforward, it is proving very difficult for coronavirus disease (COVID-19) modeling because of 1) high levels of noise in observations of COVID-19 cases, 2) a lack of available information that directly addresses decision maker concerns about hospital infrastructure stress, and 3) trade-offs between micro- and macro-level analysis.

This presentation will explore how we execute verification and validation given these challenges to better understand and communicate model performance.

AP135:
DAWN Rising: Distributed Wargaming and Analysis for Force Design

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DAWN Rising 1 (DR1) was the first event of the (Australian) Defence Analytical Wargaming Network (DAWN) developmental analytical wargame series. DAWN is a capability resident within Joint and Operations Analysis Division (JOAD), Defence Science and Technology (DST) Group, established to develop and focus existing analytical wargaming capabilities to support concept development and capability assessment for future Australian Defence Force needs. The aim of

DR1 was to develop distributed analytical wargaming methods, models and tools at the whole of force level considering multi-domain capabilities enabled by the Joint Analytical Wargaming Tool (JAWT). It included over 30 participants from four defence sites as well as a number connecting from home locations and was conducted over 6 weeks with half a day per week of planning plus two full days of post H hour wargaming.

This presentation will discuss the challenges of developing and applying wargames in a distributed adjudication role and insights into their contribution to the analytical process. The benefits include, balancing plausible combat results with repeatable outcomes, immersion of participants in future context and enhanced data capture.

AP136:
Cost Comparison Analysis Tool for Stationing (CCATS)

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The Department of Defense (DoD) has used a cost comparison model since the first Base Realignment and Closure (BRAC) round in 1988 to compare competing BRAC scenarios. Up until now, DoD has not used a cost comparison tool for stationing actions outside of BRAC. In 2016, the Office of the Secretary of Defense (OSD) initiated a three-phase effort, co-led by the Center for Army Analysis (CAA) and OSD, to update the cost comparison model, Cost of Base Realignment Actions (COBRA), utilizing a Joint Process Action Team (JPAT) with representatives from all Services. The Cost Comparison Analysis Tool for Stationing (CCATS) is configured and customized for use by OSD and the Military Departments to meet hundreds of unique requirements defined by the JPAT. The CCATS utilizes multiple updated algorithms to account for changes in technology and DoD business operations with a sophisticated interface allowing users to track data, change assumptions, and report scenarios with more control than formerly provided in cost comparison models. As the portfolio manager for CCATS, CAA is in the process of making CCATS available through the Amazon Web Services (AWS) U.S. GovCloud hosting environment to permit OSD and the Military Departments access to the model and its capabilities to allow for cost comparisons of day-to-day stationing actions or inform strategic stationing decisions.

AP137:
Emerging Growth Priority Analysis

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Working Groups: WG5

Total Army Analysis (TAA) stakeholders annually submit resourcing requests to Headquarters, Department of the Army, to compete for resources for emerging growth requirements. These requests can range from a single person to an entire unit and include both capacity and capability requirements. The broad scope of the requests makes it difficult to establish a common denominator with which to compare them, identify those with the most benefit to the Army, and defend the selection in an easily understandable way. In the past, the Army has determined which requests to approve by voting on them. Analysts at the Center for Army Analysis have used

decision analysis methods to develop a more analytical, less biased method of comparing and selecting resourcing requests for emerging growth.

AP138:
Sustainment Transportation Energy Assessment Model (STEAM)

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This study evaluates the sufficiency of the North Atlantic Treaty Organization's sustainment distribution and storage network to meet requirements in a competitive steady state and a specific wartime contingency.

Key areas evaluated include sustainment demand by location and time, location-specific storage requirements, sufficiency of military and commercial trucking given a set number of commercial trucks, sustainment relationships within the theater, and quantity of sustainment required.

The study's modeling information includes sustainment distribution infrastructure (e.g., roads, rail, pipelines, and storage facilities), resources (e.g., trucks, railcar, and pipeline), business rules (e.g., convoy restrictions), and the general concept of logistics support (e.g., route planning and support dependencies).

