

Army Analysis, Modeling, and Simulation Education, Training, and Development Effort

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ABSTRACT

As part of the Army Modeling and Simulation Office, the Army Modeling and Simulation School (AMSS) provides targeted education, training, qualification, and certification. The AMSS works to ensure the U.S. Army modeling and simulation (M&S) workforce, including Functional Area 57 (military) and Career Program 36 (civilian), is well educated and trained in the use and application of the Army's analysis, modeling, and simulation (AM&S) tools and capabilities. As part of this mission, AMSS routinely updates its education and training opportunities based on the evolving tasks, technologies, knowledge, skills, and abilities required. To understand and address the Army's current and future educational needs better, AMSS has been conducting the AM&S Education, Training, and Development Effort.

This paper will describe the effort and outline the process used to collect information, the analysis of the data collected, and the results of the effort. The effort closely follows the Analysis, Design, Development, Implementation, and Evaluation (ADDIE) process, which is required for Army schools as part of U.S. Army Training and Doctrine Command (TRADOC) Regulation 350-70 and TRADOC Pamphlet 350-70-14. During the 3 years of execution, AMSS has collected survey and interview data and conducted critical task selection working groups with participation from Soldiers and Department of the Army Civilians. The data collected are both quantitative and qualitative, encompassing 16 major educational categories with numerous critical tasks under each major area. Examples of major educational categories include data science, federating models and simulations, scenario planning and development, data generation and management, and identifying and applying existing Army AM&S assets.

As a result of this effort, AMSS has identified existing education and training solutions to meet needs and is developing new lessons and courses for needs without solutions. This effort is an ongoing, iterative process, and AMSS will continue to seek additional interviews and data on AM&S educational needs across the Army.

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INTRODUCTION

The Army Modeling and Simulation School (AMSS) mission is to provide effective education, training, and qualification for a trained and ready modeling and simulation (M&S) workforce that meets current and future Army warfighting requirements. As part of its mission, AMSS obtains and refines information on the tasks, knowledge, skills, and abilities of civilian and military employees who currently work with analysis, modeling, and simulation (AM&S), and associated AM&S activities. AMSS also supports future acquisition, development, and sustainment of all AM&S professionals to meet the Army’s vital AM&S requirements. To remain informed and gather data regarding AM&S education and training needs, AMSS has initiated the Army AM&S Education, Training, and Development Effort. The following paper will outline the process used, data collected to date, and actions AMSS is taking to address Army AM&S education and training needs.

PROCESS

The Army AM&S Education, Training, and Development Analysis Effort is based on the U.S. Army Training and Doctrine Command (TRADOC) Analysis, Design, Development, Implementation and Evaluation (ADDIE) process outlined and referenced in TRADOC Regulation 350-70 (TRADOC, 2017), TRADOC Pamphlet 350-70-1 (TRADOC, 2019), and TRADOC Pamphlet 350-70-14 (TRADOC 2015). The initial focus of this effort was on the “Analysis” portion of the shown in Figure 1. The Army ADDIE process, as documented in TRADOC Pamphlet 350-70-1 (TRADOC, 2019), has the Analysis phase gathering information on:

- What is the need for the training?
- Who are the personnel requiring the training?
- What are the critical tasks associated with the training?

This effort started with these questions in mind to inform the information gathering process. The following sections describe how the analysis team expanded on this baseline to obtain sufficient fidelity data to inform education and training development efforts.

Using this process as a guide, the AMSS analysis team developed a process to engage each Army community, identify educational needs, and gather detailed

