

Part I

Foundation

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An Introduction to the Facets of the Profession of Modeling and Simulation

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1.1 Profession, Professionals, and Professionalism

Modeling and simulation (M&S) seems to be applied everywhere. Within the M&S community, we are currently celebrating many 50 years' anniversaries; so M&S seems to be often applied and has a large group of supporters, researchers, and practitioners. Within the academic realm, the annually conducted *Winter Simulation Conference*, organized by a group of simulation organization and societies, started as the "Conference on the Applications of Simulation Using GPSS" in November 1967 in New York, NY, and evolved into one of the biggest simulation conferences worldwide. It celebrates its 50th anniversary in December 2017. The *Annual Simulation Symposium* is the oldest international symposium continuously operating conference dedicated to simulation under the lead of the Society of M&S, it celebrated its 50th anniversary in April 2017. Practitioners in the field have also celebrated their 50th anniversary of the *Interservice/Industry Training, Simulation and Education Conference* (I/ITSEC) in November 2016. These conferences are all well attended and address a variety of application domains, covering all simulation paradigms and methods. In addition, many specialty conferences feature simulation track, in particular in the medical and healthcare community, but also in not so well-known fields, such as religion. Undoubtedly, simulation is ubiquitous, and many people apply simulation. *But is M&S a profession, and if not, should it be?*

To answer this question, some definitions are needed first. The Professional Standards Councils of Australia (<http://www.psc.gov.au> (accessed December 2016)) compiled a set of key definitions based on international literature research. Furthermore, they provided some different views on

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professions and professionals from various perspectives of academia, regulators, and more. Their recommended definitions are as follows:

- A *profession* is a disciplined group of individuals who adhere to ethical standards. This group positions itself as possessing special knowledge and skills in a widely recognized body of learning derived from research, education, and training at a high level, and is recognized by the public as such. A profession is also prepared to apply this knowledge and exercise these skills in the interest of others.
- A *professional* is a member of a profession. Professionals are governed by codes of ethics, and profess commitment to competence, integrity and morality, altruism, and the promotion of the public good within their expert domain. Professionals are accountable to those served and to society.
- *Professionalism* comprises the personally held beliefs about one's own conduct as a professional. It is often linked to the upholding of the principles, laws, ethics, and conventions of a profession as a way of practice.
- *Professionalization* is the pattern of how a profession develops, as well as the process of how becoming a profession.

A practical definition often referenced is that professionals use their *special skills to make money*. These skills may require certain characteristics by an individual or a group of individuals, such as professional athletes, but in any case they involve prolonged training and a formal qualification, such as for teachers or engineers.

In his groundbreaking work on the attributes of profession, Greenwood (1957) identified the following topics to be pivotal for any profession, independent of its specialty:

- Each profession needs systematic body of theory or *body of knowledge* that codifies the skills and expertise needed.
- A profession provides *authority and credibility* in the field. This includes examinations and certifications documenting the expertise of professionals.
- A profession is guided by ethical behavior. A professional *code of ethics* usually builds a moral contract and the foundation for a professional culture, or a culture of values, norms, and symbols. It also provides the basis for sanctions or regulation and control of its members, ensuring that ethics, authority, and credibility are sustained.

Ethical behavior of professionals is a common factor in the various definitions: professionals behave professionally, and this excludes lying, cheating, or deceiving. As important as general ethics, education in the

special domain to master the skill sets plays an outstanding role for professions. A profession shall clearly communicate what the entry-level qualifications are, what the supported curriculums of academia need to cover, and how professional continuous education needs to look like.

Related disciplines are often described regarding their *theoretical contributions* (science), their *derived methods* that make the research results applicable to solve daily life problems (engineering), and often a practical branch that mainly focuses on the *application* of such methods (practice). Examinations to formally test the knowledge of professionals do belong to this category as well, and are often referenced as unique certificates testifying the professionalism of those who pass it.

Professional societies are another important pillar for each profession. Societies publish journals, raise public awareness, and bestow awards on outstanding members. Through their work, they help to define, publish, and archive the continuously growing body of knowledge. They set the standards for their professional fields, and they promote high standards of quality and ethics. Societies also provide access to the experts to support work with subject matter expertise, or to conduct peer reviews for research and applications.

