Certified Modeling and Simulation Professional 3.0 - Reinvention!

Ivar Oswalt, PhD, CMSP
The MIL Corporation
Lexington Park, MD
ioswalt@milcorp.com

Linda Brent, EdD, CMSP
The ASTA Group LLC
Pensacola, FL
linda.brent@theastagroup.com

Neal Finkelstein, PhD
National Center for Simulation
Orlando, FL
drnealfink@simulationinformation.com

Steve Gordon, PhD
Georgia Tech Research Institute
Atlanta, GA
steve.gordon@gtri.gatech.edu

Alan Lynch
Orange Technical College
Orlando, FL
alan.lynch@ocps.net

Sean Osmond, CMSP
The Contec Group
Orlando, FL
sean.osmond@us.contec.com

Mikel D. Petty, PhD
University of Alabama in Huntsville
Huntsville, AL
pettym@uah.edu

Gregory Reed, PhD, CMSP
Northrop Grumman Corporation
Huntsville, AL
greg@gsreed.com

George Stone, PhD
QinetiQ Inc.
Lorton, VA
george.stone@us.qinetiq.com

David 'Fuzzy' Wells, PhD, CSMP
UCF Institute for Simulation & Training
Orlando, FL
fuzzywells@ist.ucf.edu

Eric Weisel, PhD
Old Dominion University
Norfolk, VA
eweisel@odu.edu

ABSTRACT

Career certification plays a key role in establishing the legitimacy of any occupational field. For modeling and simulation (M&S), this recognition is earned primarily through becoming a Certified Modeling and Simulation Professional (CMSP). Achieving this recognition means that an individual has the education, experience, professional standing, ethics, and knowledge required of a true M&S professional. Yet, like in many technology-oriented certification programs, the certification processes and criteria need to evolve with the times. New M&S techniques are emerging: artificial intelligence and machine learning; additional applications are being envisioned: space warfare; a new breed of inductees is joining the ranks: tech-savvy and process weary; and there is always a constant need to educate, inform, and conduct outreach for any certification. This article will summarize key initiatives and ongoing activities to increase the demand signal, improve awareness, restructure the certification process, coexist with other M&S and related certificates, increase certificate holder engagement, consider new certifications and sub-certifications, revised and update the exam, and develop and implement a marketing plan. Being a CMSP demonstrates knowledge and currency in a constantly changing career field that is unmatched by academic degrees, experience, or government or corporate affiliation. Yet, it needs to be renewed and reborn to remain relevant. This article describes this process; where it stands today, and what it will become tomorrow.

ABOUT THE AUTHORS

Dr. Ivar Oswalt, Senior M&S Associate for The MIL Corporation, conducts M&S and LVC simulation planning and analyses; requirements characterization; metrics definition and assessment; as well as policy and standards development. He is currently co-authoring LVC Federation Cybersecurity Implementation Guidelines, an M&S Contracting Reference Guide, and an LVC Data Policy Guidebook for the Department of Navy. For the Navy's M&S Office (NMSO) he leads plans, policy, standards, and outreach and for the Naval Research Laboratory (NRL) Dr. Oswalt provides VV&A support. With significant experience in multi-attribute utility theory, he has developed M&S metrics and measurement approaches for the Office of Naval Research, Operations Analysis Program and has formulated composability requirements and Enterprise metrics for the Department of Defense M&S Office (DMSCO). Dr. Oswalt has developed and taught courses on CMSP, LVC, and System Design and Analysis and he received his PhD from The Claremont Graduate University.

Dr. Linda Brent, CEO for The ASTA Group, LLC, has developed and operated government-oriented businesses for the past 25 years. Dr. Brent brings experience in both the defense industry and other government agencies, has made numerous presentations at state, national and international conferences, and has conducted research and published in the areas of human performance, simulation technologies, business capture, and psychology. She has held faculty and research positions at several leading universities and colleges and earned a B.A. and M.S. degree in Education/Psychology from Wittenberg University and Nazareth College of Rochester, respectively, and her Ed.D. from the University of Rochester.

Dr. Neal Finkelstein serves as the COO for the National Center for Simulation (NCS), and as a principle senior advisor on promoting, protecting, and growing the modeling, simulation, and training community. Dr. Finkelstein served in DoD for 31 years. He is a graduate of FAU with a degree in Electrical Engineering. Dr. Finkelstein holds a Master's in Industrial Engineering from Texas A&M and a Doctorate in Industrial Engineering from UCF. He has worked in various capacities of increased responsibility specializing in human-in-the-loop immersive training and simulation effectiveness, human/system integration, human sciences, human/unmanned research, mobile application development, mixed reality, and served on billions of dollars in projects that cut across the military, DHS, and VA to name a few. Dr. Finkelstein also served at the Pentagon while supporting the establishment of the Army Modeling and Simulation Office in Alexandria, Virginia.

