NAFEMS

What is

Simulation Governance and Management?






THE INTERNATIONAL ASSOCIATION FOR THE ENGINEERING MODELLING, ANALYSIS AND SIMULATION COMMUNITY

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The trends of automation and data exchange in manufacturing technologies (Industry 4.0 and 5.0) encompass the information-intensive transformation of manufacturing and other industries in a connected environment of people, processes, data, services, systems and IoT-enabled industrial assets. The technological breakthroughs emerging from this focus, such as intelligent robots, autonomous air and land vehicles, mobile supercomputing capabilities, biomedical devices and neuro-technologies, have resulted in the ever-increasing complexity of products over time. This has resulted in a digital revolution which in turn, has led directly to an increasing demand for engineering simulations that are performed in less time, with a reduced cost, and with higher fidelity.

Although the concept of industrial revolutions has been conceived in the context of manufacturing, it is essential to realize the full value chains that are impacted. Consider, for example, the next-generation advancements in mobile communication and connectivity such as moving from 3G to 4G and then to 5G. New applications based on these technologies, along with digital threads, tapestries and twins, in addition to extended (virtual and augmented) reality blur the difference between the physical and simulated worlds. Although it might be intuitive, these breakthroughs have been spawning an engineering simulation revolution!

Engineering Simulation Governance and Management

Developing a simulation governance strategy is necessary to build and nurture modeling and simulation capabilities and a company's confidence in those capabilities. It emphasizes the essential role of senior executive management to set the tone and send the message of how simulation will be used for product development and manufacturing, lifecycle support, and for decision-making. It addresses the organizational capability, confidence, and understanding. As such, this is a classic business problem that involves people, processes, and technology; all three needing to be addressed together and throughout the organization.

The foundational components of "Simulation Governance" are the executive management policies and procedures assuring that the business benefits of engineering modeling and simulation across the product lines are aligned with the strategic vision and goals of the company. Simulation governance should drive simulation management procedures and capability improvements to meet the company's simulation business objectives. These additional "simulation" components should be aligned with and complement the many different aspects already implemented in governing a successful company such as business plans, finances, legal and ethical issues, human capital, organizational infrastructure, intellectual property, IT, etc.

Effective implementation of simulation governance principles is contingent on having a collaborative simulation management organization that directs and develops people, processes and technology in performing and integrating engineering simulation across the lifecycles of product lines to meet business objectives. The simulation management organization has the responsibility for executing the "Engineering Simulation" processes of using physics-based mathematical (numerical) models, physical models, and/or logical models as representations of conceptual or real-world systems, phenomena or processes in studying their technical requirements and operational behavior. Typical math models include those used in performing FEA, CFD and multibody dynamic simulations, physical model test results are typically used in support of validating virtual simulation predictions, whereas logical models are typically used to capture and study the structural and functional architectures of parts and components of a system.

As illustrated in Figure 1, the scope of engineering simulation is founded upon the implementation of a corporate-based simulation governance vision, strategies and goals, along with appropriate simulation management operations, capabilities and qualities.

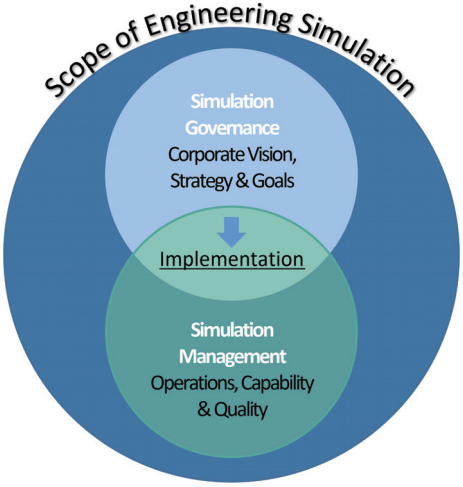

Figure 1: Scope of Engineering Simulation

Figure 2 illustrates the overall engineering simulation elements that need to be addressed in an organizational architecture, with engineering management being encompassed by appropriate simulation governance policies and procedures.

