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**DEFENSE SCIENCE BOARD**

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OFFICE OF PREPUBLICATION AND SECURITY REVIEW

gaming, exercising,  
**GEMS**  
modeling, & simulation

January 2021

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This report is a product of the Defense Science Board (DSB). The DSB is a Federal Advisory Committee established to provide independent advice to the Secretary of Defense. Statements, opinions, conclusions, and recommendations in this report do not necessarily represent the official position of the Department of Defense.



DEFENSE SCIENCE  
BOARD

OFFICE OF THE SECRETARY OF DEFENSE  
3140 DEFENSE PENTAGON  
WASHINGTON, DC 20301-3140

MEMORANDUM FOR UNDER SECRETARY OF DEFENSE FOR RESEARCH AND  
ENGINEERING

SUBJECT: Final Report of the Defense Science Board (DSB) Task Force on Gaming,  
Exercising, Modeling, and Simulation

I am pleased to forward the final report of the Defense Science Board's Task Force on Gaming, Exercising, Modeling, and Simulation (GEMS), co-chaired by Dr. Ruth David and Dr. Bill LaPlante.

GEMS technologies and capabilities have improved greatly as developments in computing power, graphics, and other enablers have accelerated. However, the pockets of GEMS excellence developed by the DoD have become isolated over time and now often lack the necessary resources to support the DoD's mission in an era of great power competition. Increased use of GEMS will be necessary to ensure that the DoD is able to meet future challenges in training, systems development, acquisition, training, deterrence, and warfighting. Accomplishing this will require both cultural and policy changes throughout the Department.

This report illustrates the importance of GEMS tools and capabilities for the Department's future success and offers a series of recommendations that, if implemented, will set the Department on the right path. I endorse the recommendations in this report and encourage all the relevant parties in the Department to begin implementing them. The benefits from doing so will be significant and extremely valuable to our ability to deter and, if necessary, fight and win wars against strategic competitors.

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Eric Evans  
Chairman, DSB

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DEFENSE SCIENCE  
BOARD

OFFICE OF THE SECRETARY OF DEFENSE  
3140 DEFENSE PENTAGON  
WASHINGTON, DC 20301-3140

MEMORANDUM TO THE CHAIRMAN, DEFENSE SCIENCE BOARD

SUBJECT: Final Report of the Defense Science Board (DSB) Task Force on Gaming, Exercising, Modeling, and Simulation

Attached is the final report of the Defense Science Board's Task Force on Gaming, Exercising, Modeling, and Simulation (GEMS). This task force was asked to review the current state of the GEMS enterprise within the DoD, assess advancements in GEMS technologies and capabilities, and provide recommendations to the DoD for better leveraging GEMS tools to meet U.S. national security objectives. This broad inquiry was divided across the following topics:

- Digital engineering to support an enterprise-level GEMS strategy that would promote effective adoption of GEMS tools;
- Training augmented with and facilitated by GEMS tools to enhance warfighter lethality and survivability in the face of emerging threats from peer competitors;
- Experimentation campaigns enabled by GEMS to discover new tactics and concepts;
- High quality virtual exercising to increase readiness;
- Evaluating and testing high-level geopolitical strategies with long time horizons through strategic gaming;
- Integrating the use of technology-based enablers such as game engines and synthetic environments for a wide variety of DoD missions; and
- Promoting effective GEMS governance to enable the proper coordination of GEMS activities and uses across the DoD and the wider national security enterprise.

This report offers a number of recommendations that will position the DoD to adopt and leverage the power of GEMS. We hope this report will receive senior-level attention to ensure that the recommendations are implemented as quickly as possible. If the DoD moves to improve its GEMS capabilities and incorporate GEMS tools in a coordinated manner, the benefits to the Department will be revolutionary. In the contemporary security environment, the DoD must not fail to take advantage of this game-changing set of tools and enablers.

Dr. Ruth David  
Co-Chair

Dr. Bill LaPlante  
Co-Chair

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## Executive Summary

The Defense Science Board Task Force on Gaming, Exercising, Modeling, and Simulation (GEMS) was tasked with reviewing DoD’s current state of practice in the use of GEMS tools and to make recommendations for improving GEMS tools to harness their full potential across the spectrum of the DoD enterprise, from administrative to warfighting. GEMS tools and capabilities provide cost-effective and innovative ways to test new ideas and concepts, design and prototype new systems, model military campaigns, conduct geopolitical analysis, and provide training to improve warfighter readiness and performance. The task force observed that such capabilities are increasingly important in today’s highly competitive and dynamic strategic environment associated with the return to great power competition and that technological advances have made GEMS capabilities even more powerful and useful than they were in the past.