AP140:
Total Army Analysis (TAA) Supporting Analysis

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Each year, the Center for Army Analysis' (CAA) Force Strategy (FS) Division has the responsibility to support Headquarters, Department of the Army (HQDA) G-3/7 Force Management Directorate (FM) during completion of Total Army Analysis (TAA). The FS Division's role is to help HQDA determine the unit composition of the Army's Total Force. This presentation will provide a brief overview of the process used, why we use it, and the products delivered to FM for the current TAA cycle.

Changing the number of units in the Army's Total Force alters the Army's ability to meet operational demands outlined in the National Defense Strategy. Additionally, unit readiness varies over time. To take these factors into account, FS uses a discrete event simulation called Modeling Army Rotation at Home or Not (MARATHON). This presentation will include a brief overview of MARATHON. We hope to inform and solicit feedback from those interested in force generation analysis and simulation.

AP141:
Blending Human-in-the-Loop and Constructive OneSAF Simulation Modeling to Support Maneuver Force Modernization During the COVID-19 Pandemic

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Working Groups: WG2, WG6

The Maneuver - Capabilities and Development Directorate (MCDID) needed analytics on the Modular Turret Mortar System (MTMS) to inform the 2023 Program Objective Memorandum (POM) and the Armored Brigade Combat Team (ABCT) O&O document. However, COVID-19 restrictions threatened the MCDID's ability to execute 3rd quarter 2020 experimentation and analysis activities. In an effort to support the mission, the MBL developed and implemented new processes and procedures that supported successful execution of the MTMS experiment.

The purpose of this presentation is threefold. First, the processes and procedures implemented by the MBL during the COVID-19 pandemic to enable continued human-in-the-loop experimentation are discussed. Followed by a brief overview of the MTMS experiment design, execution and analysis approach. Finally, an overview of a blended modeling approach developed by the MBL using human-in-the-loop experimentation supplemented with OneSAF constructive modeling is discussed.

AP142:
Theater Focused Forces (TFF) Analysis

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By late fall 2019, the Center for Army Analysis' (CAA's) Force Strategy (FS) Division demonstrated that the Army Readiness and Modernization Model (ARMM) increased the probability that the Army will align modernized forces against appropriate near-peer threats. However, Army senior leaders (ASLs) asked if ARMM could be extended to help the Army better organize to modernize, compete, and transition to war. The ASLs contended that units with habitual theater relationships would have an advantage when transitioning to war from competition. The advantages could include greater opportunities for partnering with other armies and knowledge of the region's people, infrastructure, issues, etc. By focusing units on specific theaters, the Army could better optimize the future force for large-scale combat operations. The integration of these ideas led to the Headquarters, Department of the Army (HQDA), G-3/5/7 effort called Theater Focused Forces (TFF).

This presentation will include a brief overview of TFF and how CAA analysis influenced ASLs to adopt the new Army readiness and modernization model called Regionally Aligned Readiness Modernization Model (ReARMM).

AP143:
Unmanned Aerial Resupply at the Tactical Edge

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The Army Expeditionary Warrior Experiment (AEWE) is the Army's primary venue for small unit modernization, providing capability developers, Cross Functional Teams (CFTs), Army Science and Technology (S&T) community, and industry a repeatable, credible, rigorous, and validated operational experiment supporting both concept and materiel development. The Maneuver Battle Lab (MBL) conducted AEWE 2020 from October 2019 - March 2020 assessing 53 concepts and capabilities in support of MDO. Capabilities were assessed in one or more of three-phases: live fire, stand-alone excursion and a networked force-on-force assessment. While there were many remarkable capabilities throughout the experiment the use of autonomous tactical resupply at the forward edge demonstrated broad multi-domain implications.

Unmanned Aircraft System (UAS) autonomous resupply was a focused effort during the 72 hour force on force experiment. This concept replicated resupply from the forward support company to the tactical edge using a UAS. Both Blue and Red forces requested supplies through the lower tactical network and received them by UAS autonomous resupply. Autonomous resupply consisted of various classes of supply including water, meals, ammunition, medical supplies, and repair parts on demand. The UAS flew at tree top level and required an accurate military grid reference system location.