Dr. Steve Gordon is the Orlando Field Office Manager and a Principal Research Engineer for Georgia Tech Research Institute. He served 26 years in the United States Air Force with tours as an F-111 Weapons Systems Officer, Instructor, and Wing Electronic Warfare Officer; Air Staff Division Chief; 13th Air Force Director of Operations and Air Operations Center Director; and Air Force Academy Department of Mathematics Professor and Head. He also served as the first Technical Director for the Air Force Agency for Modeling and Simulation. Dr. Gordon has a bachelor's degree in Mathematics (Marymount); Master's Degrees in Education (Peabody/Vanderbilt), Industrial Engineering/Operations Research (Purdue), and in Business (Florida); and a PhD in Aero and Astro Engineering (Purdue). His research interests include return on investment for simulation-based training, trade space tools for training systems, statistical techniques for test and evaluation, and decision support tools for military operations.

Alan Lynch, Professor at Orange Technical College, responsible for the development and support of four simulation and animation training programs called Launch Site. Working with simulation organizations and industry partners, Alan designed and built motion capture and likeness capture facilities, a 3D scanning studio, a 3D printing lab, video/audio production studios, HP render farm, and simulator lab. The course was designed to teach students either visual asset creation or programming using game engines and programming languages such as C++ and C#. Students work with industry professionals to design and build augmented and virtual reality products for K12 classrooms. Professor Lynch also developed curriculum frameworks for State of Florida Department of Education**.**

Sean Osmond is the Simulation and Defense Account Executive for Contec Americas. A Certified Modeling and Simulation Professional with over 20 years of military experience, he brings subject matter expertise to the high technology manufacturing industry. Mr. Osmond is also a Master Sergeant in the Marine Corps Reserve, and currently serves as the Detachment Staff NCO. MSgt Osmond has served in many commands including 4th AAV BN, PMTRASYS, and MASS-6. He is a strong advocate for community involvement and volunteerism and has leading roles for the central Florida chapters of NDIA, AAAA, Orange Technical College Workforce Advisory Committee,

and National Eagle Scout Association. Mr. Osmond earned a bachelor's degree in Marketing, a master's degree in Modeling and Simulation, and two graduate certificates from the University of Central Florida.

Dr Mikel D. Petty is Senior Scientist for Modeling and Simulation at the University of Alabama in Huntsville's Information Technology and Systems Center, and an Associate Professor of Computer Science. He was Director of UAH's Center for Modeling, Simulation, and Analysis for ten years. Prior to joining UAH, he was Chief Scientist at Old Dominion University's Virginia Modeling, Analysis, and Simulation Center and Assistant Director at the University of Central Florida's Institute for Simulation and Training. He received a Ph.D. in Computer Science from the University of Central Florida in 1997. Dr. Petty has worked in M&S since 1990 in areas that include verification and validation methods, simulation interoperability and composability, human behavior modeling, multi-resolution simulation, and simulation software frameworks. He has published over 235 research articles, chapters, and papers and has been awarded over $17 million in research funding. He served on National Research Council and National Science Foundation committees on modeling and simulation and is Editor-in-Chief of the journal *SIMULATION: Transactions of the Society for Modeling and Simulation International*. He has served as dissertation advisor to twelve graduated Ph.D. students in four different academic disciplines: Modeling and Simulation, Computer Science, Industrial and Systems Engineering, and Computer Engineering.

Dr. Gregory S. Reed is a Senior Principal Systems Engineer at Northrop Grumman Corporation. Throughout his career, his primary research areas have included modeling and simulation (M&S) and applications toward training and education, human behavior and decision modeling, and systems engineering. Many of his projects have involved modeling decision processes, synthesizing and analyzing data, developing decision support tools and user interfaces, and designing and executing trade studies. In 2013, he became the first student to receive a Ph.D. in the Modeling and Simulation degree program at University of Alabama in Huntsville (UAH), where his dissertation research involved the design and development of a machine ethics model in support of U.S. military Course of Action (CoA) analysis. After a ten-year employment as a full-time researcher at UAH, he has continued to stay active in education, STEM outreach, and professional service. Among other efforts, he conducts a graduate-level M&S course, serves as committee member for graduate students, serves as an Associate Editor for the journal SIMULATION, and actively coordinates with the National Training and Simulation Association (NTSA) on the maintenance, operations, and design of the Certified Modeling and Simulation Professional examination.

Dr. George Stone has over 40 years of US DoD and Army experience in modeling, simulation and analysis. Within the US Army and DoD, he held positions such as director, assistant professor, program manager, technical director and software team lead for major military acquisition simulations programs valued from $350M to $1B that contribute to our nation's readiness for operations. Dr. Stone has extensive experience with strategy, mission command and simulations for all domains in analysis, training, experimentation, testing, evaluation and planning.