While the DoD has pockets of GEMS excellence and innovation, the task force observed that it lacks the necessary integration, resources, and talent to reap the full benefit now available from GEMS. Particularly lacking are mechanisms to effectively integrate insights derived from GEMS into senior leader decision-making about defense requirements and acquisition programs.

Given the broad spectrum of GEMS tools as well as their diverse applicability, the task force opted to focus on the five broad application areas (Digital Engineering, Training, Experimentation and Exercising, Campaign Modeling & Analysis, and Strategic Gaming), shown in hierarchical form in Figure ExS-1, and their interdependencies.

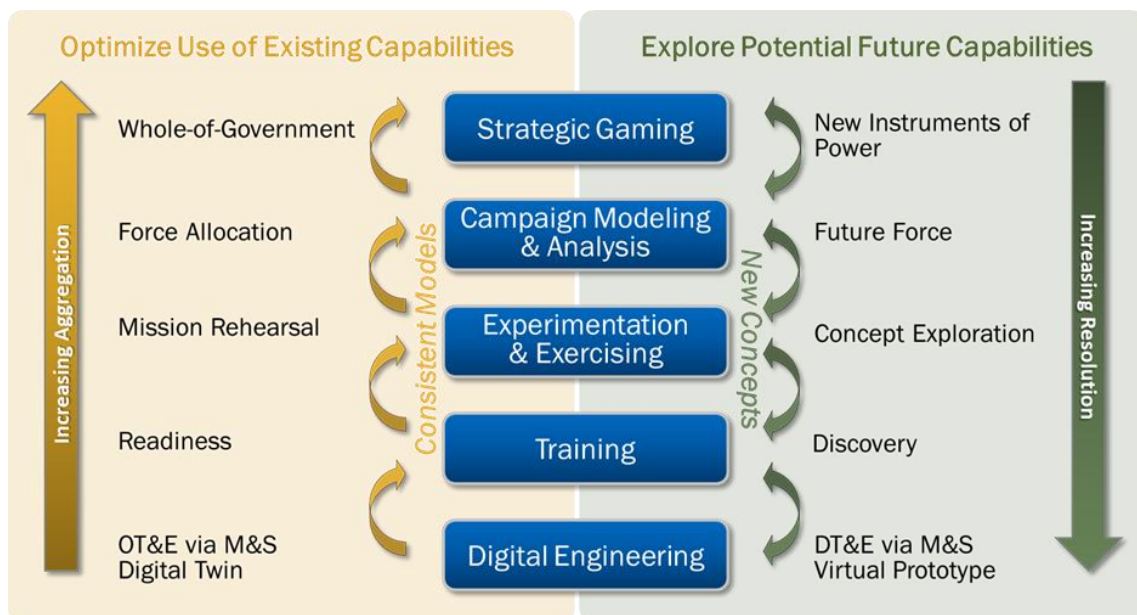


Figure ExS-1: GEMS Application Areas

The task force offers recommendations in these five application areas as well as in two cross-cutting topical areas: Technology-Based Enablers and GEMS Governance.

**Digital Engineering:** The DoD has nascent efforts underway to advance Digital Engineering (DE), which are encouraging. For example, there has been a push inside the military services to use digital engineering in considering new system concepts; however widespread adoption of DE remains a work in progress. The task force notes that organizations that have adopted the rigor of DE reap measurable benefits, and strongly recommends accelerated DE adoption across the enterprise. Moreover, this capability provides the necessary foundation for the DoD to fully exploit GEMS tools and produce warfighting capabilities efficiently at scale. The task force believes that full adoption of DE by the DoD does not require a substantial change in the acquisition process; however, it will require some adaptation, particularly by the DoD evaluation and review processes in order to derive the full value added of DE as employed in virtual testing. Also, DE depends upon rigorous discipline in the use of validated tools and data from the authoritative representation across all engineering activities. That means DoD engineers must be fluent in DE methods, discipline, tools, and techniques. Enabling and supporting that workforce will require that the DoD invest in the necessary information infrastructure, specifically, greater automation across a range of engineering tasks.