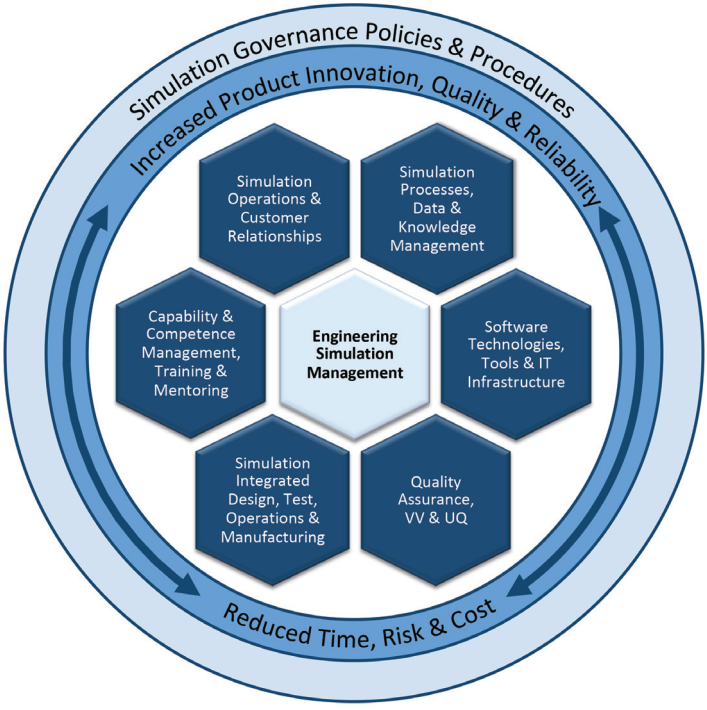

Figure 2: Scope of Engineering Simulation Management

Simulation governance extends beyond simulation management, which is getting the day-to-day work done, applying simulation to product and manufacturing development. Simulation governance addresses the development of technical competence and best practices codified in standard work for quality assurance and verification, validation, and uncertainty quantification. It also addresses the engineering development process: How, and when, does simulation support engineering decisions? The responsibilities for a well-implemented engineering simulation infrastructure are summarized in Table 1.

Executive Management
➢ Develop and implement simulation governance policies and procedures in collaboration with middle management and simulation experts. ➢ Ensure the business benefits of engineering simulation across the product lines are aligned with the strategic vision and goals of the company. ➢ Address standardization and enhancement of the modeling and simulation capabilities, knowledge capitalization, credibility assurance and risk-informed decision-making. ➢ Implement a structured organization within the company that is amenable to integrating the related simulation technologies across design, engineering, manufacturing, IT, physical test & in-service operations.
Middle Management
➢ Contribute to developing and implementing the simulation governance policies and procedures. ➢ Direct and manage the personnel and simulation processes, including quality assurance procedures for verification, validation & uncertainty quantification of simulations, and for data & knowledge management. ➢ Ensure the required technical resources and competencies are developed through continued training and mentoring. ➢ Ensure implementation, enhancement and usability of modeling and simulation software within the required IT infrastructure. ➢ Interact with customers to ensure the simulation deliverables are as expected. ➢ Ensure integration of modeling and simulation functions across product lifecycles, including physical testing, manufacturing & in-service operations.
First-Level Management
➢ Collaborate with middle management in assigning modeling and simulation tasks to qualified engineering personnel for performing the engineering simulation tasks at hand. ➢ Ensure the appropriate processes and procedures are utilized and the required quality assurance requirements are satisfied in performing the simulation tasks.

Table 1. Engineering Simulation Responsibilities

Business Drivers of Simulation Governance and Management

Engineering modeling and simulation technologies have been developing at a very rapid pace. This has been due in large part because they are essential to managing and analyzing the massive amounts of information being generated via the ongoing Internet of Things requirements, including assurance of cybersecurity and interoperability. More and more, futuristic companies are exploiting engineering simulation in making technical and business decisions and in developing strategic business plans. Furthermore, dynamic computational models that are tightly coupled within deployed systems are updated as the systems evolve in time. In this case, modeling and simulation are inherent to online monitoring and control of operational systems.

The demand for model-based engineering solutions integrated across all of the contributing engineering disciplines and throughout the entire lifecycle of a product has been driving the need for more disciplined collaborative engineering simulation to a new level. The principal business drivers continue to be the need for reduced times and cost in product development and lifecycle support processes, and for higher levels of fidelity in making technical and business decisions more quickly. As such, engineering simulation has been becoming more pervasive in support of the overarching product lifecycle processes. Thus, it is imperative that engineering modeling and simulation capability be recognized as a corporate strategic business asset.