On demand resupply at the tactical edge provides commanders the ability to tailor combat loads, retain the initiative, and exploit success without having to pause for traditional resupply. Incremental supplies forward provides the option to press the fight and mitigates the higher risk of resupply from manned aircraft and ground convoy resupply. This presentation describes the AEWE experiment design, execution, analysis, and follow-on efforts in support of unmanned aerial resupply at the tactical edge.

AP144:
Historical Force Employment

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The Office of the Secretary of Defense (OSD) Cost Assessment and Program Evaluation (CAPE) requested Headquarters, Department of the Army (HQDA) assistance in identifying historic Army deployments to use in their models, studies, and war games. This presentation will report on the process the Center for Army Analysis (CAA) and OSD CAPE developed to convert and aggregate Army historic deployment data found in the Mobilization and Deployment Information System (MDIS) into a format compatible with OSD CAPE models, studies, and war games. The purpose of this presentation is to provide visibility of these data for other Army organizations and to determine if there are other data sources that would improve the process. We will present the potential applications of these data for Army studies and simulations.

Every quarter, we conduct a review of Army deployments to scour the step-by-step data processing. Parsing tools provide the ability to measure the magnitude of the deployment in terms of personnel as well as timing related issues during initiating and sustainment of the deployed force. Our data processing checks for completeness and consistency and then applies the business rules that convert the data into the OSD CAPE format. We make observations to look for patterns of conformity or notably differing anomalous conditions. The historical information indicates the types of Army units assigned to different missions that occur as well as dwell cycles.

AP145:
Unraveling a Gordian Knot: When Your Boss Asks You to Solve the Impossible

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One of the core challenges an analyst faces is communicating large quantities of data to senior decision makers in a context they can efficiently and effectively consume to quickly take action. G8 Force Development (FD) must communicate information on the status and impact that multiple long-term equipping procurement efforts will have on the Army. The variant timeframes in which equipment is developed, produced, and delivered to units add an additional layer of complexity. Unit sets are common frames of reference senior leaders use to consume information. However, required quantities of an equipment type for each unit set are variant across unit types. In addition, with the exception of brigade combat teams (BCTs), most brigade formations still have a modular design with limited common organic configuration. As a result, when senior leaders ask how many brigades we can field with a program, the answer is often an unsatisfactory and complicated “It depends.” While a standardized brigade layout would be convenient for briefing and planning purposes, any layout that does not accommodate the unique conundrums inherent in the modular design of maneuver support and sustainment units will have limited application and may potentially be misapplied. A long-term solution will require coordination and collaboration across multiple stakeholders. As an initial effort, G8 FD and the Center for Army Analysis (CAA) have conducted several phases of a study with the intent of defining the problem space, providing an initial brigade layout mapped to battalion-level unit identification codes (UICs), and modified table of organization and equipment (MTOE) equipping requirements. Moving forward, the team will continue to build unit set relationships and collaborate with key stakeholders within the force structure and equipping communities to ensure a useful solution is developed, maintained, and executed.

AP146:
Is the War in Afghanistan Over for Good?

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The United States and Taliban signed a historic peace agreement that every Afghan hoped would bring an end to a long and bloody war that has taken the lives of far too many. How do militaries fare in a time of proposed peace when violence skyrockets around them? How much value do militaries place on objective assessment when peace seems inevitable? This briefing covers the

lessons learned during a 2020 deployment to Afghanistan, which started pre-COVID and ended with the key decision (the U.S. to stay or leave) still undecided.