**Training:** Training capabilities across the military departments have long benefitted from the use of GEMS tools and innovations that helped spur a revolution in training that began decades ago and contributed significantly to U.S. military advantage. While the task force noted that a second training revolution in the military departments is underway, driven by advances in simulations, modeling, virtual reality (VR), and artificial intelligence (AI), it observed the need for significant improvements in Joint Force training. While the Combatant Commands (CCMDs) strive to maintain joint training, the reality is that most CCMD exercises are led by the military department most responsible for the given scenario—thus the training has a service-specific flavor. To present potential adversaries with multiple dilemmas and complicate their planning it is essential that the Joint Force train to fight collaboratively and simultaneously across all domains. To that end, the task force recommends focusing on motivating the military departments to make their training more joint—more representative of “how we will fight,” on ensuring the needed network connectivity among the military departments to support joint training, and on establishing a robust capability for joint all-domain training. The task force also recommends an ongoing effort to strengthen its distributed training capabilities, identifying specific simulations that deliver the high quality of training at a major training center, yet be operated from home station. Like other GEMS capabilities, the ability to realize this joint and all-domain training vision will require sustained executive-level leadership and adequate resourcing over a period of years.

**Experimentation & Exercising:** The National Defense Strategy (NDS) Commission Report calls for “new operational concepts to achieve strategic advantage...validated through experimentation, exercises and training.” The task force endorses this call and concludes that the DoD must revitalize concept-based experimentation at the combined military department/partner-level to meet long-term challenges presented by peer competitors. The task force observed that joint concept experimentation has become a lost art in the DoD. The task force recommends that this capability be reinvigorated, employing a campaign-based approach to more rapidly deliver new ways of warfighting combined with new capabilities to counter current and

emerging operational challenges. The task force recommends a campaign approach that produces a feedback cycle that iteratively refines concepts and capabilities, weeding out failures as early as possible in the process, while feeding forward the refined concept and capability to the next stage of experimentation. The task force further recommends that joint warfighting issues and ideas be injected into ongoing service experimentation; that the DoD sponsor joint concept experimentation beyond the military departments; and provide additional support to military service and CCMD (especially United States Indo-Pacific Command (USINDOPACOM) and United States European Command (USEUCOM)) experimentation campaigns and exercises.

**Campaign Modeling & Analysis:** The DoD's current campaign models are used to inform investment decision-making, especially among the military departments; however, these models fall short in key areas. In particular, they do not effectively address the complexity of the multi-domain security environment in which the DoD operates and they are not equipped to provide quick-turn analyses to inform decision-makers. The task force also found mixed support and confidence in campaign modeling among DoD leadership. The task force's recommendations, therefore, focus on the development of complementary campaign analytics with an increased emphasis on timely, simple, qualitative/quantitative models while also investing in next-generation campaign modeling capabilities that leverage technological advances in areas including artificial intelligence and machine learning. Improving these capabilities is needed to instill confidence in the usefulness of these tools to inform investment decisions. The task force also recommends a more robust effort in development of joint concept of operations (CONOPS) based on planning scenarios to drive campaign modeling, analysis, and to inform resource allocations.

**Strategic Gaming:** The United States made good use of strategic gaming techniques during the Cold War—playing out “move-countermove” assessments over a long-term analytical interval. More recently efforts have focused on immediate threats (e.g., terrorism) and strategic gaming has become a rarely employed tool for analyzing today's larger and longer term challenges. Now, the United States faces advanced great power rivals with technology capability and economic strength rivaling our own. To confront these challenges, the DoD needs to reinvigorate its strategic gaming. Tools are only as good as the participants who use them. Effective strategic gaming will require serious senior-leader participation in the gaming itself. The task force recommends taking advantage of new technological and analytical developments to re-build a strategic gaming capability to better understand geopolitical shifts, adversary goals, and rivals' potential reactions to U.S. operations and initiatives in an era of great power competition. The task force noted that opportunities exist to exploit technological advances in development of new gaming tools—including algorithmic analysis of social, financial, and communication networks, factor trees, quantitative modeling, and distributed gaming techniques—to more effectively support strategic gaming. The task force also acknowledges that effectively competing with great power rivals will require a whole-of-government approach and that the DoD should take the lead in expanding strategic gaming to relevant parts of the USG.

**Technology-Based Enablers:** While GEMS tools benefit from technological advances in many areas (e.g., increasing computing power, artificial intelligence/machine learning) the task force focused on two related technologies—game engines and synthetic environments. Commercially available game engines can accelerate GEMS tool development and robust synthetic environments can enhance the utility of digital models. The task force observed that a number of organizations across the DoD are already making use of these technologies, but in a largely ad hoc fashion. Recommendations, therefore, focus on: building an infrastructure to enable and motivate reuse, thus accelerating progress while reducing costs; and, ensuring that compliant synthetic environments built by contractors during product acquisition (or significant upgrades) are made available for reuse across the Department. Employing better data analytics to generate after action reports at scale will help maximize value from gaming, experimentation and exercises, and prototyping.