Dr. David 'Fuzzy' Wells, CSMP, is the Deputy Director of the University of Central Florida's School of Modeling, Simulation, and Training responsible for overseeing the operations of the Institute for Simulation & Training. Previously, Dr. Wells was the Director of U.S. Indo-Pacific Command's Cyber War Innovation Center. He is a retired Air Force officer whose last assignment was as Chief Scientist for Research at the Joint Warfare Analysis Center. He was the first Air Force officer to obtain a Ph.D. in Modeling, Virtual Environments, and Simulation from the Naval Postgraduate School. He also earned the first M.S. in Modeling & Simulation from the Air Force Institute of Technology. He is a Certified Modeling & Simulation Professional Charter Member.

Dr. Eric Weisel is Associate Vice President for Applied Research at Old Dominion University and Executive Director at ODU's Virginia Modeling, Analysis, and Simulation Center, an applied research center focusing on innovation, workforce development, and industry engagement programs leading to digital transformation. He serves on the Boards of Directors for the Society for Modeling and Simulation International and the Commonwealth Center for Advanced Manufacturing and teaches courses at ODU in Engineering Management and Computational Modeling and Simulation Engineering.

Certified Modeling and Simulation Professional 3.0 - Reinvention!

Ivar Oswalt, PhD, CMSP
The MIL Corporation
Stafford, VA
ioswalt@milcorp.com

Linda Brent, EdD, CMSP
The ASTA Group LLC
Pensacola, FL
linda.brent@theastagroup.com

Neal Finkelstein, PhD
National Center for Simulation
Orlando, FL
drnealfink@simulationinformation.com

Steve Gordon, PhD
Georgia Tech Research Institute
Atlanta, GA
steve.gordon@gtri.gatech.edu

Alan Lynch
Orange Technical College
Orlando, FL
alan.lynch@ocps.net

Sean Osmond, CMSP
The Contec Group
Orlando, FL
sean.osmond@us.contec.com

Mikel D. Petty, PhD
University of Alabama in Huntsville
Huntsville, AL
pettym@uah.edu

Gregory Reed, PhD, CMSP
Northrop Grumman Corporation
Huntsville, AL
greg@gsreed.com

George Stone, PhD
QinetiQ Inc.
Lorton, VA
george.stone@us.qinetiq.com

David 'Fuzzy' Wells, PhD, CSMP
UCF Institute for Simulation & Training
Orlando, FL
fuzzywells@ist.ucf.edu

Eric Weisel, PhD
Old Dominion University
Norfolk, VA
eweisel@odu.edu

INTRODUCTION

Credentialing is a key element of turning any job into a professional occupation. For modeling and simulation (M&S), despite it being recognized as a National Critical Technology [Forbes, 2007], formalizing it into a discipline continues to be a challenge. It has been well established that the wide range of application domains, uses, and specialized expertise makes it difficult to describe the education, training, and career of an M&S professional [Bair, 2013]. In response, the National Training and Simulation Association (NTSA), in conjunction with the Simulation Interoperability Standards Organization (SISO) and the Society for Modeling and Simulation International (SCS) established the M&S Professional Certification Commission in 2001 to implement and operate the Certified Modeling and Simulation Professional (CMSP) program. It was created to engender industry confidence in the quality and level of education among M&S professionals ([Bair, 2015], [Lewis, 2010], [Lord, 2019], [Petty, 2017]).

These professionals include a wide range of personnel who design, develop, and apply M&S including systems and software engineers, analysts and operations researchers, forecasters of many types, and managers at many levels and within a wide variety of organizations – all of whom are simulationists. Current certificate holders achieved this certification for a variety of timeless reasons from how it helps to qualify for a job, to wanting to support M&S as a profession. A summary is provided in Figure 1. To address these needs within an ever-growing group and to keep pace with the advancement in M&S methodologies, techniques, and technology, this program and the criteria for

achieving the certification have evolved over the years. Yet M&S, itself and in concert with Digital Engineering (DE), Model Based Systems Engineering (MBSE), and Live, Virtual, and Constructive (LVC) Federations, is experiencing unprecedented growth, and so it is time to jump-start this evolution and re-invent this important certification.

CMSP reinvention – coined CMSP 3.0 – began in 2019 with a focus on providing recommendations within seven initiative areas:

1. Improve awareness and demand within academia, industry, government, and professional societies
2. Restructure the certification process
3. Engage with other certifications
4. Increase certificate holder engagement
5. Consider new certifications and sub-certifications
6. Revise and update the certification exam
7. Improve outreach

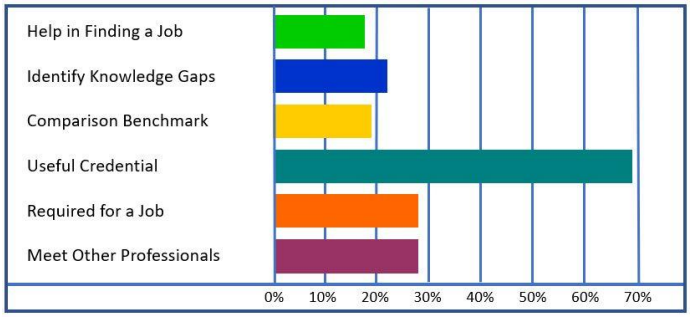

Figure 1. Certificate Achievement Rationale

These initiative areas would be relevant to keeping any professional certification current; in this case however, the focus is on M&S. Each of these areas was championed by a senior M&S professional who defined the area, researched key aspects, examined parallel and associated activities, socialized their findings, and presented the results. The analytic approach employed combined traditional subject matter expert-based investigation with two distributions of a specifically designed questionnaire sent to current and past certification recipients. This survey was sent to 220 and generated 65 inputs (30%). It sought data relevant to the seven initiative areas, included answers that used Likert scales options and fill in the blank, and concluded with the ubiquitous "what did we forget to ask" question.

