2020 NATO CA²X² FORUM

@ Virtual Edition

22 – 24 September 2020

Event Agenda and Outline

Modelling and Simulation
Centre of Excellence
www.mscoe.org

A MULTI-NATIONAL
COLLABORATION

2020 NATO CA2X2 FORUM – BATTLE RYTHM

Timezone CEST (UTC+2, GMT+2)

	Booths and Lounges available for networking opportunities	Booths and Lounges available for networking opportunities	Booths and Lounges available for networking opportunities		12:30 14:30
12:30 14:30					

	Day 1 (Tuesday 22-Sep-2020)		Day 2 (Wed 23-Sep-2020)		Day 3 (Thu 24-Sep-2020)		
	Time	Plenary	Time	Sessions in 4 Tracks	Time	Sessions in 5 Tracks	
14:30	5'	Welcome Message					14:30
14:35	20'	NATO/ITA FOGOs' Messages	70'	A1 A2 A3 A4	70'	D1 D2 D3 D4 D5	
14:55	5'	Announcing 10th DHSS Workshop					
15:00	95'	Keynote Presentations	15'	Coffee break	15'	Coffee break	15:40
			70'	B1 B2 B3 B4	70'	E1 E2 E3 E4 E5	15:55
16:35	30'	Round Table with Keynote Presenters					
17:05	15'	Coffee break	15'	Coffee break	15'	Coffee break	17:05
17:20	70'	SISO Session on M&S Standards	70'	C1 C2 C3 C4	70'	Final Plenary AI presentation Hot Sum-Up Closing Remarks	17:20
18:30 20:30	Booths and Lounges available for networking opportunities		Booths and Lounges available for networking opportunities		Booths and Lounges available for networking opportunities		18:30 20:30

2020 NATO CA2X2 FORUM – DAY 1, PLENARY

Tuesday 22 September 2020, Timezone CEST (UTC+2, GMT+2)

	Time	Plenary Agenda
12:30 14:30		*Booths and Lounges available for networking opportunities*
14:30	5'	**Welcome Message (Col. Michele Turi)**
14:35	20'	**NATO/ITA FOGOs' Messages** 1. NATO DSACT Gen. Paolo Ruggiero 2. ITALY DCHOD Lt.Gen. Francesco De Leverano 3. NATO DCOS JFD M.Gen. Guillermo Cavo
14:55	5'	***Announcing 10th DHSS Workshop (Prof. Agostino Bruzzone)***
15:00	95'	**Keynote Presentations** 1. Sébastien Lozé, Epic Games 2. COL Brian Walsh, US Army Futures Command 3. Robert Siegfried, NATO STO NMSG Chairman 4. COL Robert Meeuwsen, NATO C2 CoE Director 5. COL Michele Turi, NATO M&S CoE Director
16:35	30'	**Round Table** *Discussion with keynote presenters*
17:05	15'	*Coffee break*
17:20	70'	# SISO Session on M&S Standards {{siso_table}} *Moderator: Patrick Rowe*
18:30 20:30		*Booths and Lounges available for networking opportunities*

SISO Session sub-schedule:

10'	SISO overview, Robert Lutz
10'	NATO STO NMSG overview, Grant Bailey
20'	SISO standards, Dr. Katherine Morse
10'	SISO standards, Grant Bailey
15'	SISO standards, Dr. Curtis Blais
5'	Wrap-Up & Look Ahead, Robert Lutz

Day 2: Wednesday, 23 September 2020 – Timezone: Rome, CEST (UTC+2, GMT+2)

12:30 14:30	120'	*Booth and Lounges available for networking opportunities*			
CEST (UTC+2)	Slot	Track 1	Track 2	Track 3	Track 4
14:30 — 15:40	**A** 70'	**Session A1** NATO MSG-164 "MSaaS Day" *The Customer Perspective* (OPR/MOD: TRIMANI)	**Session A2** XR in Support of Operations Pres# 5, 15, 19, 33 + Discussion Mod.: Sebastien Loze	**Session A3** M&S Standards and Technologies Presentations: 9, 17 (OPR/MOD: CAMBI)	**Session A4** Decision Support and Analysis Presentations: 16, 21 (OPR/MOD: FRANGELLA)
15:40 – 15:55	15'	*Coffee Break*			
15:55 — 17:05	**B** 70'	**Session B1** NATO MSG-164 "MSaaS Day" *The User Perspective* (OPR/MOD: TRIMANI)	**Session B2** Applying New Technologies: Challenges for the Trainers Discussion Round Table Mod.: Wolfhard Schmidt	**Session B3** Training and Education Presentations: 34, 35, 18 (OPR/MOD: LO STORTO)	**Session B4** Decision Support and Analysis Presentations: 3, 10, 25 (OPR/MOD: FRANGELLA)
17:05 – 17:20	15'	*Coffee Break*			
17:20 — 18:30	**C** 70'	**Session C1** NATO MSG-164 "MSaaS Day" *The User Perspective* (OPR/MOD: TRIMANI)	**Session C2** Immersive Technology *Applications and Trends* Presentations: 49, 50, 46, 13 Mod.: Gabriele Romagnoli	**Session C3** Mission Readiness and Support Presentations: 22, 31, 30 (OPR/MOD: LO STORTO)	**Session C4** Experimentation Presentations: 14, 24 (OPR/MOD: FRANGELLA)
18:30 20:30	120'	*Booth and Lounges available for networking opportunities*			

Day 3: Thursday, 24 September 2020 – Timezone: Rome, CEST (UTC+2, GMT+2)

12:30 14:30	120'	Booth and Lounges available for networking opportunities				
CEST (UTC+2)	Slot	Track 1	Track 2	Track 3	Track 4	
14:30 15:40	D 70'	**Session D1** M&S as a Service (MSaaS) *Industry Perspectives* (OPR/MOD: TRIMANI)	**Session D2** Decision Support and Analysis Presentations: 1, 4, 23, 18 Mod.: Wim Huiskamp	**Session D3** NATO MSG-182 Tutorial *HLA standards and certification* Presentation # 2 (OPR/MOD: CENSORI)	**Session D4** Wargaming Pres # 11, 7, 48 (OPR/MOD: PASQUALINI)	**Session D5** DHSS Workshop *Training & Education to Face a Major Crisis* Pres # 51, 52, 53, 54 Mod: Bruzzone, Longo
15:40 – 15:55	15'	Coffee Break				
15:55 17:05	E 70'	**Session E1** Cyber M&S for Training and Exercise Pres # 20, 37, 38, 39 Mod: Luc Dandurand	**Session E2** NATO MSG-189 Workshop *Emerging Tech for Decision Making* Pres# 41, 40, 42 + Discussion Mod.: Agatino Mursia	**Session E3** AIxIA *Artificial Intelligence* Pres # 26, 27, 28, 29 Mod: Emanuela Girardi	**Session E4** Decision Support and Analysis Presentation # 6 (OPR/MOD: PASQUALINI)	**Session E5** DHSS Workshop *Complex Scenarios and Systems* Pres # 55, 56, 57 Mod: Solis, Mattei
17:05 – 17:20	15'	Coffee Break				
17:20 18:30	FP 70'	*Final Plenary*	15'	Successes, current limitations, and challenges of Artificial Intelligence. Research and Application Perspectives (**Prof. Piero Poccianti, Pres. AIxIA, Italian Association for AI**)		*Final Plenary*
			50'	**Hot Sum-Up** *(findings, take aways, follow on)*		
			5'	Closing Remarks (Col. Michele Turi, M&S CoE Director)		
18:30 20:30	120'	Booth and Lounges available for networking opportunities				

2020 NATO CA²X² FORUM
Sessions' direct links

#	SESSION	DAY	TIME	LINK
A1	NATO MSG-164: MSaaS - Customer Pespective	2	14:30 - 15:40	https://ca2x2.liveforum.space/workshop/22
A2	XR in support of operations	2	14:30 - 15:40	https://ca2x2.liveforum.space/workshop/25
A3	M&S Standards and Technologies	2	14:30 - 15:40	https://ca2x2.liveforum.space/workshop/28
A4	Decision Support and Analysis	2	14:30 - 15:40	https://ca2x2.liveforum.space/workshop/31
B1	NATO MSG-164: MSaaS - User Perspective	2	15:55 - 17:05	https://ca2x2.liveforum.space/workshop/23
B2	Applying New Technologies: Challenges for the Trainers.	2	15:55 - 17:05	https://ca2x2.liveforum.space/workshop/26
B3	Training and Education	2	15:55 - 17:05	https://ca2x2.liveforum.space/workshop/29
B4	Decision Support and Analysis	2	15:55 - 17:05	https://ca2x2.liveforum.space/workshop/33
C1	NATO MSG-164: MSaaS - Technical Perspective	2	17:20 - 18:30	https://ca2x2.liveforum.space/workshop/24
C2	Immersive Technology. Application and Trends	2	17:20 - 18:30	https://ca2x2.liveforum.space/workshop/27
C3	Mission Readiness and Support	2	17:20 - 18:30	https://ca2x2.liveforum.space/workshop/30
C4	Experimentation	2	17:20 - 18:30	https://ca2x2.liveforum.space/workshop/34
D1	MSaaS: Industry Perspectives	3	14:30 - 15:40	https://ca2x2.liveforum.space/workshop/35
D2	Decision Support and Analysis	3	14:30 - 15:40	https://ca2x2.liveforum.space/workshop/37
D3	MSG-182: tutorial on HLA standards and certification	3	14:30 - 15:40	https://ca2x2.liveforum.space/workshop/39
D4	Wargaming	3	14:30 - 15:40	https://ca2x2.liveforum.space/workshop/41
D5	DSST-1: Training & Education to Face a Major Crisis	3	14:30 - 15:40	https://ca2x2.liveforum.space/workshop/49
E1	Cyber M&S for Training and Exercise	3	15:55 - 17:05	https://ca2x2.liveforum.space/workshop/36
E2	NATO MSG-189: Emerging Technologies for Decision Making	3	15:55 - 17:05	https://ca2x2.liveforum.space/workshop/38
E3	AIxIA: Artificial Intelligence	3	15:55 - 17:05	https://ca2x2.liveforum.space/workshop/40
E4	Decision Support and Analysis	3	15:55 - 17:05	https://ca2x2.liveforum.space/workshop/42
E5	DHSS-2: Complex Scenarios and Systems	3	15:55 - 17:05	https://ca2x2.liveforum.space/workshop/50