**GEMS Governance:** The task force observed that while industry success stories demonstrate the need and pay-off from sustained, top-down leadership and governance to effect change and realize the potential benefits from GEMS tools, the DoD management structures do not promote an enterprise-wide approach. Given the apparent need for both cultural and technological change across the DoD, a more coherent governance structure is imperative. Recommendations in this area focus on actions to promote GEMS interoperability and reusability, as well as establishing a governance structure under a senior leader with appropriate authorities and resources for guiding the DoD modeling and simulation (M&S) enterprise.

Most of the recommendations in this report represent starting points for the cultural and technological transformations that must occur if the DoD is to derive full benefits from GEMS tools. While the task force applauds the GEMS initiatives already underway, we concluded that an enterprise-wide effort is essential if the DoD is to fully harness the potentially game-changing power of GEMS for the application areas discussed above.

The complex choices confronting the DoD (and the U.S. government) in this new era of great power competition require analytically informed options; never has the need for speed and agility in decision-making been more acute. In this regard, the task force concluded that the DoD must significantly advance its GEMS capabilities to keep pace with its competitors and effectively counter threats—today and in the coming years. Doing so will demand both cultural change and technological change across the enterprise. A robust GEMS toolkit is needed to inform DoD decision-making in the highly competitive and dynamic national security environment in which the United States finds itself today. Yet, if the DoD is to realize the potential of GEMS, the Department's senior leadership must take responsibility for providing the vision, support, and persistent resourcing to enable the needed changes. This report offers a roadmap for the DoD to take full advantage of the GEMS tools necessary for enabling better decision-making, smarter exercising and experimentation, and ultimately a stronger military force.

## Recommendations

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### Digital Engineering Recommendations

**Recommendation 1.1. Under Secretary of Defense for Acquisition and Sustainment (USD(A&S))** adapt the acquisition process and contractual milestones to support digital engineering; require digital deliverables that are directly derivable from the contractor's digital core for the design to date.

- Make demonstrated achievement using rigorous digital engineering a source selection criterion—reward appropriate reuse of architecture and design patterns.
- Items in the Contract Data Requirements List (CDRL) should be in digital format, submitted together with an architectural schema on which to base (government) automated testing of completeness and consistency, prior to evaluation.
- Prior to Milestone B, the Joint Requirements Oversight Council (JROC) should assess the complementary virtual versus physical test strategy proposed by the Test and Evaluation Integrated Product Team.
- Add contractual requirements for new engineering activities required for digital engineering, e.g., model curation management vs. configuration management, and lifetime access to digital twins.

**Recommendation 1.2. Each Service Acquisition Executive (SAE)** invest in a DE infrastructure and incorporate rigorous digital engineering at levels where it maximizes benefits and future capability reuse.

- Where existing programs of record utilize digital engineering, conduct Technical Exchange Meetings to gain insight into how to adapt the acquisition approval processes and to assess benefits. Engage selectively with industry leaders (e.g., Ford, GE) to learn best practices.
- Ensure maintenance of, and DoD access to, the authoritative digital representation for the full life cycle.
- Seek to maximize virtual testing to complement physical testing (used to validate behavioral models).
- Plan maintenance based on digital twins; assess maintenance outcomes.

**Recommendation 1.3. Service Acquisition Workforce Directors** develop a government workforce fluent in digital engineering techniques, both to oversee system development, and to perform government life-cycle engineering.

- Military departments, as well as OSD Test & Evaluation (both Developmental T&E and Operational T&E), should invest in and sustain the infrastructure that is necessary to support the workforce and to get full value from virtual testing.

## Training Recommendations

**Recommendation 2.1. Secretary of Defense (SecDef), Chairman of the Joint Chiefs of Staff (CJCS), and Joint Staff J7** provide incentives, directives, and support to the military services to make their training, including with GEMS, more joint and more representative of “how we will fight,” including augmentation via simulation, with multi-domain capabilities.

**Recommendation 2.2. Under Secretary of Defense for Intelligence and Security (USD(I&S)), Under Secretary of Defense for Research and Engineering (USD(R&E)), and USD(A&S)** ensure the needed connectivity among the Military Departments for home station training and add innovative training technologies to major R&E modernization objectives.