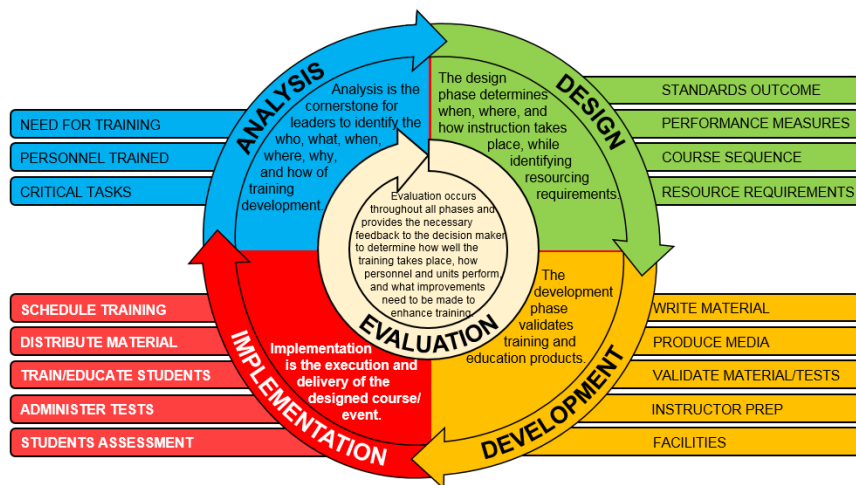


Figure 1. ADDIE Process (TRADOC, 2019, p. 13)

information regarding those needs. The design, development, implementation, and evaluation team members would be included in the data collection process, analysis of the data, and evaluation of potential solutions and courses of action. This process is shown in Figure 2 below and will be elaborated in detail in this paper.

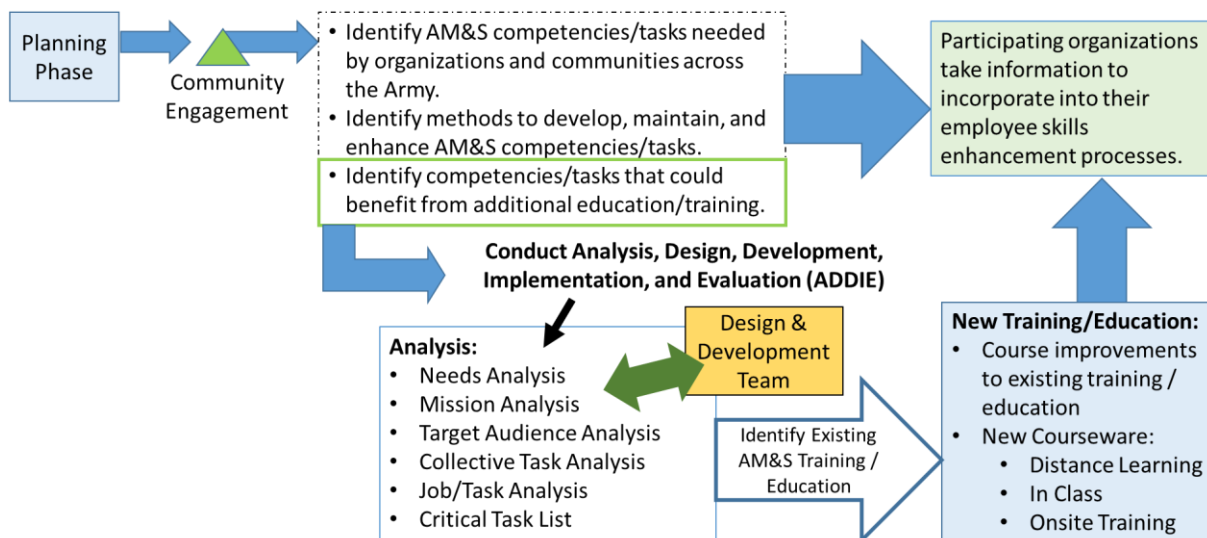


Figure 2. AM&S Skills Analysis Process

Initial Planning Phase

The process began by identifying recognized and emerging communities enabled by M&S. Army Regulation 5-11 establishes the Army M&S framework structure, including recognizing six communities enabled by M&S: Acquisition, Analysis, Experimentation, Intelligence, Test and Evaluation, and Training (U.S. Department of the Army, 2014). The analysis interview team conducted interviews and performed data analysis within each fiscal year. As a best practice, the team focused on one to three Army communities each year. The planning phase also involved the development and updating of interview questions to capture details of each identified need. As an additional best practice, interview questions were designed to facilitate the gathering of data to support the ADDIE collective task analysis, job/task analysis, and development of a critical task list. Interviewers received advanced training on appropriate interview methods to ensure uniform interviews and data collection.