Opening Plenary Session Speakers

1st session, 14:30 – 17:05 CEST, UTC+2

Announcer:

Lieutenant Colonel Antimo Russo
NATO M&S Centre of Excellence

Welcome Message

- **Colonel Michele Turi**
  Director, NATO M&S Centre of Excellence

NATO/ITALY FOGOs' Messages

- **General Paolo Ruggiero**
  Deputy Supreme Allied Commander Transformation, NATO ACT
- **Lieutenant General Luigi De Leverano**
  Deputy Chief of Defence, ITALY
- **Major General Guillermo Cavo**
  Deputy Chief of Staff Joint Force Development, NATO ACT

Announcing the 10th International Defense & Homeland Security Simulation Workshop

- **Prof. Agostino Giacinto Bruzzone**
  University of Genoa, Department of Engineering, Simulation Team

Keynote Presentations

- **Mr. Sébastien Lozé**
  Industry Manager, Simulations at Epic Games
- **Colonel Brian Walsh**
  Capabilities Development Chief, United States Army Futures Command
- **Dr. Robert Siegfried**
  Chairman, NATO STO Modelling and Simulation Group
- **Colonel Robert Meeuwsen**
  Director, NATO C2 Centre of Excellence
- **Colonel Michele Turi**
  Director, NATO M&S Centre of Excellence

Round Table

Discussion with keynote presenters

SISO Session on Modelling and Simulation Standards

Tuesday 22 September @ 1720 CEST (UTC+2) / 1120 EDT (UTC-4)

(Total session length = 70 minutes)

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SISO Session on M&S Standards

This session will provide an update from SISO on the current M&S Standards landscape. The session will consist of short briefings about SISO (the Simulation Interoperability Standards Organization) and NMSG (the NATO Modelling & Simulation Group), followed by an examination of various SISO standards, to include "core" standards like HLA and DIS; "recent" standards like C2SIM and Space FOM; and "standards in development" like Cyber DEM and Simulation & Wargaming.

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Agenda

- SISO Overview – 10 minutes
    - Robert Lutz, Chair, SISO Executive Committee
- NMSG Overview -10 minutes
    - - Grant Bailey, Chair, NMSG M&S Standards Subgroup (MS3)
- SISO Standards
    - HLA, DIS, DSEEP/DMAO plus Cyber DEM **-** 20 minutes
        - Dr. Katherine Morse, former Chair, SISO Standards Activity Committee
    - Space FOM and UCATT – 10 minutes
        - Grant Bailey, Chair, NMSG M&S Standards Subgroup (MS3)
    - C2SIM and Simulation & Wargaming – 10 minutes
    - Other Standards Activities – 5 minutes
        - Dr. Curtis Blais, Vice Chair, SISO Standards Activity Committee
- Wrap-Up & Look Ahead - 5 minutes
    - Robert Lutz, Chair, SISO Executive Committee

Moderator:

Patrick Rowe, Executive Director
Simulation Interoperability Standards Organization (SISO)

<u>NATO MSG-164 "MSaaS Day"</u>

M&S as a Service (MSaaS) is an emerging concept to provide simulation-based training and exercises more effectively and more efficiently. Essentially, the objective is to give all users access to the proper simulation applications whenever and wherever needed. To achieve this, it is important to understand that MSaaS is not just a technical approach to delivering simulation using cloud computing technologies. MSaaS is an enterprise approach and holistic concept that involves organizational issues as much as technical ideas.

The MSaaS Day provides an overview of the state-of-the-art regarding MSaaS. Under the umbrella of the NATO Modelling and Simulation Group more than 18 nations and 100+ experts have been working together to define the Allied Framework for MSaaS as the common approach towards implementing interoperable MSaaS solutions across all nations.

In three sessions, the MSaaS Day will present key aspects from the Customer Perspective (e.g., units with an operational need for training), from the User Perspective (e.g., training centers providing the requested training), and from the Technical Perspective (e.g., White Cell and EXCON personnel building a simulation environment.

- Session A1: Customer Perspective

- Session B1: User Perspective

- Session C1: Technical Perspective

<u>NATO MSG-164 "MSaaS Day"</u>

Session A1: Customer Perspective

23-Sep, 14:30 – 15:40 CEST (UTC+2), 08:30 – 09:40 EDT (UTC-4)

Robert Siegfried, Peter Lindskog, Wim Huiskamp

This session presents an overview of "M&S as a Service" and illustrates key aspects of MSaaS from the Customer Perspective, i.e. how can military operational user and units with an operational need for training benefit from MSaaS. Using the Swedish Combined Joint Staff Exercise (CJSE) as an example use case, the sessions outlines how operational needs can be satisfied by the "Allied Framework for MSaaS" that is currently being developed by the NATO Modelling and Simulation Group (NMSG). This session includes a live demonstration how simulation services are discovered (and shared) in a future allied MSaaS environment.

<u>Session flow:</u>

1. Slides (Robert) ~10min

2. Slides (Peter) ~15min

3. Demo (Peter or Robert) ~15min

4. Slides (Wim) ~10min

5. Slides (Robert) 10 min

6. Q&A ~10 min

<u>NATO MSG-164 "MSaaS Day"</u>

Session B1: User Perspective

23-Sep, 15:55 – 17:05 CEST (UTC+2), 09:55 – 11:05 EDT (UTC-4)

Rob Kewley, Peter Linkskog, Marco Picollo

Demonstration of the MSaaS process used to provide a Disrupted Network Communications Service to the Swedish training federation to support training commanders how to react to cyber and electronic warfare effects. Seven different nations collaborated to supply 12 different microservices, which were composed and provided by the NATO M&S Center of Excellence to the Swedish user as a single composed service, available on demand. This session will discuss the effectiveness of the MSaaS approach with respect to affordability, suitability, availability, and usability.

<u>Session Agenda:</u>

- **MSaaS overview**
- **MSaaS Customer – Swedish training needs**
- **MSaaS Solution**
    - o Operational needs
    - o Affordability
    - o Disrupted network communications service
- **Demonstration**
    - o MSaaS User - Swedish Training Federation
    - o MSaaS Provider – MSCOE Ocean Platform
    - o MSaaS Suppliers – Disrupted Network Communications Service

<u>NATO MSG-164 "MSaaS Day"</u>

Session C1: Technical Perspective

23-Sep, 17:20 – 18:30 CEST (UTC+2), 11:20 – 12:30 EDT (UTC-4)

Tom van den Berg, Daniel Kallfass, Rob Kewley, Marco Picollo

This session presents the technical perspective of "what is under the hood" of MSaaS. The session presents the technology that is used in creating the demo in session 2, the user perspective. Several advantages of using modern cloud technology, applied to both newly developed and existing simulation applications, will be demonstrated: elasticity, scalability, replication and on-demand deployment of services. Almost all software in creating the "MSaaS environment" is open source, enabling anybody to create such an environment and benefit from the advantages.

<u>Session Agenda:</u>

1. Kubernetes, Helm charts, Docker; some examples of services, and the ease of deployment, scalability and replication of these services (Tom van den Berg)

2. Service-based CGFs from Kubernetes (Daniel Kallfass)

3. Sensor calculations and terrain service elasticity using Kubernetes (Rob Kewley)

4. The Ocean environment (Marco Picollo)

5. Q&A

Session A2 – Discussion Panel

XR in Support of Operations

23-Sep, 14:30 – 15:40 CEST (UTC+2), 08:30 – 09:40 EDT (UTC-4)

This session, moderated by Sebastien Loze (Simulations Industry Manager at Epic Games), will present the coherent international vision within several nations to augment readiness of the warfighters. It illustrates how XR stopped being a distraction or a toy, and is actually becoming a solution to serve the nations training and operative goals.

Session Agenda:

- 10': Presentation # 15 – Kevin Seavey, Emilie Reitz and Robert Wilson
  "Virtual Mission Rehearsal for Special Operations Forces: A Sweden – U.S. Collaborative Effort"

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- 10': Presentation # 19 – Sebastien Loze, Dave De Bie
  "Soldiers awareness: The future is now"

- 10': Presentation # 33 **–** Gordon Judd, Máté Koch and Colin Bigg
  "Mixed Reality Displays and Multi-User 3D Visualisation for Collaborative Mission Planning"

- 10': Presentation # 5 – John Ferrell, Chris McFarland and Clay Woody
  "Aviator Training Next – Experiment in COTS VR Training for Army Pilots"

- 30': Discussion Round Table moderated by Sebastien Loze

Session B2 – Discussion Panel

Applying and utilize new technologies in training. Challenges and limitations from a trainer's perspective.

Moderated by Wolfhard Schmidt, ST Engineering Antycip

23-Sep, 15:55 – 17:05 CEST (UTC+2), 09:55 – 11:05 EDT (UTC-4)

Industry and science are continuously improving existing/ developing new technologies to improve training. New technologies definitely open the doors for new training opportunities. But...

Do the users really need all this? Can they use it in the daily training? What industry can do / shall do to get new products better introduced and used?

This panel will, from a trainer's and daily user's point of view, discuss their experiences with apply new technologies in training, and the real challenges and limitations they see and experienced.

Panelists:
Per Klembo, Warrant Officer II Royal Danish Army
Army Combat and Fire Support Centre - Project Officer Sim Branch

Kurt Vanderheyden, Major Belgium Army
HQ CC Land - Commanding Officer Sim Centre

Joerg Feldhusen, Commander German Navy
CoE for Operations in confined and shallow waters - Staff Officer Education
And Training; Chairman of the MORS sub group of the NATO M&S Group

John M. Ferrell, Colonel US Army
US Army Aviation Center of Excellence - Director of Simulation

Heath L. McCormick, Colonel US Army7th Army Training Command - Director
Joint Multinational Sim Center

Session E2 – NATO MSG-189 Workshop

Emerging Technologies
For
Decision Making Support
in 21st Century.

24-Sep, 15:55 – 17:05 CEST (UTC+2), 09:55 – 11:05 EDT (UTC-4)

Chairs: Agatino Mursia, Wim Huiskamp

The MSG-189 Specialist Team of the NATO Modelling and Simulation Group (NMSG) will conduct a Workshop on "Emerging Simulation Technologies for Decision Making Support in 21st Century". The event will provide a virtual venue where the participants will have the opportunity to engage with the NMSG Community in addressing state-of-the-art technologies that are considered relevant for a very challenging area like the Decision Making process.