**Recommendation 2.3. Military Departments** identify specific simulations that can bring the high quality of training at a major training center, yet be operated from home stations.

**Recommendation 2.4. Director, Joint Staff J7** establish planning and oversight for Joint Multi-Domain Training such as INDOPACOM concept:

- Assign J7, in partnership with USD(R&E), the responsibility to identify a lead architect/system engineer (with both resources and authorities) to develop a plan for Pacific Multi-Domain Training and Experimentation Capability (PMTEC) within 120 days.
  - Specify the initial capabilities and growth path for the PMTEC initiative.
  - Address costs, connectivity, network, data sharing, instrumentation, M&S tools to support LVC, etc.
  - Architecture should include the superior capability for analyses needed to derive full value from the copious data that can flow from the exercises and experiments.
- Establish a review board comprised of the Vice Chairman of the Joint Chiefs of Staff (VCJCS), USD(R&E), USD(P&R), and Commander, USINDOPACOM, to recommend a path forward.
- Create a high priority Joint Concept Technology Demonstration (JCTD) to explore and demonstrate a beta version of the PMTEC.
  - Involve the Defense Innovative Unit to inject innovative commercial technology and ideas into the joint training challenge.
- Assure adequate funds in the Program Objective Memorandum (POM).

## Experimentation and Exercising Recommendation

**Recommendation 3.1. USD(R&E), with Director, Joint Staff J7,** serve as the designated senior authorities to oversee development of a robust Department-wide capability for concept-based experimentation.

- Focus on disruptive joint operational concepts to achieve strategic objectives.
- Foster learning environments through continuous experimentation.
- Inject joint issues into ongoing service experimentation – such as Army Futures Command and Air Force Warfighter Integration Center experiments; enable cooperative cross-service experimentation and sponsor joint concept experimentation beyond the military services.
- Support the military services and Combatant Commands (especially USINDOPACOM and USEUCOM) in the CCMDs’ campaign of experimentation.
- Identify and disseminate best experimentation practices.
- Develop a reusable, integrated GEMS “framework” to support experimentation.

Ensure robust representation of C2, human cognitive effects, cyber warfare, electronic warfare, information warfare, and other gray-zone activities.

## Campaign Modeling and Analysis Recommendations

**Recommendation 4.1. Military Departments,** in coordination with the **Office of Cost Assessment and Program Evaluation (CAPE),** invest in research for complementary campaign analytics with an increased emphasis on timely, simple qualitative/quantitative models.

- Accelerate addition of new capabilities (as described in the observations); first priority to the needs of USINDOPACOM and USEUCOM.

**Recommendation 4.2. USD(R&E) and Defense Advanced Research Projects Agency (DARPA)** establish a research program to build next generation campaign modeling capabilities, such as use of AI/ML and the representation of networked information from all relevant assets.

- Invest in research for complementary campaign analytics with an increased emphasis on timely, simple qualitative/quantitative models.
- Continue to invest in next generation architectures and tools, including the use of AI/ML and the representation of networked information from all relevant assets.

**Recommendation 4.3. Joint Staff J8** work with **Military Services** to develop joint CONOPS based on planning scenarios to drive campaign analysis and resource allocations.

## Strategic Gaming Recommendation

**Recommendation 5.1. Secretary of Defense** direct the **Office of Net Assessment** to conduct bi-annual, week-long, off-site path games. **USD(R&E)** develop associated path-gaming tools.

- Assess adversary goals, capabilities, and potential strategies.
  - Informed by current threat models
  - Staffed with expert red teams
- Assess DoD capabilities and effective integration with other instruments of national power.
  - Inputs from CCMDs, CJCS, Intelligence Community, NSC, DOS, DT
- Results of path gaming exercises should be summarized into simple models that:
  - Identify asymmetrical objectives.
  - Describe adversary concerns and potential reasoning.

Provide a basis for discussion and action at Cabinet and Deputies meetings.

## Technology-Based Enablers Recommendations

**Recommendation 6.1. Game Engines – Defense Innovation Marketplace, Defense Technical Information Center (DTIC)** maintain and inventory DoD-wide asset store of reference models, libraries, and games as reusable assets.

- Include models, textures, audio libraries, terrain maps, behavioral modes, etc. to encourage the community to focus on key advancements rather than starting from scratch.
- Such data can be gathered as part of their yearly R&D and program RFIs.