Army AM&S Community Engagement

The optimal process involves inviting the units/commands/organizations identified to participate in the analysis to an Army AM&S community workshop. Time, mission constraints, and world events, such as the coronavirus pandemic (COVID 19), do not always allow a preliminary workshop to occur, but when feasible, the first step is conducting a meeting or workshop attended by subject matter experts and community leaders. Prior to the workshop, attendees complete pre-workshop surveys to identify their organization’s highest priority AM&S educational needs. The survey helps generate discussions during the workshop and gives attendees the opportunity to discuss missions, tasks, knowledge, skills, abilities, and competencies of their individuals using AM&S. The AMSS facilitates workshop discussions using the ADDIE analysis process described in TRADOC Pamphlet 350-70-14, and shown in Figure 3, as a guide to gathering information pertinent to identifying educational needs (TRADOC, 2015). When appropriate, workshop attendees

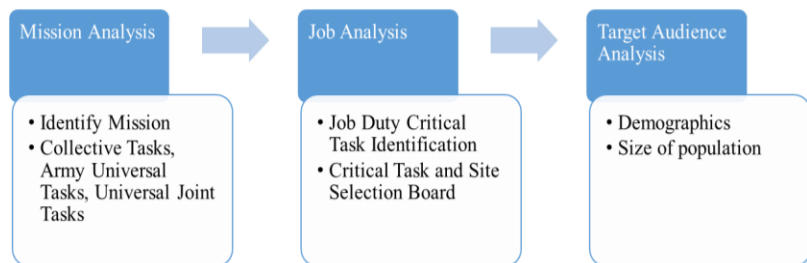


Figure 3. Analysis Process of ADDIE

provided applicable contacts within their organizations. The interviewees included supervisors, subject matter experts, and performers at all levels. The workshop attendees or their analysis team representatives scheduled some of the interviews. The outcome of this meeting was the identification of the common and unique knowledge, skills, abilities, and competencies required by each organization. These required skills may be prerequisites needed prior to obtaining the job, or skills learned during employment through training and/or mentoring. There may also be skills that could benefit from being enhanced through additional training. Some skills are taught at the beginning of a career; however, due to demanding schedules, there may not be opportunities to refresh or expand these skills as a career progress. Other skills may not have a suitable course to address the organizational needs.

Pre-Interview Surveys

The pre-interview survey was designed to help identify and define education and training needs of the individuals taking the survey prior to conducting interviews. Information gathered from prior community engagements, such as workshops, is also provided to interviewees to help stimulate thought. Additionally, the survey requested demographic information and identification of any previous related coursework they have completed related to the identified need.

Interviews

Interviews were scheduled within a month after the conclusion of a workshop or community engagement and were conducted face-to-face and telephonically. Individual interviews were scheduled to last no more than 1 hour; however, small groups (2 - 10 persons) often take a full 90 minutes to allow all participants to add to the discussion. Pre-interview survey data was used to help direct the interviews, and for group interviews, the survey allowed all participants to submit needs equally and be provided time for discussion. During the interview, individuals were encouraged to provide greater detail of the needs addressed on their survey and provide additional information as it related to their scope of work. Interviews employed a standard set of questions designed to investigate each need, the tasks associated with it, the desired educational courses to be developed, and the intended outcomes to be achieved. Interviewees were asked additional questions concerning each need’s impact on their mission, related training they have completed, perceived obstacles to training, and anticipated future knowledge and skills not currently addressed in available coursework. Table 1 represents the analysis used for defining the education and training needs. The analysis conducted by this effort provided information about what skills or knowledge are needed to be trained or learned, the conditions under which the skills should be performed, or the knowledge used, and the standard of performance that must be achieved. Every fiscal year the new data collected are analyzed and compared with the previously collected data, documented, and provided to the AMSS Training Developers.

Interview Demographics

During this effort, the AMSS analysis team interviewed 370 personnel with AM&S education or training needs. Those participants possessed a wide variety of levels of experience in career fields, functional areas, as well as professional and personal backgrounds, both Military and Civilian. Figure 4 displays the level of experience of interviewees by Army community. Figure 5 shows the number of interviewees by career field/functional area represented across the Army communities.