This article provides a summary of the results of the first step in re-inventing this certification: that is, the recommended initiatives needed to make significant progress within each of the seven areas. Subsequently, for those deemed to be critical, an implementation plan will be developed and executed. There is no single recommendation that alone can reinvent a credential. The best exam ever conceived of could be written, the most alluring website established, a DoD-wide policy requiring this certification for all key M&S personnel promulgated, etc., yet CMSP 3.0 would still not meet its full potential. Instead the goal is to define and then implement a balanced approach across at least the minimum set of essential recommendations.

INDIVIDUAL INITIATIVES

After conducting the analysis and incorporating the results of the survey data, a series of recommendations have been developed within each of the seven initiative areas. The intention is to implement a set of these recommendations to re-invigorate CMSP and significantly increase its contribution to establishing M&S as a profession. Each of the initiatives is characterized, its importance and what needs to be improved described, and then recommendations are made.

Improve Awareness and Demand within Academia, Industry, Government, and Professional Societies

It is critical to increase the recognition of this certification, and to stimulate an associated demand, for it to grow and prosper. For the purpose of this discussion, academia includes K-12, two- and four-year colleges and universities, online universities, military colleges, and other degree- and certification-granting organizations; industry and government organizations include government units, and industry-oriented, trade, and government-oriented associations; professional societies include organizations existing primarily to promote the advancement of specific disciplines. Awareness is important within academia and academic societies since these organizations begin the pipeline for candidates, establish awareness of this certification early in academic programs, and design the curricula and contribute to the research agenda to supporting M&S knowledge, skills, and abilities. Awareness that leads to a codified and long-term demand is especially important within industry and government organizations because these organizations establish the need for it through hiring actions, labor category and job skill conditions, and acquisition requirements.

Prioritized recommendations are as follows:

1. Identify an NTSA-affiliated group or establish a committee to serve as the owner that will maintain, update, and execute the action plan and outreach effort. Select a Chair and Co-Chair, establish a task schedule and working agenda, and prioritize actions and groups for outreach. Create marketing materials that include a general value proposition that can be easily tailored.
2. Develop and execute a recurring action plan. On a recurring bases, select a set of new target groups for outreach. Schedule engagements beginning with initial contact and then advancing to conference attendance and dedicated meetings by designated individuals or delegations. Formalize the relationship through reciprocal sponsorships, Memoranda of Understanding, or similar.
3. Partner with universities and colleges to offer a suggested course / certification within masters or doctorate level programs. This would increase the candidate pool and enhance visibility.
4. Coordinate with academia, industry, government, and professional societies to promote certified professional standards for hiring and contractual practices.
5. Review how the certificate is seen by industry and government employers and ensure that they understand the qualifications it represents.

Restructure the CMSP Certification Process

Restructuring and streamlining the certification process in order to increase the number of individuals seeking and attaining certification is vital. The process needs to clear, easily accessible, and well defined. In addition, well-defined rubrics needs to be established for all certification types. Certification is important to the industry, but accessibility, consistency, and opportunity are important to the achievement of this initiatives.

Prioritized recommendations are as follows:

1. Adopt a largely on-line approach to registration, completion of requirements, and testing for certification. While most is currently online, the total system lacks “flow” across the process and ease of follow through. For example, the preparation support process can be further refined and most accessible online with current resources, mentors, class availability, etc.
2. Develop a list of on-line and other resources that can be used by a person preparing for certification that provides current, relevant, and consistent information. While there is currently a list of references and preparation course slides that are available, there is no distilled data nor are there items like points of contact, possible mentors, etc.
3. Establish a course that can be taught on-line or in person to prepare an individual for certification. While there is currently a course provided at I/ITSEC, it has lost some of its currency.
4. Make it easy to renew, so that this certification is better able to compete with other certifications that make it difficult to keep their credentials current.
5. Create a Renewal Support System, perhaps follow the approach taken by the International Association for the Engineering Modelling, Analysis and Simulation Community that includes a Competency Framework for Simulation Engineers, an Educational Resource Guide, and an Online Competency Management and Tracking System.