**Recommendation 6.2. Synthetic Environments – USD(A&S), USD(R&E), Director, Operational Test and Evaluation (DOT&E), and Service Acquisition Executives** establish technical agent, requirements, and develop contracting approaches that will require delivery of synthetic environments as part of the deliverables for all appropriate new products and significant upgrades.

## GEMS Governance Recommendations

**Recommendation 7.1. Office of the Secretary of Defense (OSD)** facilitate the adoption of GEMS interoperability and reusability.



- **USD(R&E)** should convene a joint Senior Executive committee of individuals who can commit on behalf of the military departments to the adoption of standards, achieving the selection of the first ten standards for capabilities with the most leverage within 18 months.
- **USD(A&S)** should enforce the use of those standards, for the military services and joint GEMS tools.
- **USD(R&E)** should finance a jumpstart population of a library of reference models and gaming assets to be created and maintained by DTIC (see Recommendation 6.1).
- **USD(R&E) with Under Secretary of Defense for Personnel and Readiness (USD(P&R))** should establish workforce policies, including GEMS specialty codes for uniformed officers, as well as provide oversight for GEMS workforce hiring, retention, and skill development.

**Recommendation 7.2.** Restructure the DoD M&S governance directly under a senior leader with appropriate authorities and resources for guiding the DoD M&S enterprise.

## Appendix A: Task Force Terms of Reference



RESEARCH  
AND ENGINEERING

THE UNDER SECRETARY OF DEFENSE  
3030 DEFENSE PENTAGON  
WASHINGTON, DC 20301-3000

JUN 18 2018

MEMORANDUM FOR CHAIRMAN, DEFENSE SCIENCE BOARD

SUBJECT: Terms of Reference - Defense Science Board Task Force on Gaming, Exercising, Modeling and Simulation

The global threat environment is stressing the Department of Defense (DoD) across all warfighting domains. Emerging existential threats demand attention; threats from terrorism persist, requiring global situational awareness; anti-access/area-denial challenges are growing; adversaries confront the U.S. with gray zone actions; and the U.S. homeland is no longer a sanctuary. This environment demands greater speed and agility across the spectrum from structuring and equipping to deploying and sustaining military forces. These growing demands amplify the need for rapid—but informed—decision-making.

Gaming, exercising, modeling, and simulation (GEMS) are all tools that complement the human mind when addressing complex tasks. Adept use promotes an empirical approach to solving problems by enabling decisions based on the a priori determined “right” bases and on evidence, not on the basis of rank, past history, or cultural bias. Increasingly, models and simulations (M&S) have become part of a larger system of people plus hardware plus software in which they play a part that either was not present in the past, or was performed by people. Such tools have matured in effectiveness over the past half century and increasingly employ machine learning algorithms, which offer substantial benefits in dealing with complexity while at the same time making traditional validation and verification techniques obsolete.

GEMS are not new to DoD. The military led in developing M&S to support the exercise of multiple people and to explore trade-space in acquisition programs. Games are used to explore operational concepts as well as to train Warfighters. DoD has established policy and implementation guidance addressing both the management and the verification, validation, and accreditation of these tools.<sup>1</sup>

The objective of the Task Force on GEMS is to review DoD’s current state of practice in the use of GEMS and will make recommendations that enable better decisions and choices—accomplished with greater speed and agility. Recommendations will address informed decision-making across a spectrum of activities including:

- Evaluation of complex choice tradeoffs (e.g., acquisition planning, including upgrade/re-purpose options); weapons mix planning; cost estimation;
- Exercise coping with complex, incrementally unfolding scenarios; training teams to work together (including man-machine teams);
- Cueing (augmenting an operational system with a model that analyzes and isolates promising “signal in noise” so that humans can focus on what is most relevant);

<sup>1</sup> Department of Defense Directive #5000.59: DoD Modeling and Simulation (M&S) Management; Department of Defense Directive #5000.61: DoD Modeling and Simulation (M&S) Verification, Validation, and Accreditation (VV&A); Department of Defense Instruction #5000.70: Management of DoD Modeling and Simulation (M&S) Activities.

- Training and evaluation of autonomous algorithms, and learning algorithms, across diverse applications and operational scenarios;
- Exercise to learn manual and mental skills (e.g., learning to distinguish and identify sounds from a submarine sonar sensor or learning to negotiate with a tribal village elder in the Middle East).

The Task Force will review the implementation of DoD policy and guidance for both management and validation of GEMS to identify gaps, barriers, and opportunities for improvement. Particular emphasis will be placed on techniques for promoting visibility and accessibility of cross-cutting tools, data, and services; and on validation and verification techniques for learning algorithms.