Table 1. Analysis of Collected Data

ADDIE Analysis	Description
Outcomes Analysis	Desired outcomes are derived from workshop discussions, interview need descriptions and from the scope of the requested courses.
Target Audience Profile	Organizational demographic data was utilized to determine the approximate number of AM&S practitioners working in participating organizations.
Mission Analysis	Research is conducted to gather organizational information to develop mission analysis profiles for each organization.
Job Analysis	The individual demographic data collected in surveys and interviews is used to compile job analysis profiles for each participant.
Task Inventory	The task inventory is collected to identify tasks, to include leader tasks, for a specific job, activity, or skill set.
Needs Analysis	Interview data is reviewed for common needs and educational requests. From this analysis needs and their related course requests are binned into major need categories.
Individual Task Analysis	Needs are further examined to discover the underlying individual tasks required to accomplish them and the data is used to develop “individual critical tasks”. Critical tasks include conditions, steps, and standards associated with performance and according to best practices.

Market Research of Existing AM&S Training and Education

A review of existing AM&S training opportunities is conducted annually to determine if existing training and education opportunities can enhance the identified skills. Applicable courses are compiled in a database and made available to Army Soldiers and Civilians. This information is published to a spreadsheet accessible on the AMSS website under the Career Program 36 “Education and Training Opportunities” section:

<https://www.ms.army.mil/sp-div2/cp36/index.html>

Identification of Tools and Desired Training by Need

During the interview process, participants identified several tools (e.g., R programming language, Python, Java) as a training and/or educational need. Many of these tools were listed as a training need across multiple communities. As an iterative process, capturing the needs and requested training on tools are updated as new data are obtained and possible education/training solutions are identified.

Critical Task Selection

Near the conclusion of each iteration, AMSS invited participating organizations to select representatives to attend community-specific Critical Task Selection meetings. These meetings provided a summary brief of all analysis results and the needs and tasks identified by participating commands, and resulted in the approval of critical tasks identified for potential development into new curriculum. Approved critical tasks were entered into the U.S. Army Training Development Capability System for Army University review.

RESULTS

The data collected from 2017 through 2020 have resulted in 25 major education and training categories. These overarching needs are frequently requested by multiple Army communities as shown in Table 2. This paper will highlight some of the most requested educational needs by Army community.