Finally, the economics of the profession are an important factor. Professions allow for improved access of the community to their special services and skills, provided by the professional organizations in the best form possible. But does it matter? Are there enough people in the community requiring a professional level of such services? What is the return of investment? Only if there are solid economic foundations, a profession will survive over time.

Sarjoughian and Zeigler (2001) summarized and proposed similar concepts for M&S as a discipline while contributing to the development of simulation curriculums at academic institutions.

Figure 1.1 visualizes the main concepts and their relations that make up a profession and may guide research as well as contributions to future discussions. This figure is neither attempting to be complete nor exclusive, but provides a framework that can be used to be populated with additional concepts and structures over time.

1.2 Contributions of the Chapters

Based on these definitions, experiences, and observations, we can ask again: *Is there a profession of M&S?* We asked the chapter authors, all of them being experts in M&S, to help address the various facets identified in this introduction. We could use many activities of the late Bill Waite, who

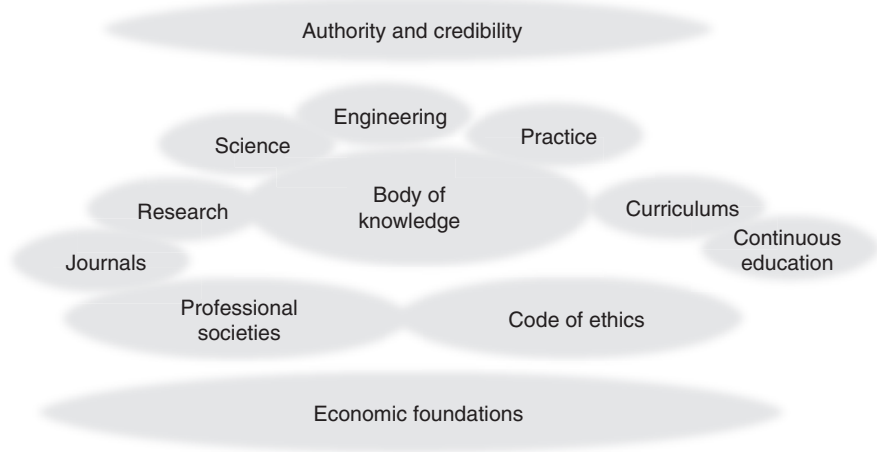


Figure 1.1 Main concepts and relations describing a profession.

can truly be recognized as one of the first true professionals of M&S. He recognized the need to create a body of knowledge and was active in this field. He was among the first M&S experts recognizing the need for strong economic foundations for M&S, so he organized workshops and tracks to address this topic. He supported partners in academia, industry, and government. And he was active in various leadership positions in M&S societies. All chapter authors knew and worked with him over the recent years, and all value his tireless contributions.

The individual contributing chapters follow the structure provided in this introduction. Chapter 2, “An Index to the Body of Knowledge of Simulation Systems Engineering” by Umut Durak, Tuncer Ören, and Andreas Tolk, provides an approach to understand what skills and knowledge make M&S unique as a discipline, and what defines an M&S professional.

Chapter 3 provides information about the “Code of Ethics” for M&S professionals. Andreas Tolk provides not only the code of professional ethics for simulationist, which has been adapted by many simulation organizations, but also puts the code into a broader context and gives some examples on how to apply the ideas in the life of a professional.

The academic foundations are described and explained in Chapter 4, “M&S as a Profession and an Academic Discipline: A Contemporary View” by John Sokolowski and Roland Mielke. Over the last decades, curriculums have been developed on the undergraduate, graduate, and postgraduate levels, allowing receiving all academic levels of recognition.

A slightly different approach is captured in Chapter 5, “Academic Education Supporting the Professional Landscape” by Margaret Loper. Her focus is on the support of the workforce in the M&S field, not only by programs leading to an academic degree but also including continuous education after graduation.

Like many other professional domains, the M&S community has an examination and certification program, “The Certified M&S Professional Certification and Examination,” described in Chapter 6 by Mikel D. Petty, Gregory S. Reed, and William V. Tucker. They not only describe the current version of this professional certification effort but also give insights into the historical developments, as it actually underwent several changes from its original inception to the current day, being a testament to the dynamics of changes within the M&S community.