The Task Force will also review the state of practice in the use of GEMS in relevant private sector analogs and across the Government-affiliated laboratory community. Opportunities will be identified for DoD to adopt/adapt capabilities and/or practices to accelerate its use of GEMS to increase speed, agility, and informed decision-making across its enterprise.

I will sponsor the study. Dr. Ruth David and William LaPlante will serve as the co-Chairmen of this study. Mr. Leigh Yu will serve as the Executive Secretary. Mr. David Moreau will serve as the Defense Science Board Secretariat representative.

The Task Force members are granted access to those DoD officials and data necessary for the appropriate conduct of their study. The Under Secretary of Defense for Research and Engineering will serve as the DoD decision-maker for the matter under consideration and will coordinate decision-making as appropriate with other stakeholders identified by the study's findings and recommendations. The nominal start date of the study period will be within 3 months of signing this Terms of Reference, and the study period will be between 9 to 12 months. The final report will be completed within three months from the end of the study period. Extensions for unforeseen circumstances will be handled accordingly.

The study will operate in accordance with the provisions of Public Law 92-463, "Federal Advisory Committee Act," and DoD Instruction 5105.04, "DoD Federal Advisory Committee Management Program." It is not anticipated that this study will need to go into any "particular matters" within the meaning of title 18, United States Code, section 208, nor will it cause any member to be placed in the position of action as a procurement official.



Michael D. Griffin

## Appendix B: Task Force Membership

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### Chairs

Dr. Ruth David  
*Private Consultant*

Dr. Bill LaPlante  
*The MITRE Corporation*

### Members

Gen Mike Carns, USAF (Ret.)  
*Private Consultant*

Dr. Ted Gold  
*Private Consultant*

Hon. Page Hoeper  
*Private Consultant*

Hon. Anita Jones  
*University of Virginia*

Dr. John Laird  
*University of Michigan*

Maj Gen Rick Lewis, USAF (Ret.)  
*Lockheed Martin*

Dr. Susan Numrich  
*Institute for Defense Analyses*

Dr. Ernest Page  
*The MITRE Corporation*

Dr. Matthew Schaffer  
*John Hopkins University Applied Physics  
Laboratory*

Dr. Dinesh Verma  
*Stevens Institute of Technology*

Dr. James Wall  
*Texas A&M University*

Dr. Terence Yeoh  
*Aerospace Corporation*

### Government Advisors

Dr. Walter Barge  
*OUSD(P&R)*

Ms. Amy Markowich  
*U.S. Navy*

COL Joseph Nolan, USA  
*AMSO*

Mr. Dennis Reed  
*U.S. Navy*

Mr. Kirby Thomas  
*U.S. Army*  
Dr. George Akst  
*U.S. Marine Corps*

Mr. Kevin Williams  
*U.S. Air Force*  
Mr. Glenn Fogg  
*ODASD(EC&P)*

### Executive Secretary

Mr. Leigh Yu  
*DMSCO*

### DSB Secretariat Representative

Mr. David Moreau  
*Designated Federal Officer*

### Study Support

Ms. Ashley Negrin  
*SAIC*

Mr. Ari Kattan  
*SAIC*

## Appendix C: Briefings Received

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### 23-24 October 2018

DMSCO Perspective  
Defense Modeling and Simulation Coordination Office (DMSCO)

Navy M&S Overview  
*U.S. Navy*

Army M&S Overview  
*U.S. Army Modeling and Simulation Office (AMSO)*

Air Force M&S Overview  
*U.S. Air Force A9*

Marine Corps M&S Overview  
*Marine Corps M&S Office (MCMSO)*

### 27-28 November 2018

Serious Games Overview  
*BreakAway Games*

NAWCTSD Overview  
*Naval Air Warfare Center Training Systems Division (NAWCTSD)*

University of Central Florida (UCF) Institute for Simulation and Training (IST) Perspective  
*University of Central Florida and UCF Complex Adaptive Systems Laboratory*

Air National Guard Perspective  
*Air National Guard*

Air Force Agency for Modeling and Simulation  
*U.S. Air Force A3T and Air Force Agency for Modeling and Simulation*

Bohemia Interactive Simulations  
*Bohemia Interactive Simulations Group*

U.S. Army RDECOM Perspective  
*Army Research Laboratory*

National Training and Simulation Association Overview  
*National Training and Simulation Association*