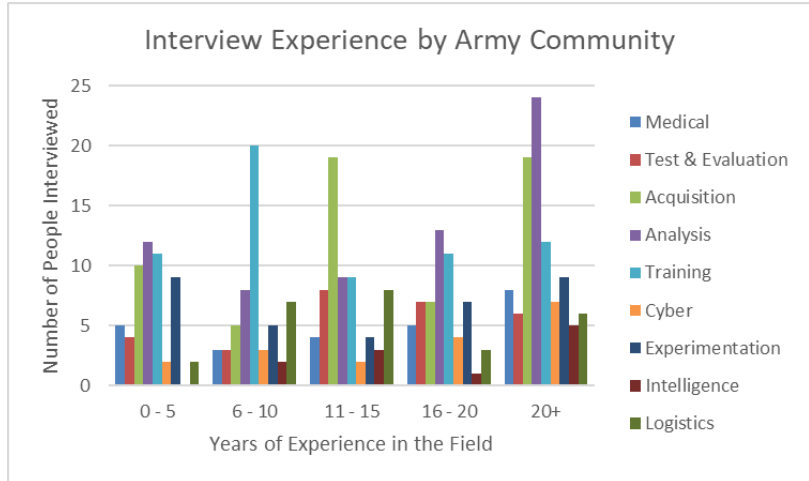


Figure 4. Interview Experience by Army Community

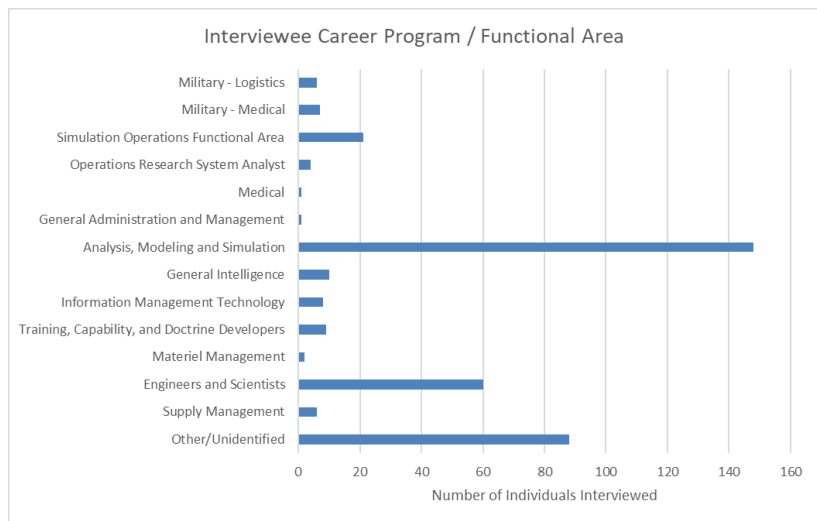


Figure 5. Interviewee Career Program / Functional Area

Table 2. Major Education and Training Need Categories by Army Community

Education and Training Need Category	Acquisition	Analysis	Cyber	Experimentation	Intelligence	Logistics	Medical	Test & Evaluation	Training
AM&S Topics for Executives	X	X					X		X
Apply Community Assets	X	X	X	X	X	X	X	X	X
Apply Doctrinal/Operational Knowledge	X	X	X	X	X	X	X	X	X
Cyber Modeling	X	X	X				X	X	X
Data Analysis	X	X	X	X	X	X	X	X	X
Data Generation and Management	X	X		X	X	X	X	X	X
Data Science	X	X	X	X			X		X
Design of Experiments	X	X	X	X			X	X	
Federating Modeling and Simulation Tools	X	X		X	X	X		X	X
Geospatial Education	X	X							X
Integrate Models, Simulations, and Live Systems	X	X		X				X	X
Knowledge Management	X	X		X		X			X
Logistics Modeling				X		X	X		
Modeling and Simulation in Support of Test and Evaluation	X							X	
Modeling and Simulation Standards, Policy, Guidance, and Directives	X	X							X
Manage Models and Simulations	X	X	X	X	X	X		X	X
Model Planning, Development, Application, and Updating	X	X	X	X	X	X	X	X	X
Modeling and Simulation Career Paths	X	X	X					X	X
Modeling and Simulation Contracts	X				X	X	X	X	X
Modeling and Simulation Exercises				X	X	X	X	X	X
Requirements Development	X	X	X	X		X	X	X	X
Scenario Planning and Development	X	X	X	X	X		X		X
Studies	X	X		X			X	X	
Verification, Validation, and Accreditation	X	X				X	X	X	X
Wargaming		X		X					X

Cross-Community Needs

There were several educational needs requested by interviewees from every Army community. The most notable of those are requests for education on data analysis and knowledge of how to learn of and apply community assets.

Data Analysis

The major need category of data analysis captures educational requests for items like how to perform data analysis, data visualizations, resource analysis, multi-attribute decision making, determining data anomalies, conducting operations research system analytics, analytic storytelling, and how to develop and conduct surveys. The outcome statement captures this need as the ability to perform data analysis to answer metrics and quick-reaction requests, recognize data trends, present findings, and answer questions. The AMSS was able to identify some existing solutions to meet system or tool specific requests such as programming (e.g., Python, C++), analytic tools and tool packages, and data analytic methods (e.g., optimization, sensitivity analysis).

Other need requests were specific to how the Army conducts or uses analysis. For example, many interviewees requested a short course or refresher course on Army Operations Research/Systems Analysis. Many requests wanted a course that was not longer than 1 week and focused on Army examples. Another Army-specific request was how to present analysis to a military leader who is using the Military Decision-Making Process and desires concise, data driven answers to their questions. Interviewees provided several examples of how analysts often present findings in a manner that does not meet the decision maker's needs. Many analysts have expressed the need of ensuring a clear understanding of desired outcomes or results to meet an intent in presenting information to a senior military leader.