Engage with Other Certifications

Collaboration, cooperation, and establishing a competitive advantage relative to other M&S certifications available to M&S professionals through industry organizations, colleges, and universities is also key. Collaborating in areas that promote recognition and expansion of industry certification for simulation and related fields would elevate the notoriety and increase adoption. Working together, credentialing organizations could increase advocation effectiveness by sharing the burdens associated with such efforts while supporting each in greater numbers. Together, with broad support from each organization, efforts to increase the number and quality of certifications including M&S offerings would be easier to manage. Cooperation with other certifications includes clearly defining lanes of operation between organizations to avoid competition in similar areas and allows organizations to specialize in areas of expertise or industry concern. Competition with related certifications is unavoidable in some circumstances, however CMSP is positioned to complement professional certifications that focus on tools and specializations. Several of the initiatives focus on the competitive aspects that need to be addressed moving forward including improving awareness, demand, accessibility, and marketing.

Prioritized recommendations are as follows:

1. Meet with influential certifying groups face to face to build momentum in key states (California, Texas, Virginia, Maryland, Florida).
2. Increase conference exposure and especially target conferences that NTSA executes and other conferences to promote this certification. Many of the complementary organizations are represented at these conferences.
3. Identify governmental efforts at local and state levels that members can be selected to work as an ambassador to other organizations. Participate on government advisory boards that set standards for government contracts to have this certification included as recognized standard.
4. Promote select members as mentors or ambassadors that can help individuals who already meet certification criteria complete the process. Also employ ambassadors to represent the effort at events that allow speakers or presentation.
5. Identify University and other educational programs partners. Encourage other certification organizations to participate in education events/efforts.

Increase Certificate Holder Engagement

Current, past, and retired certificate holders are uniquely qualified to help reinventing it. Increasing their active support will improve the overall experience and increase the number of qualified personnel. Engagement is intended to cover both active and passive activities. Active engagement includes reaching out to contact certificate holders via email and within group activities and conferences (e.g., scheduled meetings). It also includes contacting and communicating with companies, government, and academic institutions within which certified personnel reside. Passive engagement includes general outreach (e.g., advertisements in I/ITSEC's Show Daily or billboards placed within the convention halls), having a strong web presence, having LinkedIn pages, and similar. It is important to note that a critical part of active and passive engagement is enticement; or providing incentives to non-accredited personnel to become certified and to certified personnel to maintain their certification.

The goals of increasing certificate holder engagement are to:

1. Motivate qualified personnel to renew or reapply.
2. Encourage qualified personnel to spread the word regarding the advantages of becoming certified.
3. Grow the number of newly qualified certificate holders (a goal shared with many of the other 3.0 initiatives).

There is a recognized need of both the value and yet also the lack of significant certificate holder engagement. This was expressed by several respondents, individually and within groups. The current status quo needs to change for this certification to remain viable and to grow.

One of the most striking findings, from the survey, was the degree to which current certificate holders are willing to get involved and support its re-invention. The results, presented in Figure 2, show the responses of 49 individuals surveyed and indicates their willingness to actively support the effort. Especially of note: 29 of the respondents are willing to be a mentor; a significant investment of time and effort.

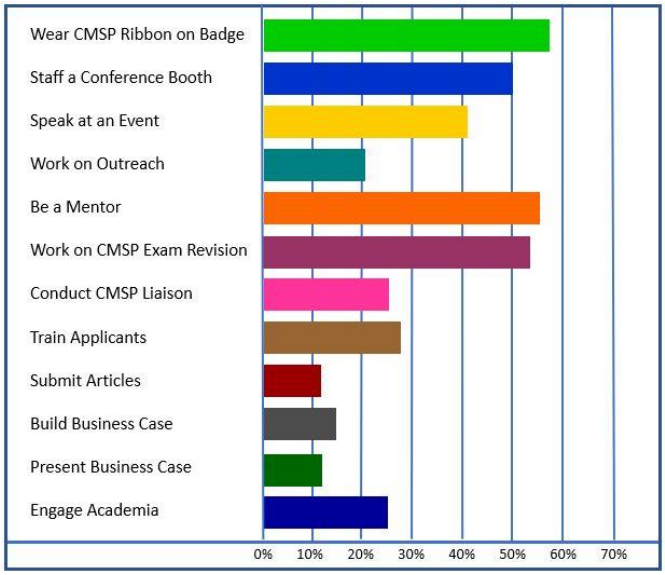

Figure 2. Willingness of Current Certificate Holders to Engage

Prioritized recommendations are as follows:

1. Contact certificate holders via email regularly to start to create a community. Information shared would both motivate and encourage. A simple newsletter covering M&S and Certificate developments, upcoming events, and a paragraph describing something particularly relevant.
2. Create a Member Children Scholarship Program as a tangible benefit to certificate holders and those considering becoming certified with university bound children pursuing STEM undergraduate or graduate

degrees. The benefits to their children include being recognized in this manner, as well as the financial support provided.