The goal set by the MSG-189 Specialist Team is to identify the most promising Emerging Technologies that are to be integrated in a common simulation framework/architecture which will support the current and possibly future Decision Making process.

Session Agenda:

- Welcome & Intro (5 min)

- Presentations (35 min)

- Discussion major challenges (30min)

The 10th International Defense & Homeland Security Simulation Workshop @ NATO CA²X² FORUM

DHSS is an International Workshop focusing on the advances and potential of using M&S in Defence and Homeland Security framework. It brings Experts together for the purpose of presenting and discussing all types of innovation related to the use of Modelling & Simulation in Defence and Homeland Security Applications. DHSS focuses on new Concepts, Methods, Techniques and Tools for advancing modelling & simulation sector. In 2020, we celebrate the 10th Edition of DHSS.

Session DHSS-1: Training & Education to Face a Major Crisis

Chair: Prof. Agostino Bruzzone, Genoa University & Prof. Francesco Longo, UNICAL

Educational and Training Aid for Protecting a Town during Epidemics
Agostino G. Bruzzone, Marina Massei, et al. Simulation Team, University of Genoa & SIM4Future

Selection of Training Methods in Systems dedicated to Detection of Chemical Hazards
Magdalena Dobrowolska-Opała, Grzegorz Gudzbeler, University of Warsaw, Poland

Simulation of Emergency Management
Adriano Solis, York University, Canada

Modeling, Interoperable Simulation and Serious Games to Educate how to develop Water Strategies during a Crisis
Agostino G. Bruzzone, et al. STRATEGOS & Simulation Team

Session DHSS-2: Complex Scenarios & Systems

Chair: Prof. Adriano Solis, York University & Dr. Marina Massei, Simulation Team

Models of STRATCOM & Cyber within an Hybrid Scenario during a Biological Crisis
Agostino G. Bruzzone, Marina Massei, et al. Simulation Team, University of Genoa & SIM4Future

Extended Reality alternative Solutions to support Education, Training, Operational Planning and Operation Support on Complex Scenarios
Agostino G. Bruzzone, Marina Massei, et al. Simulation Team

Aid of Thermal and sRGB imaging Techniques for Surveillance System
Martin Sagayam Kulandairaj, Diana Andrushia, Amir Anton Jone A, Dhanasekar S, John Paul J, Rajesh G, Karunya University, India

Final Plenary Session Speakers

Thursday 24 September @ 17:20 – 18:30 CEST (UTC+2)

Announcer:
Lieutenant Colonel Antimo Russo
NATO M&S Centre of Excellence

Successes, current limitations, and challenges of Artificial Intelligence. Research and Application Perspectives:
Piero Poccianti
President, Italian Association for Artificial Intelligence (AIxIA)

Hot Sum-Up (findings, take aways, follow on):

- **Wolfhard Schmidt**
  ST Engineering Antycip

- **Gabriele Romagnoli, PhD**
  XR Coach, GRTalk

- **Christopher McGroarty**
  U.S. Army Combat Capabilities Development Command - Soldier Center

- **Agatino Mursia**
  Leonardo Electronics Division, MSG-189 ST Chairman

- **Sébastien Lozé**
  Industry Manager, Simulations at Epic Games

Closing Remarks:
Colonel Michele Turi
Director, NATO M&S Centre of Excellence

2020 NATO CA2X2 FORUM
Presentations' Schedule

#	Authors	Title	OPR	Sess	Day	Timeslot
1	Iain McNeil	Bringing Commercial Games to Defence	PALOMBI	D2	3	14:30 - 15:40
2	Tobias Kuhn, Bjorn Lofstrand, Horst Behner and Reinhard Herzog	Tutorial on HLA standards and certification	CENSORI	D3	3	14:30 - 15:40
3	Pierre Bazot, Aurelien Brucher, Gustave Cresp and Clara Chapuy	How a taylored sniffer helps to get accurate information on pawns and the issue of one to one fight	FRANGELLA	B4	2	15:55 - 17:05
4	Luca Palombi	WISDOM – How digital overlays in a geographic environment lead to wiser decisions	PALOMBI	D2	3	14:30 - 15:40
5	John Ferrell, Chris McFarland and Clay Woody	Aviator Training Next – Experiment in COTS VR Training for Army Pilots	ZAMPONI	A2	2	14:30 - 15:40
6	Ron Woersdoerfer	SIMULATION-BASED ANALYSIS OF MEDICAL CONCEPTS AND CAPABILITIES IN THE MEDICAL EVACUATION CHAIN	PASQUALINI	E4	3	15:55 - 17:05
7	Quentin Ladetto	Technology War-gaming : Experiencing future technologies at tactical level	PASQUALINI	D4	3	14:30 - 15:40
8	Sebastien Loze	The simulation technologies ecosystem evolution [PLENARY]	RUSSO	OP	1	14:30 - 17:05
9	Peter Swan	The Trend Toward Common Architectures for Simulation	CAMBI	A3	2	14:30 - 15:40
10	Uwe Gaertner	A SYSTEM DYNAMICS MODEL TO EVALUATE MAINTENANCE CAPABILITIES IN MAJOR JOINT OPERATIONS	FRANGELLA	B4	2	15:55 - 17:05
11	Jeffrey Hodges, James Sterrett and Michael Dunn	Wargaming to support current operations Military Decision Making Process (MDMP)	PASQUALINI	D4	3	14:30 - 15:40

12	Robert Meeuwsen and Paul Serne	Demonstrating the Future of the Decision-Making Process - The NATO C2COE C2 Demonstrator platform **[PLENARY]**	RUSSO	OP	1	14:30 - 17:05
14	Emilie Reitz and Kevin Seavey	Improving Terrain Interoperability in USSOCOM Distributed Mission Operations	FRANGELLA	C4	2	17:20 - 18:30
15	Kevin Seavey, Emilie Reitz and Robert Wilson	Virtual Mission Rehearsal for Special Operations Forces: A Sweden – U.S. Collaborative Effort	ZAMPONI	A2	2	14:30 - 15:40
16	Lillian Madigan	Radical Transparency	FRANGELLA	A4	2	14:30 - 15:40
17	J Mark Pullen and Fabio Corona	NATO Federated Mission Networking Standards for CAX	CAMBI	A3	2	14:30 - 15:40
18	Peter Morrison	Virtual Battlespace 4 (VBS4) - Cloud-Enabled, High Fidelity and Whole-Earth Simulation	LO STORTO	B3	2	15:55 - 17:05
18 bis	Peter Morrison	Virtual Battlespace 4 (VBS4) - Cloud-Enabled, High Fidelity and Whole-Earth Simulation	PALOMBI	D2	3	14:30 - 15:40
19	Sebastien Loze and Dave De Bie	Soldiers awareness : The future is now	ZAMPONI	A2	2	14:30 - 15:40
20	Marco Pelusi	Building cyber resilience through training by using a LVC systems approach	PIZZI	E1	3	15:55 - 17:05
21	Stephan Seichter, Gary Horne, Bernt Åkesson, Manuel Löwer, Marvin Richter and Nikolai Muts	Data Farming Services (DFS) for Analysis and Simulation-Based Decision Support	FRANGELLA	A4	2	14:30 - 15:40
22	Cathy Boscarino, Victoria Catterson, Gabe Musso, Marti Jett-Tilton, Charles Chapus, Major Jameson Voss, Erik Fosse, Margaret Varga, Earnst-Paul van Etten, Wout van Wissen and Richard Wintle	Genomic Data and Machine Learning for Deployment Readiness	LO STORTO	C3	2	17:20 - 18:30
23	Joseph McDonnell, Christopher McGroarty, Chris Meteiver, Scott Gallant and Lana McGlynn	Discovering and Leveraging Emerging Technologies for Application in M&S	PALOMBI	D2	3	14:30 - 15:40
24	Katherine Morse and David Drake	Multi-Viewpoint Conceptual Modeling	FRANGELLA	C4	2	17:20 - 18:30
25	David Chupick	Collaborative Exercise Planning in an Isolated Environment	FRANGELLA	B4	2	15:55 - 17:05
26	Stefania Costantini	Self-Adapting Human-AI Teaming	ZAMPONI	E3	3	15:55 - 17:05

27	Nicola Gatti	AI and game theory for real-world strategic environments	ZAMPONI	E3	3	15:55 - 17:05
28	Amedeo Cesta	Integration of AI technologies as a key aspect for safe autonomy and interactions	ZAMPONI	E3	3	15:55 - 17:05
29	Roberto Basili	Modern Intelligent Systems between accuracy and ethics: the role of natural language in explainable Machine Learning.	ZAMPONI	E3	3	15:55 - 17:05
30	John Quinn	Simulation in military medicine: the case for the Vigorous Warrior Exercise and Experimentation	LO STORTO	C3	2	17:20 - 18:30
31	John Quinn	NATO Medicine and pandemic response: the nexus of interoperability	LO STORTO	C3	2	17:20 - 18:30
32	Piero Poccianti	successes, current limitations, and challenges of artificial intelligence: research and application perspectives	ZAMPONI	FP	3	17:20 - 18:30
33	Gordon Judd, Máté Koch and Colin Bigg	Mixed Reality Displays and Multi-User 3D Visualisation for Collaborative Mission Planning	ZAMPONI	A2	2	14:30 - 15:40
34	Imre Balogh, Kirk Stork and Christian Fitzpatrick	Using Data-Limited Mesh Networks to create a Realistic, Distributed LVC Training Environment at the Small Unit Level	LO STORTO	B3	2	15:55 - 17:05
35	Kalle Saastamoinen	Simulation course – Action research approach	LO STORTO	B3	2	15:55 - 17:05
39	M&S CoE	M&S Services for Cyber Synthetic Environments	PIZZI	E1	3	15:55 - 17:05
40	Paolo Proietti	Cybersickness: a problem to overcome to ensure effective training	PALOMBI	E2	3	15:55 - 17:05
46	Ciro Donalek	Immersive technologies: a new Platform for Real-time collaboration and Explainable AI	CAMBI	C2	2	17:20 - 18:30
48	Alex Hoover	Wargaming Cyber _Tactical Hack	PASQUALINI	D4	3	14:30 - 15:40
49	John Nicol	Using Virtual Reality for Collaborative Immersive Operations and Planning.	CAMBI	C2	2	17:20 - 18:30
50	Gabriele Romagnoli	Immersive Technologies: the future is now?	CAMBI	C2	2	17:20 - 18:30