Apply Community Assets

Nearly all interviewees requested more information on what tools, models, simulations, processes, and best practices other organizations are using. There is a cross-community desire to share information, learn from others experience, and leverage existing Army tools. The outcome statement summarizes this need as the ability to collaborate, share, and apply the missions, functions, expertise, and available resources within each Army community for mutual advancement and advancement of the total Army mission. This need has increased with the reduction in conference attendance over the last several years and is not fully addressed by existing solutions. The AMSS continues to seek data on this topic and what solutions AM&S members would find most beneficial to their current and future mission.

Model Planning, Development, Application and Updating

The outcome statement for this need is defined as the ability to plan, develop, apply, and implement models and simulations from requirements; gather specifications of the models and simulations; and answer questions. This need was requested by every Army community. Many careerist with this need stated the desire for more educational opportunities to provide introductory and advanced modeling and simulation education with specific Army examples, terminology, and updates from Army communities.

Acquisition Community

The Acquisition Community was a focus community in 2017 and held its initial working group at Fort Belvoir, Virginia. The AMSS analysis team was able to interview a wide range of workforce members representing the Acquisition Community who interact with models, simulation, and conduct data analysis. Army Civilian and Military interviewees identified the need for greater education on how to manage a model or simulation program developed either internally by the Army or externally by a contracted or academic partner. While there are available classes that cover managing programs and other courses describing contract procedures, there are no current courses covering the nuances of contract and program management of an Army model program. The outcome statement for this need is the ability to apply program management techniques to oversee modeling and simulation personnel, systems, acquisition, and contracts. The AMSS will continue to gather additional data on this need and how to best address the education and training objectives.

Analysis Community

The Analysis Community was a focus community in 2017 and held its initial workshop at Fort Belvoir, Virginia, and a second workshop in 2019. The Analysis Community has the majority of educational needs in the Data Analysis category that was covered in Cross-Community Needs section and has been further identified as a need in the Data Science category. Two specific needs identified within the Analysis Community are:

Data Generation and Management

Many of the needs collected relate to the development of databases, management of data, and generation of data. Many interviewees indicated a desire to know the best practices of others in the Army when it came to data generation and management practices. The outcome statement for this need is the ability to perform data generation and management to answer pre-defined metrics and quick-reaction requests, recognize data trends, present findings, and answer questions. The AMSS has been able to identify some existing solutions that are captured in a spreadsheet of courses on the Army Modeling and Simulation Office website. This spreadsheet identifies courses offered by Army schools, industry, and academia that may address educational needs related to data generation and management. The

spreadsheet will be updated on a regular basis to ensure courses listed are still being offered and to add new courses identified.

Verification, Validation, and Accreditation (VV&A)

Multiple organizations requested the need for education regarding the ability to conduct verification, validation, and accreditation activities, especially from the Acquisition, Analysis, and Test and Evaluation Communities. The outcome statement for this need is the ability to conduct Verification, Validation, and Accreditation activities. Interviewees indicated that the current education and training does not sufficiently explain how to apply the Army regulations and guidance. Requests asked for practical examples of VV&A that could be applied to a model or simulation, best practices, and lessons learned. The AMSS organized a meeting of subject matter experts to discuss this educational need further, how to best present information, and the desired duration of a course. Additional efforts are being planned for this topic area to possibly support a new seminar offering in the future.

Cyber Community

The Cyber Community includes representatives from all other Army communities and was the focus for 2019. For several years, the interview team has been able to participate in the Cyber Electronic Warfare Modeling and Simulation Working Group, which holds regular teleconference and meets at the annual Army Modeling and Simulation Forum. The primary educational need for the Cyber Community was the request for education and training on Cyber Modeling. The outcome statement for this need is the ability to understand how cyber and electronic warfare are modeled, what are the capabilities and limitations of major models implementing those effects, and how can cyber or electronic warfare be implemented during a test, exercise, or training. Within the need for cyber modeling, interviewees requested education and training on how to model the impact or effect of a cyber action, not how to model the details of the cyber action. The difference is important because most modeling and simulation projects do not require an exact representation of the cyber action, only the correct modeling of how that action impacts elements and players. This is another key issue AMSS will be looking to obtain additional information on to better define the educational requirements.