3. Host a "Jeopardy Night" at I/ITSEC to have some fun and build esprit de corps. Create a few rounds, include the questions from the exam, hold it mid-week, award the overall winner with a plaque that recognizes their accomplishment.
4. Recognize Personnel and Companies with certified employees at Conferences and Workshops. Individuals with a ribbon, companies with employees with a badge.
5. Provide Financial Incentives to become certified and renew. This recommendation is to provide discounts on conference registration fees to M&S oriented events (I/ITSEC, MODSIM, NMSC, SISO, etc.) to current certificate holders.
6. Schedule regular focused meetings like the "Certified M&S Professional State of the Nation" Discussion held at I/ITSEC in 2019.
7. Establish an Association, membership to which is only available to certificate holders in good standing. Hold meetings, mini tutorials on topics of interest, and special events. Include Specific Awards. This association would provide a venue to support certificate marketing, business case development, and other important activities, which could be reported in the newsletter (#1 above).
8. Initiate a Technical Fellows program to recognize outstanding contributions made by retired certificate holders who have been active in advancing M&S's concepts, constructs, and initiatives and have made a significant contribution to this community.
9. Start a Mentorship Program. This recommendation would require the most commitment by current certificate holders, but it could hold significant promise to increase the number of certificate holders and the professionalism of M&S.
10. Actively Engage Retired certificate holders by reaching out to involve them in mentoring, manning conference booths, providing tutorials, leading tours of simulation facilities and exhibits, etc. to remain engaged in M&S while also supporting this certification.

Consider New Certifications and Sub-Certifications

The current Certified M&S Professional program allows certifications for generalized professionals in M&S. For this analysis, several possible new certifications and sub-certifications were explored. For example, Model-Based Systems Engineering (MBSE), Digital Engineering (DE), Medical M&S, Verification and Validation, and LVC development were evaluated as new certifications. In some cases, these certifications are already established, have current certification sources, or are a clear subset of the current M&S certification.

The survey conducted in support of this effort indicated support for potential new certifications in Model-Based Systems Engineering (MBSE) with 60% support; Digital Engineering (DE) with 40% support; Modeling, Simulation, and Analysis (MS&A) with 78% support; and Modeling, Simulation, and Training (MS&T) with 80% support. Given the popularity of digital engineering, it would be possible to envision a Digital Simulation Professional (DSP). This certification could cover topics such as developing digital twins and digital threads; the harnessing of data; verification, validation, and accreditation of digital M&S, and visualization as the source of digital change. The use of DSP would require an understanding of M&S with the additional focus on distributed digital data-based decision making based on and within multiple types of simulation environments.

Table 1. Interest in Sub-Certifications

	STRONGLY SUPPORT
AI Modeler	29.63%
AR/VR Developer	24.07%
Certified Distributed Simulation Engineer	37.50%
Certified V&V Agent	44.64%
Cyber Modeler	38.18%
Logistics Modeler	16.36%
Physics-based Modeler	35.55%
Stochastic Modeler	29.09%

The survey also provided important insights on the popularity of sub-certifications. The survey found, for instance, that 44.64% of the respondents strongly supported a Verification and Validation (V&V) sub-certification and that 38.18 strongly supported a sub-certification in cyber modeling. Additional findings are presented in Table 1.

Prioritized recommendations are as follows:

1. Define the relationship between CMSP and other possible companion certifications like MS&A, MS&T and DSP. Perhaps these could be the graduate-level certification of M&S professional certifications. Also assess the appetite within the M&S community for sub-certifications.
2. Develop a plan on how NTSA could build on this healthy and popular M&S certification by offering a follow-on DSP Certification and desired sub-certifications.
3. Create a DSP and sub-certification course of study, sources of evaluation questions, etc.

Revise and Update the Certification Exam

To achieve this certification a candidate must, among other requirements, demonstrate substantial expertise in M&S by passing a comprehensive certification examination (for more detail, see [Petty, 2017]). The current examination is based on a consensus-based topic index adapted and extended from the SimSummit M&S Body of Knowledge Index [Waite, 2010]. Basing the examination on a community body of knowledge index enhanced the reliability and credibility of the examination and it helped to ensure that successful candidates have a representative understanding of the full spectrum of M&S. The breadth of knowledge required to pass the exam is not likely to be acquired via brief intense study of a small number of sources.

However, the examination is take-home, and it is expected that candidates will search for and use sources to complete the exam and the process of completing the exam will be an educational experience for the candidate. In the CMSP 3.0 initiative, the structure and content of the examination was reviewed and, as expected, it was found the current set of questions used for the certification examination should be significantly expanded and updated. The number of questions per subtopic in the current question bank varies widely and should be normalized. Moreover, some questions have been rendered obsolete by the passage of time; they refer to organizations that no longer exist or technologies that have changed. Those questions should be deleted or replaced. Finally, subtopics and questions covering new technologies (e.g., machine learning) and new related disciplines (e.g., data analytics) that have emerged to influence the practice of M&S should be added.