AP151:
The Army COVID-19 Model for Epidemics: A tool for Medical Treatment Facility Pandemic Response

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The Army COVID-19 Model for Epidemics (ACME) was developed through a collaboration between US Army Public Health Center and the Futures Command Artificial Intelligence Task Force early on in the pandemic to assist Medical Treatment Facility (MTF) Commanders in projecting hospital capacity and resource needs. The tool has since expanded and developed, in partnership with the Department of Mathematical Sciences at the U.S. Military Academy, to take incorporate county-level transmission in our projections. We have also established green-amber-red indicators for each installation to reduce Force Health Protection Conditions (HPCON) based on the epidemiological characteristics. The newest feature allows users to specify a date for reducing HPCON and make assumptions on how the increase in transmission that will occur as a result of increased mixing. This talk will discuss the formation of the team, describe details on how the ACME tool has developed over time, walk through the CAC-enabled website, and discuss products that we have created to communicate our science to Senior Leaders.

AP152:
Common Pitfalls in the Design and Analysis of Simulation Experiments

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The Land Capability Analysis branch within the Defence Science and Technology Group in Australia has been steadily developing a capability to design and analyse simulation experiments (DASE), which are a structured investigation through a high-dimensional input parameter-space and a simulation's stochastic response in order to support a particular analytical objective. Characterising the form and strength of the sensitivity of a combat simulation's response to large (small) changes to input settings can provide insight into sub-system/attribute contributions to joint warfighting operational effectiveness and the trade-space between them. This presentation sets out to highlight some of the more common pitfalls analysts might face when conducting such a sensitivity analysis of stochastic simulations.

General linear regression fits a mathematical model where the coefficients (which reflect the sensitivity of the parameters) are chosen to make the model close to the simulation response at a number of user-specified design points and replications. A very common choice is to consider a baseline scenario and other scenarios where only one parameter is changed at a time. This One Factor At a Time (OFAT) design intuitively makes sense, but it's a trap for new players. The

second issue is that common regression software appear to take as fact the assumption that the simulation responses at the design points are independent and identically distributed (iid), which allows the analysis to be conducted using common (and simpler) Analysis of Variance (ANOVA) procedures. But for simulations that employ common random numbers the assumption of independence is not met (by design) and the assumption of identically distributed simulation responses at each of the design points has no theoretical basis to it, and is simply an assumption of convenience, but one where anecdotal evidence to the contrary exists.

A simple example using an in-house combat simulation is used to demonstrate the negative implications of relying on OFAT designs and/or iid assumptions. First, it will be shown that the OFAT design contains more bias than an equivalent sized (thus, superior) design, as well as suffering false negatives (two of three sensitive parameters were not picked up as such). Secondly, even when using this superior design, the iid assumptions will be shown to either under-estimate or over-estimate the regression coefficient confidence intervals, potentially causing false positives (claiming a sensitive parameter when it is not).

These false positives (negatives) are a undesirable consequence of the statistical significance testing procedure applied to the regression coefficients, which are typically based on individual confidence intervals (as used in the example above). To control the family-wise error-rate associated with multiple comparisons, some form of correction to the confidence level of each interval is sometimes used. Recent analytical work will be presented, based on confidence regions, detailing a procedure that doesn't require corrections, and illustrating the impact of deviations from iid conditions.

This presentation, by detailing the required mathematical formulations and illustrating through small but typical examples, potentially offers analysts a more informed foundation when conducting DASE.

AP153:
Australian Simulation Study Process for Exploring Future Military Concepts and Capabilities

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Combat simulation is a powerful tool designed for the exploration of future military concepts and capabilities. While simulation provides great utility in representing combined arms close combat, the mere possession of a simulation is insufficient to ensure robust analysis in support of the decision maker; this requires the development of rigorous processes and methods within the simulation studies.
The Land Capability Analysis (LCA) Branch of DST Group has a long history of using combat simulation to provide evidence-based analysis in order to address complex problems. Such problems include comparisons of capability options, investigations of alternative force structures, evaluation of weapon system modifications, and exploration of concepts of employment and tactics. Importantly, combat simulation has provided LCA with an ability to explore the effectiveness of options within the context of force-on-force combat operations in realistic scenarios against credible threats.