51	Agostino G. Bruzzone, Marina Massei, et al.	Educational and Training Aid for Protecting a Town during Epidemics	LO STORTO	D5	3	14:30 - 15:40
52	Magdalena Dobrowolska-Opała, Grzegorz Gudzbeler	Selection of Training Methods in Systems dedicated to Detection of Chemical Hazards	LO STORTO	D5	3	14:30 - 15:40
53	Adriano Solis	Simulation of Emergency Management	LO STORTO	D5	3	14:30 - 15:40
54	Agostino G. Bruzzone, et al.	Modeling, Interoperable Simulation and Serious Games to Educate how to develop Water Strategies during a Crisis	LO STORTO	D5	3	14:30 - 15:40
55	Agostino G.Bruzzone, Marina Massei, et al.	Models of STRATCOM & Cyber within an Hybrid Scenario during a Biological Crisis	LO STORTO	E5	3	15:55 - 17:05
56	Agostino G.Bruzzone, Marina Massei, et al.	Extended Reality alternative Solutions to support Education, Training, Operational Planning and Operation Support on Complex Scenarios	LO STORTO	E5	3	15:55 - 17:05
57	Martin Sagayam Kulandairaj, Diana Andrushia, Amir Anton Jone A, Dhanasekar S, John Paul J, Rajesh G	Aid of Thermal and sRGB imaging Techniques for Surveillance System	LO STORTO	E5	3	15:55 - 17:05

2020 NATO CA2X2 FORUM
Presentations' Abstracts

1 Iain McNeil (Slitherine / Matrix Games). *Bringing Commercial Games to Defence.*

Abstract. In this talk Iain will present an overview of Slitherine's activities and how it accidentally found its way in to the defence industry. Iain will give examples of Slitherine's line up of game and dig deeper in to key defence titles such as Command, Flashpoint Campaigns and Battlefront. The talk also gives insights in to a commercial gaming companies experiences of working with defence – the highs and lows, the pitfalls and opportunities. Most importantly Iain will cover why commercial games are such a big opportunity for defence to revolutionize how it wargames. This talk was recently presented to a MORS CoP and attained the highest attendance on record, with 50% more attendees than any previous CoP.

2 Tobias Kuhn (MSCOE), Bjorn Lofstrand (Pitch Technologies AB), Horst Behner (Bundeswehr Joint Material Office) and Reinhard Herzog (Fraunhofer IOSB). *Tutorial on HLA standards and certification.*

Abstract. This abstract is for a tutorial about HLA standard, certification and IVCT. It represents the work of MSG-163.

3 Pierre Bazot (French Army), Aurelien Brucher (French Army), Gustave Cresp (GiS scientist) and Clara Chapuy (Data analyst). *How a taylored sniffer helps to get accurate information on pawns and the issue of one to one fight .*

Abstract. The best simulation tool will always have an infinite number of biases, gaps. In addition, and even if these tools allow more and more in-depth analyzes, they will never be able to answer the questions that no one had ever thought of. Finally, it is sometimes complex to integrate new equipment or new course of action, not yet fully validated in the forces. In the end, the outcome of a confrontation may sometimes be different from what was expected and players will ask for details that nobody get.

We have developed a sniffer that records all messages from our constructive simulation tool SWORD. Basically, it is a supervisor that does nothing and does not exist for the players. However, at all times, it captures and saves basic data in a structured file such as JSon, Xml, etc. A game of a few hours at brigade level can lead to the creation of a million of these files. A specific treatment (in C #, python or other) then allows getting the situation in detail of a set of pawns and especially their interactions.

This sniffer makes it possible to answer very diverse questions like 3D conflicts, the effectiveness of artillery fire, the distances CP - combat units and the capacity of command or still the effectiveness of the chain of intelligence with the knowledge of the troop's enemies. Finally, it is an effective tool, both in real time and for after-action analysis that allows us to go beyond the simple perception of leaders.

4 Luca Palombi (NATO Modelling & Simulation COE). *WISDOM – How digital overlays in a geographic environment lead to wiser decisions.*

Abstract. The Wargame Interactive Scenario Digital Overlay Model (WISDOM) is a new project that the NATO Modelling and Simulation Centre of Excellence (M&S COE) started at the end of 2019

WISDOM is a training portal and platform, where you can configure multiple geographic environments up to full wargaming scenarios aimed at supporting military and/or civilian training audiences to get wiser decisions during their MDMP, WARGAME phase or continuously during the planning and executing phases of simulated events.

Pending the available data, a user benefits from playing a serious game in a geographic environment composed by a number of digital overlays grouped by nature or topics. In fact, WISDOM is a collection of tools able to display raw scenario data in digital overlays.

During the presentation we will show the scenarios Archaria and Ṭarābulus, a storybook app called Raleigh, the methods used to build digital overlays and the results obtained.

WISDOM has been designed to evolve over time in order to support all kinds of scenarios and new emerging technologies so far unknown. It will be the future venue that supports all the Training Audience's training objectives. Moreover, WISDOM supports any kind of training audience when dealing with exercise or mission rehearsal.

5 John Ferrell (Directorate of Simulation, U.S. Army Aviation Center of Excellence), Chris McFarland (Directorate of Simulation, U.S. Army Aviation Center of Excellence) and Clay Woody (Operational Research Center (ORCEN), U.S. Military Academy). *Aviator Training Next – Experiment in COTS VR Training for Army Pilots.*

Abstract. Over the last year, the U.S. Army Aviation Center of Excellence conducted an experiment to measure the effectiveness of low-fidelity, commercial off the shelf (COTS) gaming technology in training ab initio flight students within the U.S. Army's Initial Entry Rotary Wing (IERW) course at Fort Rucker, AL. The experiment showed that students who flew with VR and less live training performed as well as students who flew primarily live flight hours. The data shows that students enrolled in the VR groups also performed better throughout all evaluated areas, including academics. The purpose of this briefing will be to discuss the COTS training capability, the experimental design, the resultant data and future plans for experimenting with low-cost trainers.

6 Ron Woersdoerfer (Bundeswehr). *SIMULATION-BASED ANALYSIS OF MEDICAL CONCEPTS AND CAPABILITIES IN THE MEDICAL EVACUATION CHAIN.*

Abstract. Bundeswehr medical concepts and capabilities are strictly oriented on NATO guidelines, which in their respective way may or may not reflect on its member nations' practical knowledge. Despite being oriented on these guidelines, current plans for GER medical resources in Major Joint Operations (MJO) and Larger Formations are but based upon rules of thumb. To identify bottlenecks and shortcomings in these estimations, a Modelling & Simulation (M&S) study has been conducted with the goal to gain insight into the problem at hand. This presentation addresses the problem as well as the methodological concept behind the study. It furthermore lights the dangers and possibilities of M&S in such a highly uncertain domain from an epistemological point of view.

7 Quentin Ladetto (armasuisse Science & Technology). *Technology War-gaming : Experiencing future technologies at tactical level.*

Abstract. How is it possible to experience what new technologies enable if the systems do not exist yet ?

To answer that question, the Technology Foresight research program at armasuisse Science and Technology, also known as DEFTECH (DEfence Future TECHnologies), initiated in 2017 an iterative process focusing on the use of gamification.

Together with various partners we experienced various methodologies such as matrix-style wargames on higher aggregated levels, red teaming efforts inspired by the "Idea of System Cards" of NATO's Disruptive Technology Assessment Game (DTAG), up to storytelling approaches. The special focus on technologies lead finally to the development of a tabletop tactical wargame entitled "New Techno War" that is commercially available.

The game was built to illustrate what new technologies are enabling and to stimulate the discussions. The goal here is not about winning, but about understanding the strengths and weaknesses presented by these future systems in given tactical scenarios.

Let's consider the example of the exoskeleton. The vision would be to equip some foot soldiers so that they can move quicker (?), carry more weight (protection? ammunition?), be less subject to physical fatigue and injuries, etc. The big question for each of these parameters is "how much?". Enabling the soldier to carry 80 kg instead of 50 kg may provide an advantage (as it could mean more protection or more ammunition given the circumstances), but is it really significant enough to focus on the development of such a system ? What if instead of 80 kg, you could carry 800 kg ?

Built as a platform, an Internet component allows also the interaction between interested stakeholders who would like to simulate additional technologies or scenarios and make them available to the community.

A digitization of the wargame is currently ongoing integrating multi-agent simulation, decision support, artificial intelligence and video-gaming. The goal of this effort is to overcome human limitations by leveraging the advantages offered by the digital world. Thanks to these new possibilities we will gain complementary insights that are not possible with a table-top approach alone, as:

wargames are not reproducible: wargames are driven by player decisions and are therefore not reproducible. Even when the starting situation is replicated, no game will ever be the same. Objective tracking of cause and effect is very difficult, if not impossible.wargames are qualitative: If the output required from an event is numerical, a wargame is unlikely to be an appropriate tool. wargames are not a substitute for more rigorous or detailed forms of analysis.wargames are not predictive: wargames illustrate possible outcomes, so there is a risk of false lessons being identified from a single run. wargames can illustrate that something is plausible, but will not be able to definitely predict that it is probable.

wargames are only as good as the participants: As in every human-in-the-loop simulation, outcomes are heavily depending on the players. An uninformed, unqualified or overconfident wargame team is unlikely to add value.

The authors will present the conclusions of past experiences and the current state of the art of the ongoing developments including identified pros and cons, best practices and vision.

This work is the result of a collaboration between armasuisse Science and Technology, Helvetia Games SA, IABG GmbH, Istituto Dalle Molle di Studi sull'Intelligenza Artificiale (IDSIA), ONI3, Scensei GmbH and the Swiss Armed Forces.

8 Sebastien Loze (Epic Games). *The simulation technologies ecosystem evolution.*

Abstract. The simulation environment evolves, not only the technology but the business model too. While in the past simulation was an obscure domain led by some subject matter experts and dedicated to some specific use cases, virtual experience and environments are everywhere now and are going to play such an infinite role in our lives both for entertainment but in play too. We are coming from a monolithic world where only fee had access to the technology allowing to build reliable simulation systems. We are now entering an era where everyone can start building virtual experiences leveraging open standards and open platforms. The ecosystem seems determined to fight attempts to build walled gardens around simulation solutions.