Experimentation Community

The interview team focused on the Experimentation Community in 2018 with additional data collection in the former and later years using other working groups and forums. The education and training need category Integrate M&S and Live Systems was an educational request primarily from the Acquisition, Experimentation, and Training Communities. Many of these communities have experts within them but found the education and training is needed for new employees and for other organizations working with integrated M&S. The outcomes statement for this need is the ability to plan, resource, and integrate models and simulations with live systems in support of materiel development.

Intelligence Community

In 2018, the interview team focused on the Intelligence Community leveraging the Army Modeling and Simulation Forum and conducting follow-on interviews after the forum. This Community expressed some of the nuances of representing Army intelligence in M&S and were the main champions for a critical task within the scenario planning and development report for the education of political, military, economic, social, infrastructure, information, physical environment, and time factors in models and simulations. The outcome statement for the Scenario Planning and Development needs category is to identify the requirements of the scenario, development of scenario plan, develop the scenario, verify the scenario characteristics, execute the scenario, perform analysis of scenario output, and obtain scenario review and approval from leadership/approval authority. The AMSS gathered additional information from experts in the field on what areas need to be taught, how to convey concepts in a tool-agnostic method, and how to provide practical hands-on exercises to enable learning. In the fall of 2019, AMSS hosted a pilot course with a scenario planning module to obtain additional feedback from participants. Based on the feedback, the courseware module was updated to address the communities' needs.

Logistics Community

Data was collected from the Logistics Community in 2017, 2018, and 2020 through interviews to define educational requests further. One need requested by the community was education on how to apply doctrinal and operational knowledge. The outcome statement for the Apply Doctrinal/Operational Knowledge need is the ability to understand and model Army structures, systems/equipment, deployment of assets, tactics, techniques and procedures, mission planning, order of battle, and logistics using appropriate symbology and terminology correctly. Educational requests came from every community on this topic. The AMSS already has existing course lessons addressing doctrinal and operational knowledge in their current curriculum and this effort will continue collecting data on what aspects individuals would like greater knowledge. Figure 6 provides some examples of topic areas identified by interviewees.

Apply Doctrinal / Operational Knowledge

- How to correctly model:
 - Joint and/or Army Systems
 - Unit structures and equipment; Force Design
 - Tactics, Techniques, and Procedures
 - Military Operations
 - Mission Planning and order of battle
 - Route Planning
 - Decision Making in an international environment
 - Logistics and Resupply
- How to understand model and simulation symbology and terminology for Joint and/or Army Systems and actions.
- Understand how Joint and Army systems are deployed, used, and resupplied to enable correct data analysis.

Figure 6. Doctrinal/Operational Knowledge Education Defined

Medical Community

The Medical Community was a focus group in 2019 and the interview team was able to conduct interviews at Joint Base San Antonio - Fort Sam Houston, Texas. This community expressed their unique situation where their AM&S is frequently informed and influenced by the global medical community of doctors and hospitals. Many of their needs aligned with other Army communities enabled by M&S and they had several requests for more education and training on data science techniques, development, and tools. More interest has been shown for data science topics including data mining, big data analytics, machine learning, deep learning, artificial neural networks, and artificial intelligence. The outcome statement for the Data Science need is the ability to analyze big data, apply machine learning methodologies, and oversee the development of a deep learning/artificial intelligence solution that provides decision-making support. This is a new and emerging field where industry and academia are offering viable educational solutions for non-Army specific needs and AMSS is developing new Army course material.