### 13-14 December 2018

GEMS Experience  
*Arizona State University*

Strategic Intelligence Analysis Cell Use of Modeling and Simulation Warfighting  
*USD(R&E) Strategic Intelligence Analysis Cell*

Air Force M&S Overview  
*U.S. Air Force*

Understanding the Interconnectivity of DoD's Modeling and Simulation Enterprise  
*Institute for Defense Analyses*

IDA Perspective  
*Institute for Defense Analyses*

### 09-10 January 2019

Air Force M&S Decision Support Overview  
*U.S. Air Force A9F*

Close Combat Lethality Task Force Overview  
*Institute for Defense Analyses and OSD(P&R)*

Digital Engineering Overview  
*OSD(R&E)/Systems Engineering*

### 11-12 February 2019

Defense Research and Engineering for Advanced Capabilities  
*OSD(R&E)*

J8 M&S Overview  
*Joint Staff J8*

Integrated Threat Analysis and Simulation Environment  
*Defense Intelligence Agency and Office of Naval Intelligence*

Geospatial Data - Foundation GEOINT 3-D  
*National Geospatial-Intelligence Agency*

Integrated Threat Analysis and Simulation Environment  
*DIA/MSIC*

ARC and AWESOME M&S Capabilities  
*Aerospace Corporation*

Senior Decision-Maker Perspective  
*Johns Hopkins University Applied Physics Laboratory*

AFWIC Overview  
*Air Force Weapons Integration Capability (AFWIC)*

### 27-28 March 2019

Office of Net Assessment Perspective  
*Telemus Group*

Threat in M&S Area  
*Hudson Institute*

J7 Perspective  
*Joint Staff J7*

The Cognitive Dimension  
*ShadowBox, LLC*

### 29-30 May 2019

CCDC GVSC Overview/M&S Strategy  
*CCDC GVSC*

Virtual Prototyping for CFT  
*CCDC GVSC*

Virtual Experimentations (as part of Virtual Prototyping)  
*CCDC GVSC*

Early Synthetic Prototyping  
*CCDC GVSC*

VCFT Goals, M&S, and VE  
*CCDC GVSC*

GVSL Overview, Briefings, and Tour  
*CCDC GVSC*

General Motors Virtual Testing Activity Center  
*General Motors*

The aDRIVE Simulation Framework: Automated Driving Refined in Virtual Environments  
*Ford Motor Company*



Propulsion System Modeling, Simulation, and Optimization  
*Ford Motor Company*

Applying an Integrated MBSE Solution Framework to the Analysis, Design, and Implementation of  
Highly Distributed System of Systems  
*Ford Motor Company*

### **17-18 June 2019**

USINDOPACOM Perspective  
*USINDOPACOM*

### **16-17 July 2019**

SSA Revival  
*U.S. Marine Corps Modeling and Simulation Office*

NAVAIR Perspective  
*NAVAIR*

STORM Briefing  
*U.S. Air Force A9IW*

### **21-22 August 2019**

MBSE  
*Jet Propulsion Laboratory*

Move/Countermove  
*Center for Strategic and Budgetary Assessments*

### **18-19 September 2019**

Pathgaming and Move/Countermove Discussion  
*Institute for Defense Analyses*

## Appendix D: Acronyms and Abbreviated Terms

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AI Artificial intelligence

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C2 Command and control  
 CCDC Combat Capabilities Development Center  
 CCMD Combatant command  
 CDRL Contract data requirements list  
 CJCS Chairman of the Joint Chiefs of Staff  
 CONOPS Concept of operations

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DARPA Defense Advanced Research Projects Agency  
 DE Digital engineering  
 DOS Department of State

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GEMS Gaming, exercises, modeling, and simulation  
 GVSC Ground Vehicle System Center

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J7 Exercises and training directorate  
 J8 Force structure, resources, and assessment directorate  
 JROC Joint Requirements Oversight Council

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LVC Live/virtual/constructive [environments]

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M&S Modeling and simulation  
 MBSE Model based system engineering  
 ML Machine learning

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NAVAIR Naval Air Systems Command  
 NSC National Security Council

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OSD Office of the Secretary of Defense  
 OT&E Operational test and evaluation

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SAE                      Service Acquisition Executive

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USD(A&S)              Under Secretary of Defense for Acquisition and Sustainment

USD(I&S)                Under Secretary of Defense for Intelligence and Security

USD(R&E)               Under Secretary of Defense for Research and Engineering

USEUCOM                United States European Command

USINDOPACOM         United States Indo-Pacific Command

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VR                        Virtual reality

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