With this context in mind, we will review some tools and practices allowing a reference frame to support the community to grow reliable and efficient simulation solutions

9 Peter Swan (MAK Technologies Inc.). *The Trend Toward Common Architectures for Simulation.*

Abstract. Defense forces around the world are starting to realize the benefits of a common distributed simulation architecture for collective training, whether in the land or air domain. Leaders are frustrated by having to pay for terrains and models multiple times, spending time and effort attempting to federate incompatible training systems, and being unable to guarantee a fair fight between these systems. This paper will describe the different architectural approaches taken to resolve these issues and to deliver collective training on two current programs that MAK is involved in.

10 Uwe Gaertner (Bundeswehr). *A SYSTEM DYNAMICS MODEL TO EVALUATE MAINTENANCE CAPABILITIES IN MAJOR JOINT OPERATIONS.*

Abstract. With the re-focusing on national and alliance defence after the Ukraine crisis, plans for further development of the Bundeswehr have also to be reviewed. Maintenance capacities is one important aspect in order to succeed in a conflict. Those must meet emerging maintenance requirement and these are significantly different in stabilization and high intensity operations. Therefore, it was expected that the review would show a significant delta between demand and available capacity. In order to close this delta, it is necessary to develop options for action, which will be implemented in the follow-up to this investigation. Due to the lack of data in a high intensity scenario - especially with regard to failure rates and maintenance requirements - a detailed simulation was not suitable and the system to be investigated was mapped in a system dynamics model. The collection of basic data for maintenance requirements, the definition of an appropriate scenario and the modelling of the system itself were essential in the model development process. The provision of the necessary data alone, which has not yet been available in this quality and quantity, has been extremely profitable. This also applies to the model developed, which provided a substantial understanding of the overall problem area also beyond the working group. The model was then implemented as a self-development in Java, as existing tools did not offer the necessary degrees of freedom. Even though the model only deterministically calculates the daily maintenance requirements in a 365-day scenario, essential insights into the system itself, current planning and possible options for action could be gained. Appropriate evaluation options have been developed with the user in order to be able to answer the research questions. In order to derive options for action, the data farming approach was pursued, in which the scope and distribution of maintenance capacities were examined.

11 Jeffrey Hodges (US Army Modeling and Simulation School), James Sterrett (US Army Command and General Staff College) and Michael Dunn (US Army Command and General Staff College). *Wargaming to support current operations Military Decision Making Process (MDMP).*

Abstract. The US Army Simulation School identified a workforce demand for Wargaming training to support current operations Military Decision Making Process (MDMP) at the Army division and corps headquarters. The school, after surveying existing Wargaming courses and seminars, partnered with the US Army Command and Staff College to design and development an introduction to Wargaming course. This course pilot will be offered in late August at the Fort Leavenworth, Kansas (USA).

This discussion will summarize the results of the initial survey, and the methodology employed to continue the analysis. It will discuss the military and private course offerings considered during analysis, and the decision to create a new course to better support the workforce education and training gaps.

This discussion will discuss design considerations made following gap analysis, as well as community input and task validation. Course development, including topic and tool selection, will be fully discussed.

Long term planning for a follow on course will also be described during this discussion.

12 Robert Meeuwsen (NATO C2COE) and Paul Serne (NATO Command and Control Centre of Excellence). *Demonstrating the Future of the Decision-Making Process - The NATO C2COE C2 Demonstrator platform.*

Abstract. In a future even more volatile, uncertain, ambiguous, and complex environment, the amount of data to be processed and the interconnected events in multiple domains will increase the demand for support to the operational level commander's decision-making process (DMP). This needs to be combined with efforts to increase survivability on the modern battlefield.

In this whitepaper, the NATO Command and Control Centre of Excellence (NATO C2COE) dives deeper into the challenges a future HQ will face. To cope with these challenges, the recently developed 'MDO C2 Demonstrator' platform is set to ignite and continuously support a discussion to bridge the gap in C2 between technology and operators, the tactical and operational level, and academia and the military with their applied and tacit knowledge.

13 Nazaro Aversano (Leonardo Company). *Innovative Training Solutions.*

Abstract. The need for a good training and the access to a large amount of documentation are essential to ensure the operation and maintenance of complex systems, especially when the applications are "mission critical".

Training costs are a significant part of the costs for many industries, especially when customers and/or employees need to learn the use of expensive and complex equipment or devices.

The problem is compounded when the training gap between trainers and trainees is very high, this is the typical situation of training for complex systems and when the staff turnover of personnel who carries out operational and maintenance is high.

In recent years the company has developed valuable tools that try to make the training more

effective and efficient (cost reduction).

The subject of this presentation is an overview of the training solutions and capabilities, as well as future developments and new interesting technologies to improve the effectiveness and efficiency of the "computer based training " .

14 Emilie Reitz (Joint Staff, J6, Joint Fires Integration Division) and Kevin Seavey (Joint Staff, J6, Joint Fires Integration Division). *Improving Terrain Interoperability in USSOCOM Distributed Mission Operations.*

Abstract. Effective and timely joint training and mission rehearsal of conventional forces and Special Operations Forces (SOF) are hindered by incompatible, non-interoperable Service and U.S. Special Operations Command (USSOCOM)-provided simulations and simulators. This substantive interoperability challenge results in costly inefficiencies to acquire cross-service simulators that provide adequate and fair representation of the battlespace for Distributed Mission Operations (DMO). One of many of the necessary solutions to this challenge is to encourage use of sharable synthetic distributed environments drawn from the same source data. This would provide cross-simulator interaction that is operationally representative of and consistent with combat operations to enable distributed SOF mission training, exercises, and no notice/short notice mission rehearsal using the existing and future inventory of Service and SOF provided 3D virtual simulations.

The above outlined U.S. challenge is amplified when U.S. Service components attempt to interconnect with partner nation simulators, who might not have access to a database that covers the same general terrain as the U.S. partners are using, never mind a high fidelity terrain drawn from the same source data.

To begin working this challenge, USSOCOM Directorate of Operations (J3), Training and Education Division (J3-T&E), in partnership with the Joint Staff, J6, and the U.S. National Geospatial Intelligence Agency (NGA), will bring together participants from AFSOC, MARSOC, JSOC, NAVSOC, and USASOC to conduct USSOCOM wide DMO and integration test events to exercise the NGA's Common Database capability. The primary goal is to assess interoperability of Foundation Geospatial Intelligence (GEOINT) 3D (FG3D) geospatial terrain databases across USSOCOM component simulators (VRSG, Vital, VBS3, Unity, etc.). The secondary goal is to support development of USSOCOM's distributed training and mission rehearsal capabilities across its components and sub-unified commands, with an assessment of the impact of terrain fidelity on task performance. This experiment will be executed in the summer of 2021, with a long term goal of integrating this interoperability work into the larger body of NATO modelling and simulation interoperability work by extending participation to coalition participants.

15 Kevin Seavey (Joint Staff, J6, Joint Fires Integration Division), Emilie Reitz (Joint Staff, J6, DDC5I, Joint Fires Integration Division (JFID), Demonstration Branch) and Robert Wilson (Swedish Armed Forces HQ, Dept of Training and Evaluation). *Virtual Mission Rehearsal for Special Operations Forces: A Sweden – U.S. Collaborative Effort.*

Abstract. During the spring of 2020, Joint Staff J6 Joint Fires Integration Division and the Swedish Armed Forces Special Operations Forces (SOF) Battle Lab joined together to design an experiment asking, "How can simulation improve capability development and mission rehearsal?" The three-phased experiment included a technical risk reduction event with measured training intervention; a modelling and simulation workshop focused on the art of the possible in technology, learning and capability development; and as the culminating event, a structured experiment on virtual mission rehearsal. This experiment focused on preparation and execution of sensor-to-shooter vignettes executed by Swedish and U.S. SOF. A SOF tactical headquarters provided command and control, intelligence and targeting support for four Swedish and U.S. ground SOF teams. The objective was

to measure the ability of virtual mission rehearsals to enhance performance of SOF tactical mission execution. During both virtual rehearsals and live execution, these missions were supported by an array of intelligence, targeting and fires assets. Swedish and U.S. planners developed a challenging scenario and order of battle for the live tactical vignettes. Accordingly, the goal of the mission rehearsals were to provide SOF teams the opportunity to exercise their plans in a virtual replication of the real world, give the teams an opportunity to familiarize themselves with the terrain, and build a shared understanding within the team of how actions at the objective should unfold. To support training for the SOF tactical HQ, higher command and any adjacent commands would be replicated by a tailored White Cell. All of this integration work was based on Federated Mission Networking principles.

While the experiment ultimately was cancelled due to COVID-19, there was a great deal learned between the teams while developing this joint, multinational, operational-outcomes focused modelling and simulation experiment. During our presentation, we will outline the general plan of the event, which we still hope to execute in the future, and where our techniques deviated from what has already been documented in the literature about using modelling and simulation for mission rehearsal. The lessons learned from the design phase of this experiment will be carried forward into future mission rehearsal experiments.

16 Lillian Madigan (Improbable). *Radical Transparency.*

Abstract. To fully harness the power of models and simulation in Decision Support and Analysis, vital information must reach the right hands, at the right time, in the right way. This maxim holds not only for model and simulation development, but user experience and customer management as well. In this presentation I discuss how user-centered research and design must integrate into the efforts of internal Engineering, Applied Science, and Product Management teams, as well as the external customer stakeholder teams, to achieve project success.

In a world where modeling and simulation software is often hard to use, difficult to learn, and expensive to maintain, it is imperative that vendors build trust with their customers by practicing radical transparency about product capabilities and how these capabilities solve customer pain points, by involving the customer in all phases of the product development process.

I will dispel some common misconceptions about user-centered design in the military, governments, and other high profile institutions, by covering the following user-centered research and design activities based on examples from projects completed for US DoD and UK MoD customers.

* Practicing radical transparency through model and simulation documentation of various kinds; while the technical expertise level of customers varies widely, a mistrust in the model and simulation output is often present yet easily eradicated.

* Focusing the end product and supporting models on the end user and their existing workflow rather than creating a new workflow that requires expensive training and potentially workforce re-skilling.

* Understanding how the qualitative inputs of user research turns into powerful tools for quantitative decision support and analysis.

From a user's initial "Big Question" through model development, simulation configuration, and reporting, bi-directional information must be presented in meaningful ways to result in higher rates of product adoption by decision makers.