LCA has developed processes and tools around the closed-loop COMBATXXI simulation, in order to ensure robust study outcomes. The iterative analytical approach encompasses five key phases:
1. Problem Definition: Understand the key questions and hypotheses, and determine the problem space to be explored
2. Study Design: Develop a plan to address how the questions and hypotheses are to be answered, including how simulation tools are to be employed. This stage also identifies the key variables to explore and their associated levels. The military vignette(s) is also developed during this stage; the chosen vignette(s) needs to balance the requirements of allowing the key variables to have a measurable effect, while representing a credible military context.
3. Tactics Capture: Engage appropriate Subject Matter Experts (SMEs) to develop appropriate military plans for the vignette(s) from both a friendly and enemy perspective; these SMEs are drawn from a number of corps within the Australian Army. This stage includes the development of schemes of manoeuvre for the plans, and the capture of key tactics, techniques and procedures (TTPs) that will be utilised throughout the vignette(s).
4. Implementation and Interim Analysis: The plans, associated schemes of manoeuvre and TTPs are implemented within the combat simulation. Where possible, this stage uses an iterative process, where interim implementations of the plans are executed within the simulation, analysed, and reviewed by SMEs, thereby informing further implementation.
5. Results Analysis: Final analysis is undertaken to address the key questions and hypotheses, and highlight key results. Where possible, the analysis will also seek to gain insights into the causes behind the key results.

The five phase iterative process has been refined throughout each iteration of simulation studies, driven by a research and development program designed to enhance both the capabilities and scientific rigour behind the studies. Two specific enhancements include the development of a library of simulation behaviours that allows for complex tactics to be reused between studies, and research to determine the appropriate number of simulation replications required to estimate key output metrics. In addition, significant research has been applied to the results analysis, including design and analysis of simulated experiment methods to estimate the impact of key factors, and analysis of simulated alternative methods to rank options under consideration. LCA aims to continue to further enhance its capabilities through the application of ongoing research.

AP156:
XXX: Analog vs. Digital: Logistics Wargaming Lessons Learned from the JETS Experience

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Abstract not for public release.

AORS
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Army Analysis Awards

Dr. Wilbur B. Payne Award

For Excellence in Analysis

Eligibility: The award recognizes the highest quality of Department of the Army ORSA work. Eligibility includes all Department of the Army analysts, technicians, scientists, or groups whose contributions were made during the period 1 Mar - 28 Feb and meet the criteria. Submissions are scored on operations research quality, impact, and presentation.

Nomination: Analysts must submit their study, not more than forty pages with a completed nomination summary, agency endorsement, and sponsor endorsement.

Operational Analysis Award

Eligibility: Includes all Department of the Army analysts, technicians, scientists, or groups whose contributions were made during the period 1 Mar - 28 Feb and meet the criteria below. Submissions are scored on operations research quality, impact, and presentation.

1. Performed in support of operational commanders planning and/or conducting current operations, security cooperation activities, or major exercises.

2. Performed by analysts assigned to operational headquarters, Brigade/Division/Corps staffs, or Army Service Component Commands. Analytic agencies are not eligible.

3. Majority of study team must be Army, inclusive of study team members from allied nations, with significant contribution from at least one US Army military or civilian analyst.

Nomination: Analysts must submit their study, not more than forty pages with a completed nomination summary, agency endorsement, and sponsor endorsement.

POC: Sheri Palmer, (202)329-1903 sheri.l.palmer4.civ@mail.miL

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U.S. Army Junior Analyst Award

Civilian and Military

Eligibility: Must be 40 years old or less with a maximum of ten years' experience and be nominated by mid-March of the given year. The nominator must have a mentor-protégé relationship with the individual and can describe the junior analysts quality and breadth of the work. Submissions are scored based on the strength and quality of the contributions, and should have one or more of the following accomplishments:

1. Outstanding publication
2. Development of a significant new analysis
3. Use of research results in the solution of a military problem

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1. Working Group Co-Chairs nominate the author(s) of the best study in their group.
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3. The Prize Evaluation Committee will make its recommendation of the best paper to the Senior Army Analytical Board through the Payne Awards Committee.

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Recording Secretary: Heather McMahon-Puhalla
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