Table 2. Survey Question on Exam Structure

ANSWER CHOICES	RESPONSES
I favor the current "learning experience" structure	46.03%
I favor transition to single test of knowledge & skills	15.87%
I favor transition to a three tiered test of knowledge & skills	28.57%

Prioritized recommendations are as follows:

1. Update the examination's topic index. Starting from the topic index used for the 2009 CMSP 2.0 examination, the panel adds, removes, merges, or splits topics and subtopics to reflect a consensus understanding of the current "body of knowledge" in M&S.
2. Consider alternative exam structures. At least four alternative structures have been proposed: (1) A two part exam, consisting of a basic knowledge proficiency test, given as a closed-book proctored exam at major M&S conferences, e.g., I/ITSEC, SummerSim, and/or WSC, and an advanced knowledge test, given like the current exam; (2) A customizable exam, with a core basic knowledge proficiency exam required of all candidates and a set of candidate-selectable specialty modules; (3) a structure modeled on current well-respected certification exams, such as the PMP exam; and (4) a three tiered test (beginner, advanced, and expert) (see Table 2).
3. Identify additional sources for questions. Starting from the updated topic index produced in step 1 and the structure selected in step 2, the panel of experts develops a list of suitable sources (published, peer reviewed, publicly available) for additional questions in any subtopics that need questions.
4. Identify problematic existing questions. The maintainer of the examination software uses statistics kept by the examination software to track the frequency of incorrect responses to questions to identify problematic current questions.
5. Write new and revise existing questions. New questions needed to cover the topic index as updated in step 1 and the structure selected in step 2 using the sources identified in step 3 should be written. Existing questions

identified as problematic instep 4 should be revised or removed. The questions should be written in a format consistent with the current questions to facilitate reuse of the current examination infrastructure software. This includes both the format of the questions themselves and the metadata associated with each question, as described earlier.

6. Conduct an independent review of the new questions. A group of M&S experts, whose membership does not include any of the question authors, should review the questions for correctness, clarity, and relevance. Feedback from the reviewers should be used by the question authors to revise the questions.
7. Modify the examination software as needed. Currently the certification examination allows candidates taking the exam to exclude a portion of the subtopics from his/her exam. If new subtopics are added in step 1 or a new structure introduced in step 2, the software may need to be revised to accommodate them. The software could additionally be enhanced to include features to extract information in support of phases 3 and 4.
8. Add the new and revised questions to examination. The maintainer of the examination software should upload the new and revised questions to the examination software.
9. Add the new sources to the sources list. A list of the sources used for the previous examination's questions was prepared by the question authors and circulated by NTSA. Update that list to include the new sources identified in step 3 and used in step 5.

Improve Outreach

This certification has the potential to be the benchmark for an industry standard of excellence in simulation. The challenge is to ensure it is recognized across the international industry, and beyond the confines of one market vertical, as can be seen with other staples of professional excellence like PMP or Six Sigma Certification. To this end, ensuring its public outreach and branding is critical to providing a value to those seeking to earn the certification as well as to those industry members seeking to employ those holding the title. To assess what path forward should be charted, several other well know professional certifications were reviewed in terms of their web presence and branding (Project Management Professional, Six Sigma, and the Society for Simulation in Healthcare). This included reviewing Google results, social media profiles, and end user utilization as it relates to professional presentation. Marketing this certification will be a critical to ensuring the professional community, and larger simulation industry, receives the benefit certified members can offer.

Prioritized recommendations are as follows:

1. Activate a social media campaign (today's target audience is not on the golf course) and leverage associated organizations that publish regular social media posts relevant to this certification.
2. Create a separate and unique NTSA marketing presence on social media (separate from NDIA) and showcase the Certified M&S Professional program. Currently, on the NTSA webpage, all social media links go to I/ITSEC pages. In addition, it is important to create or expand LinkedIn showcase pages, Facebook, Twitter, and Instagram accounts. In addition, Google analytics should be used regularly to monitor search results.
3. Improve web page design and navigation to minimize the number of clicks it takes to get to the CMSP home page. Place a tab on the front page of the NTSA web page for relevant resources and add an Alumni page or certified members list (opt in of course). Invest in search engine optimization to improve search results and identify common tools, testing platforms, website standards that can be implemented across organizations to make it easier to manage and easier for professionals to access.
4. Partner with a group like LinkedIn Learning and do master classes to expand the certificate's outreach and allow current certificate holders to present as experts.
5. Need to break this certification out as a unique product. Include having a booth at targeted shows, including those of groups like International Meeting on Simulation in Healthcare (IMSH), National Modeling and Simulation Coalition (NMSC) National Meeting, Defense Acquisition University meetings, and similar. Engage LinkedIn to have CMSP listed as a known certificate/title and establish a Showcase page.

CROSS-CUTTING IMPLEMENTATION AREAS

When examining these recommendations, while they are made within each of the seven individual initiative areas, many of them can be grouped into four basic categories: advocate, create or increase the demand for this certification, improve the certifications administrative infrastructure, and continue to mature and improve CMSP after 3.0 is

launched. It is useful to quickly examine the reinvention of this certification through this orthogonal viewpoint, since it provides insights regarding sequencing initiative recommendations to achieve important synergy.