17 J Mark Pullen (George Mason University C4I & Cyber Center) and Fabio Corona (NATO Modelling and Simulation Centre of Excellence). *NATO Federated Mission Networking Standards for CAX.*

Abstract. Computer Assisted Exercises (CAX) are a well-accepted capability for achieving collective training of today's national and coalition military in preparation for operations. However, there is a need to harmonize CAX technology with NATO's new approach to operational collaboration, command, and control: Federated Mission Networking (FMN).

Two decades ago in Afghanistan, NATO's International Security Assistance Force was hampered in operations until the Afghan Mission Network (AMN) was assembled to support collaboration and coordination of forces. Today, Allied Command Transformation is preparing for a future where a coalition force has a network far superior to AMN on Day Zero of coalition operations. Toward this end, the FMN project is assembling a framework of NATO and commercial standards with the expectation that the 30 member nations will configure their networking capabilities to interoperate over the FMN standards. FMN standards thus will provide the basis for "train as you fight" communications as well as supporting distributed simulation for that training.

The NATO Modelling and Simulation Group (MSG) Technical Activity 145 and SISO Product Development Group for the C2-Simulation Interoperation (C2SIM) standard have been working together to standardize and operationalize a new capability, which has been described in previous CAX Fora by the author. The team that assembled C2SIM standards now finds a new challenge: assembling and justifying a collection of standards for modeling and simulation (M&S) that suit FMN needs, with C2SIM an obvious cornerstone of that collection. This paper addresses from a CAX viewpoint the technical issues and process whereby standards for networked computer simulation within the FMN are nominated. The paper introduces the FMN concept, followed by a discussion of the role of networking in coalition exercises, and finishes with a review of likely standards for networked military simulation that will be included.

18 Peter Morrison (Bohemia Interactive Simulations). *Virtual Battlespace 4 (VBS4) - Cloud-Enabled, High Fidelity and Whole-Earth Simulation.*

Abstract. Military organizations are striving to leverage best-of-breed simulation and web technologies to deliver high-quality training to the point of need — from Battle Simulation Centers to home computers. VBS4 is an easy-to-use, whole-earth virtual and constructive simulation that supports both individual and collective cognitive training. The VBS4 simulation and rendering engine (VBS Blue) has been developed to support both terrain streaming from the cloud and scalability. A complete replacement for its predecessor VBS3, VBS4 supports hundreds of training use cases including new use cases like small unit Course of Action (CoA) development and analysis, and combined arms and staff planning. The new VBS4 workflow dramatically speeds up the development of training content through its new modes VBS Geo (an easy-to-use but powerful terrain editor) and VBS Plan (a highly efficient mission planning capability). The new VBS World Server is an optional and cloud-enabled companion product for VBS4, which streams terrain to VBS4 instances across a network. It also centralizes the storage of VBS4 Battlespaces - further reducing the overhead of administering multiple VBS4 installations.

19 Sebastien Loze (Epic Games) and Dave De Bie (Microsoft). *Soldiers awareness : The future is now.*

Abstract. Army researchers from several NATO nations laid out their perspectives and plans that use XR technology to establish a common operating picture for soldiers. Establishing the next generation of soldiers awareness allows them to safely and efficiently train and deploy while finding the right information sweet spot (avoiding the fog of war while protecting the men and

women in the field from information overload). Information presentation and visual cues are entering into a new era. Microsoft with the Hololens 2 is at the forefront of the technology charge in this domain. The hardware is not to be proven anymore and fields deployment for testing started. TRL reached the maturity level to build confidence from the forces around the world. In parallel, Epic Games is providing with their Unreal Engine a software capability bringing an unrivalled level of accuracy and visual realism to real time applications. For the first time in Europe at the CAX Forum 2020, Microsoft Dave De Bie, Technology Strategist for NATO and Epic Games Sebastien Loze, Simulations Industry Manager, will demonstrate an operational proof of concept leveraging the joined strengths of Unreal Engine and the HL2. They will also explain how this combined hardware and software technologies will benefit the NATO nations both for training and for operations.

20 Marco Pelusi (ST Engineering Antycip). *Building cyber resilience through training by using a LVC systems approach.*

Abstract. Cyberattacks are on the increase – and as they become more sophisticated, the consequences can be catastrophic for an organisation. Building cyber resilience through training is therefore key, leveraging all the tools available which enable users to optimise the network, systems and applications performance and the physical structure to mitigate risks.

Cyber security training for any 'mission' – whether it is keeping a bank's website operational, running an airline operations centre, or fielding a defence exercise – must be as realistic as possible in order to avoid 'negative training', where ineffective behaviour or procedures are picked up. In cyber defence training, this translates to having the behaviour of the systems under cyberattack perform in a repeatable manner consistent with how they would in the real world – made possible by advances in cybersecurity technologies which are elevating the capabilities of organisations the world over.

We have architected and developed a new approach that integrates real and simulated cyberspace operations, wired and wireless virtual networks, live and virtual equipment and applications, and traditional kinetic warfare training simulators into a full, instrumented, synthetic cyber warfare training environment. The combined LVC (live-virtual-constructive) kinetic / cyberspace environment provides improved, higher fidelity training for the combination of cyberspace operations with traditional warfare, with damage in one domain affecting performance in the other. The approach allows trainees to learn individually and as teams to detect when something is wrong, assess what is happening, contain the attack, take countermeasures, and modify operations to assure the mission. The ability to train command and staff to work around the cyberspace operations and complete a mission, while network administrators learn to detect and react to threats as they occur, in the same exercise, can provide a true "train as you fight" environment to help warfighters prepare for future conflicts. The LVC defense trainer system can seamlessly integrate (federate) with other training systems such as air traffic control, flight training and kinetic battlefield simulators.

The LVC defense trainer solution leverages unique and innovative technologies that allow the user to effectively represent mobile wireless equipment and applications (and the vulnerabilities they include) as they interoperate with wired backbone network infrastructure and fixed computing systems. It also accurately models the information transport fabric between servers and end-point systems in high fidelity to better demonstrate the effects of cyber-attacks. Unlike most cyber ranges which use interconnected virtual machines running various operating systems and applications to replicate a live environment, LVC defense trainer solution system leverages a true virtual network model that accurately emulates a distributed network system. Both live and virtual hosts can be connected to the virtual network model, and the system can be federated with other training simulators to create powerful training solutions.

LVC defense trainer solution reduces costs and risks by early identification of inter-operability or

performance gaps as systems scale up to realistic operational scenarios. It improves the timeliness and thoroughness of system test & evaluation by using the simulations for rapid evaluation of alternative configurations and emulating operational hosts in terrestrial laboratory interaction with HWIL components. LVC defense trainer system will enhance DoD system capabilities by using the emulations to assess the impact of and mitigation strategies for cyber threats on the network and on the mission.

The LVC systems approach described above was developed by Scalable Network Technologies and it's available as Network Defense Trainer (NDT). For details please meet us at the ST Engineering Antycip booth.

21 Stephan Seichter (Bundeswehr Office for Defence Planning), Gary Horne (self), Bernt Åkesson (Finnish Defense Research Agency), Manuel Löwer (German Army Concepts and Capabilities Developement Center), Marvin Richter (Fraunhofer IAIS) and Nikolai Muts (Fraunhofer IAIS). *Data Farming Services (DFS) for Analysis and Simulation-Based Decision Support.*

Abstract. Data Farming is a simulation-based methodology that supports military decision-making in areas such as defence planning, operations planning, warfare development, and concept development and experimentation. By performing many simulation runs, a huge variety of alternatives can be explored to allow decision-makers to make more informed and robust decisions. This process allows for the consideration of uncertainties and the discovery of unexpected outcomes. Paradoxically, this method can be used to declutter the immense amount of information known and allow commanders and staff improved situational awareness.

MSG-155 is providing the structure to establish Data Farming core services for the efficient utilisation of Data Farming as previously documented in MSG-088 and MSG-124. The realization of the concept is being developed through use cases which are relevant to NATO and nations.

Data Farming Services (DFS) is developed and implemented in NATO MSG-155 by a multi-national team. MSG-155 and DFS are based on the Data Farming basics codified in MSG-088 and the actionable decision support capability developed in MSG-124. The developed services are designed as a mesh of microservices as well as an integrated toolset and shall facilitate the use of Data Farming in NATO. DFS provides, inter alia, isolated services as dockerized containers for Model Execution, creating the Design of Experiment, calculating on High Performance Computing clusters like Docker Swarm and for Analysis and Visualization of the results.

Use Case Demonstration "Future Ground Combat Operations"

Embedding simulation analysis capability into the decision making process on tactical level has been a long-term goal of the German Army for some time now. This use case combines Course of Action analysis on battalion level with capability development by utilizing the data-farmable agent-based constructive simulation software PAXSEM (by AIRBUS) in the DFS environment. Evaluating well defined Robotic and Autonomous Systems (RAS) Capabilities and Manned-Unmanned Teaming (MUM-T) concepts with respect to their combat effectiveness lies within the center of this use case.

Use Case Demonstration "Optimal Placement of Sensors in a Computer Network"

The decision-maker objective of this use case is to investigate how various network monitoring and detection systems should be deployed in order to effectively protect critical services from a wide range of malicious cyber activity. The Data-farmable Agent-based Cyber Defence Assessment Model (DACDAM) was developed as an extensible proof-of-concept model in MSG-124 and has been developed further to support this use case.