Test and Evaluation Community

In 2017, several representatives of the Test and Evaluation Community participated in a workshop to discuss their community's AM&S educational needs. This workshop led to interviews at multiple test and evaluation locations and additional interviews and data were provided at forums such as the Army Modeling and Simulation Forum held annually. A need identified by the Test and Evaluation Community was education on requirements development. The outcome statement for the Requirements Development need is the ability to understand the intent of a requirement, develop measurable metrics to answer the requirement and allow flexibility, decompose the requirement to data elements, and capture information to answer the original requirement. Almost every community expressed that modeling and simulation requirements were often unique in their need for flexible requirements that can adjust to the changes with information technology and supporting programs. Currently there are Army- and industry-provided courses that offer techniques on developing clear and measurable requirements. Those courses are being identified and posted in AMSS's online spreadsheet of available courses. Additional data will continue to be gathered to determine if there are additional aspects of this need that require new course development.

Training Community

The Training Community was a focus group for 2018 and the interview team was able to leverage the Mission Training Complex Users' Workshop. Additional data was also collected in 2019 from the Medical Mission Training Center.

The Training Community had several requests for the education of Federating Modeling and Simulation Tools. This topic has resident experts requesting education and training for individuals who do not conduct federation functions on a regular basis. The outcome statement for this need is the ability to establish a model federation based on a requirement or objective. Examples of educational topics for this need are shown in Figure 7. Many of these topics are already addressed by AMSS's Simulations Operations Course. The AMSS is continually evaluating and updating courseware to ensure its curriculum remains current.

Federating Modeling and Simulation Tools educational topics:

- Establish a Model Federation
- Understanding Network Topology
- Develop the Architecture for a Simulated Supported Training Event
- Provide Recommendation for Individual and Collective Training Exercises Involving Army Mission Command Information Systems, Models, Simulations, and Live-Virtual-Constructive Environments
- Conduct Risk Management
- Cloud Computing

PATH FORWARD

New Course Design, Development, and Implementation

In response to the needs expressed by various organizations, AMSS is developing pilot lessons/courses/seminars including:

- **Analysis, Modeling, and Simulation Topics Course:** Data Generation and Scenario Development (1 week), modeling and simulation use in each Army community, Scenario Development, Database Management, Database Design, and Programming to Manipulate a Database.
- **Business of Data Science Course (3 days)**
- **Wargaming**
- **Verification, Validation and Accreditation**

Education and Training Database

The AMSS provides updates to an existing database of known education and training courses identified by academia, industry, and on military installations. These courses are identified as potential solutions to needs expressed by interviewees. This database helps to consolidate education and training opportunities related to AM&S needs, tasks, and functions.

Call for Additional Data

The AMSS analysis team has collected information from 370 individuals; however, it is likely that there are AM&S education and training needs that have not been captured. This effort is an ongoing process to ensure modeling and simulation practitioners have the training and/or education to complete their mission.

Analysis, Modeling, and Simulation Community Communications

The analysis team is working to develop a newsletter to provide periodic updates on what various communities are doing with models and simulation, best practices, new analytic methodologies, and available tools and data.

Modeling and Simulation Needs across the Department of Defense

The primary focus of the effort thus far has been Army-centric. However, the application of lessons learned from this effort could assist other services throughout the Department of Defense to apply to their education and training needs. Collaboration and sharing of information on education and training needs across the Joint environment would prove to be valuable to Military members and Department of Defense Civilians from each branch of service collectively (i.e., the Army could provide needed no tuition training to Navy/Air Force/Marines/Coast Guard, and likewise, other services could provide no tuition training to Military personnel and Civilians from each service branch).

Figure 7. Federating Modeling and Simulation Tool Educational Topics

COVID 19 Adaptability

As a result of COVID 19, AMSS initiated the use of the Blackboard Collaborate web conferencing application, which enables virtual collaboration courses including presentations, video, and audio. Within Blackboard Collaborate, there is a “raise hand” function to discourage people from speaking over each other. Going forward in the post COVID 19 environment, AMSS will be able to use Blackboard Collaborate to conduct distributed interviews.

ACKNOWLEDGEMENTS

Execution of the Army AM&S Education, Training, and Development Effort occurred with the help of many participants from each of the Army communities, Headquarters Staff, Joint and Industry partners. Interview, workshops, and forums had support from a broad spectrum of experts, stakeholders, and leadership. This effort was only successful because of the Army AM&S community providing their time, knowledge, and support.

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