Advocacy includes recommendations such as developing and executing an outreach plan, launching a social media campaign, and energizing current certificate holders. These entail the proactively contacting and engaging personnel, organizations, and institutions one on one, via meetings and working groups, and through scheduling and conducting presentations and briefings. The goal in this case is to increase the general awareness while also building needed momentum. Increasing the demand for this certification is similarly a preemptive endeavor, but in this case, it is focused on the one hand on establishing specific requirements language in procurement documents, contracting guidance, and job requisitions. On the other hand, it also concentrates on developing and providing a tangible set of benefits to certificate holders themselves so that M&S professionals will more actively seek to become certified.

Certification is the result of a candidate meeting a set of selection criteria, successfully passing an examination, signing an ethics statement, and paying a small fee. Each has an associated series of steps in a process, and the easier it is for the applicant to understand and make their way through that process the better. In addition, this implementation area covers the revision and updating of the examination, a critical process unto itself. Yet, both need to be efficient and to effectively deliver important capabilities for CMSP 3.0 to be successful. Finally, while the need for continual improvement may be obvious, the institutionalization of an organizational structure and implementing process to achieve it are often difficult to sustain, even if well described and intended initially. The long-term evolution of this certification is another element that is critical for it to prevail.

In terms of sequencing these activities, there are several approaches that could be employed. Some would conduct outreach and build the demand first, and then back-fill with the needed infrastructure; which could grow along with its increased use. Others, using a perhaps more conservative approach, would advance all implementation areas simultaneously, and thus be less likely to disappoint potential applicants if the demand rises quickly and outstrips the capabilities of the infrastructure. Such sequencing will be an important part of the next step, developing and executing an implementation plan.

CONCLUSIONS AND RECOMMENDATIONS

Certification is one indicator of a mature profession - CMSP provides this to the M&S community. This value can be increased via reinvention; by pursuing many of the recommendations provided within each of the seven initiative areas, soonest. CMSP 3.0 is most likely to be successful if multiple simultaneous actions are taken, within of course, the resources that are available. An inch deep and a mile wide is unlikely to be successful, as is an inch wide and a mile deep, but an efficacious balance can be struck. This is true for the M&S community, but it is equally true for other professional certifications that are in a similar position with: an expanding subject area, increased specialization, the infusion of new technologies and techniques, and a target audience that is impatient with bureaucratic processes, social media savvy, and who are digital natives.

It is critical to begin this reinvention soonest. Appropriately, those activities seen as quick wins, like holding a “State of the CMSP Nation” at I/ITSEC have already begun. Next, it is important to continue to refine and to then implement a balanced approach across at least the minimum set of essential recommendations. Resources will need to be specified and then their use orchestrated to further the case. Also, it will be valuable to utilize reliable individuals with relevant knowledge and skin in the game while adding digital natives for fresh insights and relevance. Finally. it will be important to pursue this evolution over the long run, without significant gaps in its progress and improvement. By implementing these recommendations, with a view to leveraging cross-cutting synergies, the reinvention of this certification and the launch of CMSP 3.0 can exceed its ambitious expectations.

REFERENCES

Bair, L. J., & Jackson, J. J. (2015). *M&S Professionals-Meeting the Demand*. Proceedings of the Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC), Orlando, FL.

Banks, J. (1998). *Handbook of Simulation: Principles, Methodology, Advances, Applications, and Practice*. John Wiley & Sons, New York, NY.

Greasley, A. (2008). *Enabling a Simulation Capability in the Organisation*. Springer-Verlag, London, UK.

Lewis, F., & Rowe, P. (2010). The Certified Modeling & Simulation Professional (CMSP) Program: Why It Was Created, Where It Stands Now, and What You Can Do to Support It. *SCS M&S Magazine, 1*(1), 16-20.

Lord, J. (2019). The Profession of Modeling and Simulations: Unifying the Organization. *Electronic Theses and Dissertations, 2004-2019.* https://stars.library.ucf.edu/etd/6341

Petty, M. D., Reed, G. S., & Tucker, W.V. (2017). The Certified Modeling and Simulation Professional Certification and Examination. In A. Tolk and T. Ören (Ed), *The Profession of Modeling and Simulation: Discipline, Ethics, Education, Vocation, Societies, and Economics* (pp. 109-128). John Wiley & Sons, Hoboken, NJ.

Sokolowski, J. A., & Banks, C. A. (2010). *Modeling and Simulation Fundamentals: Theoretical Underpinnings and Practical Domains*. John Wiley & Sons, Hoboken, NJ.

Tolk, A. (Ed) (2012). *Engineering Principles of Combat Modeling and Distributed Simulation*. John Wiley & Sons, Hoboken, NJ.

Waite, W. F. (2010). "SimSummit – Shaping the Future of Modeling and Simulation, Part 1 – Establishing the SimSummit Forum", *SCS M&S Magazine, 1*(1), 21-32.