22 Cathy Boscarino (Defence Research and Development Canada), Victoria Catterson (Biosymetrics), Gabe Musso (Biosymetrics), Marti Jett-Tilton (US Army Medical Research & Development Command Walter Reed Army Institute of Research), Charles Chapus (Armed Forces Biomedical Research Institute, France | IRBA · Departement des Services), Major Jameson Voss (United States Air Force), Erik Fosse (Oslo University Hospital), Margaret Varga (University of Oxford), Earnst-Paul van Etten (Royal Netherlands Navy), Wout van Wissen (Royal Netherlands Army) and Richard Wintle (The Centre for Applied Genomics (TCAG)). *Genomic Data and Machine Learning for Deployment Readiness.*

Abstract. Armed Forces personnel are expected to maintain mission capability under all weather conditions. Unfortunately, exertional heat illness (EHI) continues to be a global, year-round threat to military populations when operating under hot weather. Emerging research suggests a genetic association with enhanced susceptibility to heat illness. NATO RTG 294 sought to determine whether using high-throughput data together with machine learning will help differentiate between soldiers susceptible to developing exertional heat illness from those who are not, thus providing commanders knowledge for deployment readiness. Approximately 150 NATO Armed Forces personnel partaking in Exercise Precise Response (Ex PR 2019) participated in the study. A series of health related questionnaires, physiological data as well as body composition (InBody 570) was collected at baseline. Tasks in the Cave were Cool/Control Group, and tasks occurring in either the Shed or Seacan were the Hot/Test Group. Blood samples were collected from each participant prior to (Pre) and following (Post) their assigned task for microRNA (miRNA) expression and comprehensive metabolic panel analyses. Core body temperature and heart rate were collected continuously throughout each task using the radiopill and Equivital, respectively. Immediately following the task, participants completed the Thermal Comfort Scale and Ratings of Perceived Exertion Scale. Machine Learning models were trained to classify those most at risk of heat-related illness. Logistic Regression models were trained with L1 regularization, to force selection of only the most important inputs as features. Two sets of models were built: one using all features (demographic, physiological, and microRNA data), and one using all features except the microRNA data. The features chosen by the resulting models were compared to indicate the relative importance of genomic data to predicting heat-related illness. Results showed that genomic data did make a difference to the behaviour of the model. In particular, 16 microRNA sequences out of 1608 total were considered important by the model, compared with 35 non-genomic features of 102 total that were selected in both the presence and absence of genomic data. Enrichment analysis on the GO terms associated with the targets of the 16 sequences indicates a link with heat tolerance, thus indicating that genomic data is useful in predicting susceptibility of soldiers to heat stress. Our work provides evidence of the feasibility and value in combining multi-national high-throughput data with machine learning as a tool for solving global military health issues.

23 Joseph McDonnell (Trideum), Christopher McGroarty (U.S. Army CCDC-SC SFC Paul Ray Smith Simulation & Training Technology Center (STTC)), Chris Meteiver (U.S. Army CCDC-SC SFC Paul Ray Smith Simulation & Training Technology Center (STTC)), Scott Gallant (Effective Applications) and Lana McGlynn (MCG). *Discovering and Leveraging Emerging Technologies for Application in M&S.*

Abstract. 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 M&S practitioners 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 a diverse body of M&S stakeholders.

This presentation will discuss relevant findings from the ENGTAM SSG and how they can be applied in the development and use of cutting-edge tools, techniques, and best practices. It will also provide an opportunity to discuss these emerging technologies and how M&S practitioners can leverage them to support the enablement of NATO.

24 Katherine Morse (JHU/APL) and David Drake (JHU/APL). *Multi-Viewpoint Conceptual Modeling.*

Abstract. Several attempts have been made over the last two decades to produce a conceptual modeling format and process that are understandable by all stakeholders, both operational and engineering. Because a conceptual model is the bridge between these stakeholders through which they create a shared understanding of what will be represented in the simulation, it's critical that the format be unquestionably lucid, while providing sufficient detail from which to engineer the solution. The Johns Hopkins Applied Physics Laboratory (JHU/APL) has developed such a format on behalf of the US Defense Modeling & Simulation Coordination Office (DMSCO). Multi-Viewpoint Conceptual Modeling (MVCM) provides multiple views of the conceptual model: intended use, narrative, behavior, causal chains, entity subset conceptual models, characteristics, references, and assumptions. Through a facilitated process, all stakeholders create a conceptual model through successive decomposition from the intended use and narrative down to the detailed views of causal chains and characteristics. The level of detail is managed within each view to ensure that sufficiently precise information is collected to support engineering, while avoiding the pitfall of getting down to design. Opportunities for tool support of the process are highlighted.

25 David Chupick (CALIAN Group Ltd). *Collaborative Exercise Planning in an Isolated Environment.*

Abstract. Conducting exercises is a complicated business: today's training audience expectations are sophisticated and demanding; there is a need to replicate the complex operational environment including the various joint, interagency, multinational and public operational levels within which operations are conducted; there exists the requirement to build multi-disciplinary exercise control teams to create the challenges for political decision makers, commanders and their staffs in order to learn; there is a need to manage and share an almost limitless accumulation of documentation; provide the guidance for the need to federate simulations with command and control systems; identify the architecture needed to integrate exercise communications means with operational communication systems; become more efficient with time, funding and resources; adapting to the many exercise development changes throughout the planning process; and a host of other major factors that need to be addressed when designing, developing and

delivering exercises. The task of planning and delivering exercises is not simply creating a scenario and developing a MEL/MIL; there is so much more involved.

Exercise teams have traditionally gathered "the team" in a single location to design, develop deliver and support exercises. Whether members of the team came from different time zones, countries or regions of countries, work depended on gathering the team. Sometimes much needed subject matter expertise was located "in theatre" and exercise planning was stalled until that person could travel to join the team. Security, management and sharing of information were challenges best met by holding conferences and working groups. Time, expense and lack of an agile and comprehensive exercise planning cycle were the "cost of doing business" in the complex NATO environment.

COVID 19 isolation has challenged the traditional way in which exercises are planned, developed and delivered. The excuse that the team cannot gather is no longer viable for not doing the work. Nations and their militaries must get on with the business of training. In many ways, COVID 19 has been a catalyst for change. With the extended duration of isolation many organizations have adapted and changed their way of doing business. They have had tools and technology to allow this adaptation. The business of exercise planning has been slower, less efficient and effective in their adaptation.

This presentation will explore these challenges more fully and discuss technology and introduce tools that are available now, that will allow exercise teams to adapt and indeed thrive in an isolated environment whether caused by disease, geography or some other unforeseen situation.

26 Stefania Costantini (Associazione Italiana per l'Intelligenza Artificiale). *Self-Adapting Human-AI Teaming.*

Abstract. According to the guidelines for trustworthy AI proposed by the European Commission, trustworthy AI should be lawful, ethical and robust. Four ethical imperatives are emphasized: respect for human autonomy, prevention of harm, fairness, and explicability, which is often referred to as explainability. This last guarantee, which sometimes is referred to as eXplainable AI (XAI), has been identified as an utmost need for the adoption of ML methods in critical contexts. Many successful machine learning methods, however, deliver opaque models where the reasons for decisions might be opaque to the end user. As a consequence, trust is difficult to build and humans are reluctant to rely on AI-based systems.

The time has come to develop architectures for building intelligent systems where humans and AIs form teams, able to learn from data but also to learn from each other by playing "serious games", for a continuous improvement of the overall system. The human-AI system will, after the initial training and compliance demonstration, be able to gather unpredictable input data while responding and self-adapting in complex uncertain environments, and to capture its own failures and deficiency, so as to self-assure and then improve its own behaviour. This in order to radically change our relationship with and use of computers through symbiosis with the human component, resilient to perturbations and able to constantly improve their behaviour and competence over time. The envisaged system architecture should allow for self-awareness via forms of transparency, and be reactive, deliberative, and reflective.

27 Nicola Gatti (Associazione Italiana per l'Intelligenza Artificiale). *AI and game theory for real-world strategic environments.*

Abstract. Artificial intelligence recently demonstrated an important tool to deal with strategic situations. The mainstream approach is based on the adoption of game theory to provide a formal model of the problem and the design algorithms to find effective solutions. Many concrete applications were developed in the field of security (e.g., every day scheduling about 2,000 federal

air marshals to protect about 10,000 domestic flights in the USA and other applications such as poaching, airport security), recreational games (e.g., poker games and bridge), and defense. In this talk, we will survey the main results achieved so far, and we will discuss the open challenges, such as, e.g., situations in which an analytical description of the game is not available, but we can only access an oracle to query the outcome of a play. We also present some experimental results with military scenarios.

28 Amedeo Cesta (Associazione Italiana per l'Intelligenza Artificiale). *Integration of AI technologies as a key aspect for safe autonomy and interactions.*

Abstract. In recent times a number of disruptive improvements in Artificial Intelligent technology have created the false perspective that older problems are de-facto already solved. Indeed, several relevant problems are still worth being addressed and solved in view of achieving a generalized intelligence. A key activity involves revisiting previous research and integrating heterogeneous results to obtain new flexible ways of functioning in intelligent agents. This talk will exemplify how the capability of integration is a key aspect. We will start by enriching an AI planner with formal methods to guarantee robustness properties in the generate plans, then we will describe a "horizontal integration" that realizes a sense-plan-act cycle abstracting sensed data into an ontological representation to create the ability to formulate different planning problems according to gathered data. Finally, we will show a "vertical integration" that copes with the different reaction times needed to produce adaptation of agent behavior. This is achieved by the joint work of the model-based pipeline that uses classical planning with a model-free approach able to react to run-time input from human users. Examples will be given demonstrating the behavior of an interactive robot in a human-assistive scenario.

29 Roberto Basili (Associazione Italiana per l'Intelligenza Artificiale). *Modern Intelligent Systems between accuracy and ethics: the role of natural language in explainable Machine Learning.*

Abstract. Ethics is a crucial problem for current AI applications for the widespread adoption of intelligent systems and devices. Although ethics has been studied in AI under several perspectives, its implications from the point of view of natural language learning has not yet fully outlined. Ethical AI systems seems to include, as a strong precondition, the epistemological transparency of the expertise and models they use. As most of them are data-driven, as they are acquired from experience and previous data through advanced Machine Learning algorithms, the explainability of ML models becomes a fundamental property. Explainability is not only a desirable property but also the effect of suitable design of ML systems, such as deep networks (DNs). In the talk, I outline the role of language-aware DNs in the use design of explainable neural models and how these latter are connected with ethically sustainable systems.

30 John Quinn (Prague Center for Global Health). *Simulation in military medicine: the case for the Vigorous Warrior Exercise and Experimentation.*

Abstract. NATO military medical doctrine prepare and provide clinical best practices for war and disaster. These medical standards must be evidenced based and provide best practices across the alliance and must be stress tested regularly across domains. The marquee training live exercise (LIVEX) event for all things health security, force health and medicine is the Vigorous Warrior (VW) Exercise series. Unfortunately due to the COVID-19 pandemic the 2021 exercise has been postponed, but this does not mean that NATO stops prepairing, training and maximizing improper ability medical skills across the lines. The NATO Military Medicine Center for Excellence (MILMED

COE) provides key leadership for this series, and in Concept Development and Experimentation (CD&E) section, a transformational process through simulation and experimentation in not only evolving clinical medicine for NATO, but has potential to impact aspects of force health.