In Chapter 7, Bob Armstrong and Simon Taylor provide an overview of “M&S Societies Shaping the Profession.” Such an overview can neither be complete nor exclusive, but by bringing experts from different continents with international experience on board, this overview may become a good starting point for further research. Although the number of professional societies is still fluctuating, the principles behind these societies are stabilizing, and as several of the featured professional societies are already several decades old, it can hence be assumed to be pretty stable and established.

Among the largest customers for M&S services, in particular for their training needs, but also for analysis of alternatives and procurement decisions, is the defense and security domain. Not only does the efficient use of M&S services require experts producing these services, but also the application side require experts. Chapter 8, “The Uniformed Military M&S Professional” by Rudolph P. Darken and Curtis L. Blais, describes how the United States Armed Forces ensure that soldiers have the necessary education to use M&S in support of their various tasks.

One of the fastest growing markets for M&S services is the Asian-Pacific realm. This growth is not driven externally, but local universities and societies are driving these efforts. Chapter 9, “M&S as a Profession and Discipline in China” by Lin Zhang, Yingnian Wu, and Gengjiao Yang, describes these developments, and how these activities are related to other efforts described in this book, and provides insight into their philosophy of simulation, application domains, education, and industry.

Chapter 10, “M&S for the Enterprise: Integrating application domains for the M&S Professional” by Steve Swenson, Mike Lightner, and Bob Gravitz, provides insights that are not often found in textbooks, namely, how M&S is used within industry. Their chapter allows gaining some ideas not only about what the needs and expectations are, but also how industry as an

active partner is driving the necessary developments. It also provides some industry insights not necessarily found in academic papers.

The academic contribution is described in Chapter 11, “A Complexity and Creative Innovation Dynamics Perspective to Sustaining the Growth and Vitality of the M&S Profession” by Levent Yilmaz. Unlike many other fields, M&S is defined by its support for other disciplines. It supports many engineering disciplines and allows computational science. Yilmaz therefore evaluates the critical building blocks of M&S research to gain better insight into how to keep it successful and creative.

Chapter 12, “Theory and Unified Process for the Practice of M&S in Cyber Environments” by Saurabh Mittal and Bernard P. Zeigler, provides an example of how M&S methods and skills can be used to address one of the main current challenges, better understanding and managing cyber environments. The described research steps and processes are applicable to other research topics as well and not limited to cyber challenges. However, as cyber environments will remain a focus area of research, some particular insights are provided for this special application domain as well.

Chapter 13, “Funding an Academic Simulation Project: The Economics of M&S” by Saikou Diallo, Christopher J. Lynch, and Navonil Mustafee, addresses the need to better understand the monetary issues behind research. The authors describe the results of content analysis on three sets of abstracts from funded projects that use M&S as one of the methods of investigation and compare and contrast the funding across geographical and disciplinary dimensions, providing empirical evidence to allow a better understanding of currently supported research needs.

In Chapter 14, Steven Gordon, Tim Cooley, and Ivar Oswalt ask the provocative question: “Why Spend One More Dollar for M&S? Observations on the Return of Investment.” They address the need to measure the positive effect of M&S applications, as they are often perceived to be expensive and time consuming without an immediately noticeable difference. The chapter documents several approaches to show the positive return of investment in M&S services.

In Chapter 15, “Does M&S Help? Operationalizing Cost Avoidance and Proficiency Evaluations,” the same group of authors looks at alternative means to evaluate the contributions of M&S that are not necessarily connected with the traditional return of investment.

Finally, in Chapter 16, Randy Garrett, RADM James Robb, Richard Severinghaus, and Richard Fujimoto document the approach of “Building a National M&S Coalition” within the United States. This coalition brings key partners from government, industry, and academia together to discuss the various research needs and application opportunities, but also funding and regulation constraints.

After studying these chapters, we hope that scholars, students, and practitioners of M&S will agree that there truly exists a profession of M&S, defined by a unique body of knowledge, well-defined curriculums and professional education programs, distinct contributions to science and engineering, supporting professional societies, and a solid economic foundation.

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