In this paper, we describe the concept development and experimentation process within the military medical center of excellence. We describe the two core upcoming experiments as they relate to prehospital and Emergency Medicine to take place in the next 2023 Vigorous Warrior exercise series. The experimentation process provides operational application of simulation to training audiences, verifies Damage Control Resuscitation and Surgery (DCR/DCS) procedures, and supports with alliance decision support and analysis. The experimentation process can descriptively demonstrate and present latest technology and medical trends. MILMED COE assists in doctrine development, identify lessons learned (LL), improves interoperability and capabilities through testing and validation experimentation of core NATO concepts. This is offered through recognized expertise and experience that is of benefit to the Alliance, and support the transformation of NATO into the future, while avoiding the duplication of assets, resources and capabilities already present.

31 John Quinn (Prague Center for Global Health). *NATO Medicine and pandemic response: the nexus of interoperability.*

Abstract. The current COVID-19 pandemic caused by the virus SARS CoV-2, Is likely to infect between 60 and 80% of the global population and will likely kill over 1 million in the first 18 months. Health Security for the global population is at risk of preventable morbidity and mortality. The dreaded "Disease X" scenario has been confronted and global response by the state sector is greatly challenged. The interoperability of not only NATO, NATO partner states and across domains of battle, but also the nexus of civilian and civilian medical sector must be in alignment to maximize best practices. NATO military medical doctrine prepare and provide clinical best practices for war and disaster and NATO clinical leadership are needed now more than ever. In this paper we describe how NATO Military Medical standards, practices and process support in the realm of interoperability prepare, support response through robust interoperability methodology. We conclude with testing, contact tracing and rapid social distancing, social isolation, quarantine, where warranted, and symptomatic treatment provide best medical outcomes.

33 Gordon Judd (CAE), Máté Koch (CAE) and Colin Bigg (CAE). *Mixed Reality Displays and Multi-User 3D Visualisation for Collaborative Mission Planning.*

Abstract. Novel commercial display technologies are increasingly being used to improve mission planning and decision support. However, any digitisation of traditional planning processes should ensure that collaboration between participants is not diminished by artificial barriers introduced by the transition from physical maps to computerised displays. The CAE ASGARD system uses multiple HoloLens mixed reality (MR) headsets and 3D visualisation to digitise the traditional 'bird table' in a way that retains the benefits of face-to-face interaction whilst leveraging technology to overcome the limitations of paper maps. The MR glasses allow multiple users to be simultaneously aware of the real world and interact with a 3D visualisation of a synthetic environment, making it possible to observe the position of other users and also manipulate a 3D map that is displayed at the same location for all users. In this immersive environment, users can visualise and better understand the importance of topography and parts of the mission may be simulated by dynamic movement of 3D entities, reducing the time to interpret relief or approach routes to target areas of interest. The system can also connect users at different locations to a shared distributed planning session, providing coherent multi-site interactivity to significantly enhance Commanders' briefings.

34 Imre Balogh (Naval Postgraduate School), Kirk Stork (Naval Postgraduate School) and Christian Fitzpatrick (Naval Postgraduate School). *Using Data-Limited Mesh Networks to create a Realistic, Distributed LVC Training Environment at the Small Unit Level.*

Abstract. Since the development of simulation interoperability standards and protocols in the early 1990s, the US Navy and Marine Corps have been networking various combat simulations together to create live virtual constructive (LVC) training environments that simulate the "fog of war" typically expected on today's modern battlefield. In theory, using constructive simulations during live training events allows operational units to train against agile enemies in a realistic environment. Critical to this concept is the development of dynamic red force behaviors that can change based on a specific entity's view of the current world state. As the world state changes, so does the red force's actions and locations within a simulated scenario. Displaying these enemy maneuvers on tactical command and control (C2) systems can then create a training environment where our warfighters need to react, make decisions and collaborate. In order to model a distributed red force across a representative battlespace, a robust data network must be deployed capable of transferring large amounts of simulation data in the appropriate format for use on existing C2 systems. We are seeking to create a network that supports the rapid creation of LVC environments using existing DoD simulations and commercial-of-the-shelf (COTS) hardware. Our goal is to create organic LVC environments using a COTS mesh networks for air, land and sea-based unit training at a low cost.

35 Kalle Saastamoinen (National Defence University of Finland). *Simulation course – Action research approach.*

Abstract. Simulation is a discipline where all kinds of technical, scientific, economical and humanistic skills are required in order to produce a working simulation that corresponds reality as well as possible. At the National Defence University (NDU), student varying knowledge and motivation towards science and engineering brings its own demands how simulation is sensible to carry out in order to achieve the best possible learning outcome.

Simulation and modelling course is aimed at learning how real-world artifacts or models work, how to acquire data, how to visualize the acquired data, and to develop understanding trough simulations. Course ends with a group work, where participating students need to produce a working simulation model either from the given list or from their professional context.

We use action research as our teaching paradigm. Action research bridge the gap between research and practice. This method guides towards real intervention, includes evaluative work and produces information that helps to find a better approach. Therefore, enhanced interventions are a cyclic process.

This study describes action research, how it works as teaching paradigm and simulators that our students have been able to produce during the course.

We show that simulation course presented here is recommendable to any nature science students, because it offers a very real linkage to the practical applications, which are connected to the theory though simulations. Whether student is physician, mathematician or chemist this kind of learning is the best way of learning. For military officers learning is normally practically oriented, while in natural sciences learning is theoretically oriented in both cases simulation is a natural "bridge" in between theory and practice.

40 Paolo Proietti (LEONARDO COMPANY). Cybersickness: a problem to overcome to ensure effective training.

Abstract. The human brain must integrate real-time visual, auditory, vestibular, somatosensory, and other inputs to produce a compelling feeling of immersion in the natural environment. In the past decade, there has been a rapid advance in immersive Virtual Reality (VR) technology which involves mainly visual and auditory senses in bimodal interactions. A problem with VR is that users develop symptoms similar to motion sickness - a malady called cybersickness. The discomfort that users experience during or after a session in a synthetic environment became widely known about in the military setting during the advent of flight simulators. The related phenomenon of simulator sickness can discourage pilots from using flight simulators, reduce the efficiency of training (through distraction and the encouragement of adaptive behaviours that are unfavourable for performance), or compromise safety when sick or disoriented pilots leave the simulator (e.g., to operate ground vehicles). In a similar manner, cybersickness can be a barrier to using VR for military training, and thereby limit the dissemination of improved training or rehabilitation tools. Cybersickness was evaluated by Study Group 323 within the Human Factor & Medicine (HFM) Panel and NATO Modelling & Simulation Group (NMSG) of the Science & Technology Organisation (STO) of the North Atlantic Treaty Organisation (NATO). They reviewed the factors contributing to sickness that are associated with the individual (e.g., history of susceptibility), the VR system (e.g., system lag), and the task (e.g., type of virtual locomotion control). Solutions to reduce symptoms of cybersickness were identified, such as earth-referenced cues and exposure limits. These can be implemented during system design and usage, and can aid in the management and treatment of cybersickness. Adoption of the guidelines in this report for mitigating cybersickness will enhance training effectiveness throughout the military community through better implementation of VR.

46 Ciro Donalek (Virtualitics). Immersive technologies: a new Platform for Real-time collaboration and Explainable AI.

Abstract. Real time collaboration for both analysis and presentations is quickly becoming a crucial need during and after the pandemic, since working remotely will become the norm and teams will be scattered in different geographic locations. Moreover, in recent years there has been a widespread adoption and use of Artificial Intelligence in both public and private sectors. Although these models can derive powerful predictions and provide useful insights, they are often opaque, leaving non-technical users in a difficult position of having to trust a model that they cannot fully understand. Thus, the rise of Explainable AI (XAI) that aims to accurately interpret and communicate finding to users without a proper data science background. In this talk I will show how immersive technologies can be leveraged for both real time collaboration and making insights, coming from complex Machine Learning models, more digestible and easier to explain and understand.

48 Alex Hoover (Irrational Number Line Games, LLC). Wargaming Cyber _Tactical Hack.

Abstract. While cyber operations are highly technical in nature, they are fundamentally no different than any other combined arms capability a force or its adversaries brings to the battlefield. Capabilities in the cyber domain evolve more rapidly and depend on more external services than other warfighting capabilities. Cyber capabilities also have a significant overlap with civilian capabilities not found in most warfighting gear. This creates a sense of separation from the non-specialist user and an inordinate focus on the technical specifics. At the end of the day, it is somewhat interesting that you can field strip and reassemble your weapon in 10 second. But it's useful if you can restore your weapon to a functioning condition in a tactically significant way.

Likewise, with cyber capabilities the focus should be on the effects, not the techniques and technologies. It is interesting if you can compromise an adversary network and steal information. It is useful if you can steal tactical deployment information in a time frame that I can proactively respond.

This presentation will discuss an approach used by Irrational Number Line Games to develop and field cyber effects supplements for tabletop wargames that can be applied to any wargaming environment and approach.

49 John Nicol (Corona Aerospace Inc). Using Virtual Reality for Collaborative Immersive Operations and Planning.

Abstract. Managing complex operations, such as military ops, UAV swarms, disaster response, or within large enterprise organizations is hard. Gaining critical situational awareness in a complex, data-rich environment is harder. Using teleconferences, video or webex during a pandemic? Extreme!

The presentation will briefly describe the use of a virtual reality (VR) application at CWIX 2020 which provided a unique, data driven collaboration space for distributed operations. The technology enables data from real or simulated systems to be visualized for planning and operations. It also allows real equipment to be operated within the virtual space. Locations in Italy, The Netherlands and Canada were connected and shared data during the event.

As we deal with the new normal of remote collaborative environments we need to not just replicate office tools, but interactive infrastructures supporting real world operations.

50 Gabriele Romagnoli (GR Talk). Immersive Technologies: the future is now?

Abstract. The term "Immersive Technology" refers to any technology that extends or creates a new reality by leveraging the 360 space. Recent hardware and software advancement have made these technologies more accessible and are opening up new opportunities to businesses and organizations. During this presentation, Gabriele Romagnoli will give a brief overview of the current landscape, discuss some military applications with relevant examples, and close with recommendations to help explore this new world.