Companies expend significant resources on human capital, software, and high-performance computing, but they may not be reaping the full technical and business potential benefits of engineering simulation. With the exponential rise in the power of computers over time and the associated development of modeling and simulation software, the issue of how a company exploits these capabilities to develop and engineer products and manufacturing systems is paramount. Companies also need to address how improvements will be made to their capability for performing modeling and simulation, their confidence in applicability of the results, and their metrics for simulation quality, reliability, and accuracy. Reference [1] presents the findings of a review looking at the rapid evolution of UK computational modeling capability, and guidelines on how it could be better used in both the public and private sectors.

The primary objectives for adopting and implementing simulation governance include the abilities to:

- Manage simulation consistently and at all levels of application.
- Plan and procure technology resources and human capital for performing simulation.
- Build simulation capability, and promote credibility and understanding of simulation's role throughout the organization.
- Ensure that simulations are repeatable, reliable, and robust.
- Manage processes, data and intellectual property rigorously for simulation users and customers.
- Provide day-to-day IT services in terms of hardware, software and operations support.

Developing confidence in engineering simulation is based on a company's capability to perform virtual assessments of how well a product, process or system performs in its operating environment. That confidence relies on prescribed standard workflow practices and tools, software and solution verification and validation processes, and a body of experience. Of prime importance is the definition of the company's scope and requirements for performing engineering simulation relative to their business strategies. Based on their stated needs and objectives, they are able to proceed in developing appropriate simulation governance and management policies and procedures.

In the context of enterprise digital transformations, industrial managers are increasingly confronted with simulation-informed decision making and associated risk assessment [2]. This requires an objective evaluation of the credibility of simulation results through the use of validation methods and the predictive maturity of simulation processes considering multiple factors such as customer alignment, software reliability, estimation of numerical accuracy, Uncertainty Quantification, data quality and traceability, staff competencies, etc. Generic approaches for addressing these topics have been developed and are presented in References [3], [4] and [5]. These assessment practices enable management to monitor performance of simulation predictive capabilities against business requirements, gap identification and prioritization of improvements. They also provide decision makers a better understanding of simulation strengths and weaknesses and how these translate into risks associated with simulation-informed decision making. Thus, an essential role of management is to promote and enforce appropriate practices for performing simulation credibility and maturity assessments.

Although simulation governance is a complex, multi-dimensional problem, many of the foundational business processes and organizational infrastructures for its implementation already exist in companies and organizations that utilize engineering simulation. To be robust; however, it is essential that these capabilities be extended to embrace simulation governance and management. Thus, one of the essential roles of top management is to support and ensure collaborative integration of engineering simulation with IT, physical testing, manufacturing, in-service product support and maintenance, etc. An example of such extensions is the similar requirement to manage both simulation data and product design data; for both cases it must be decided how selected sets of information are to be shared by multiple groups and/or saved for future retrieval.

Reliance on simulation brings different elements of risk which must be recognized and managed. The root cause of many different types of classical product failures in the past, for example, has been largely due to management issues. Often, these situations were due to the lack of appropriate risk assessments being performed on simulation-informed decisions to mitigate such failures. This is not just a matter for the simulation experts or the Simulation Department. Expectations and guidance on the proper use, interpretation and appropriate quality assurance of modeling and simulation need to be set by executive management, and understood throughout the company. While most organizations have mature physical test management systems, only the most advanced have virtual test management systems, and Simulation Process and Data Management (SPDM) solutions.

It is imperative in today's competitive business environment for a company that utilizes engineering simulation to adopt and implement a comprehensive simulation strategy across the entire company. This involves senior managers and others who are not obviously part of the engineering simulation organization. This overall organizational scheme is called "Simulation Governance and Management".

Simulation Governance and Management Working Group (SGMWG)

The focus of the NAFEMS SGMWG is to champion and improve best practices that relate to engineering modeling, analysis and simulation. It promotes and enriches simulation management practices aligned with the rapidly developing technologies in advancing the productivity and quality of virtual engineering modeling and simulation processes. This includes the development and promotion of requirements and standards that will have general benefits to the international engineering analysis and simulation community.

The mission of the NAFEMS SGMWG is to provide a vendor-neutral, end-user driven consortium that promotes advancement of the technology and practices associated with all aspects of managing engineering simulation processes and techniques. Its vision is that engineering analysis and simulation processes, procedures, and best practices for ensuring quality and reliable simulations are adopted appropriately as strategic business assets within all companies utilizing virtual engineering modeling and simulation techniques.

Find out more about the NAFEMS SGMWG and get involved at: **nafe.ms/sgm**

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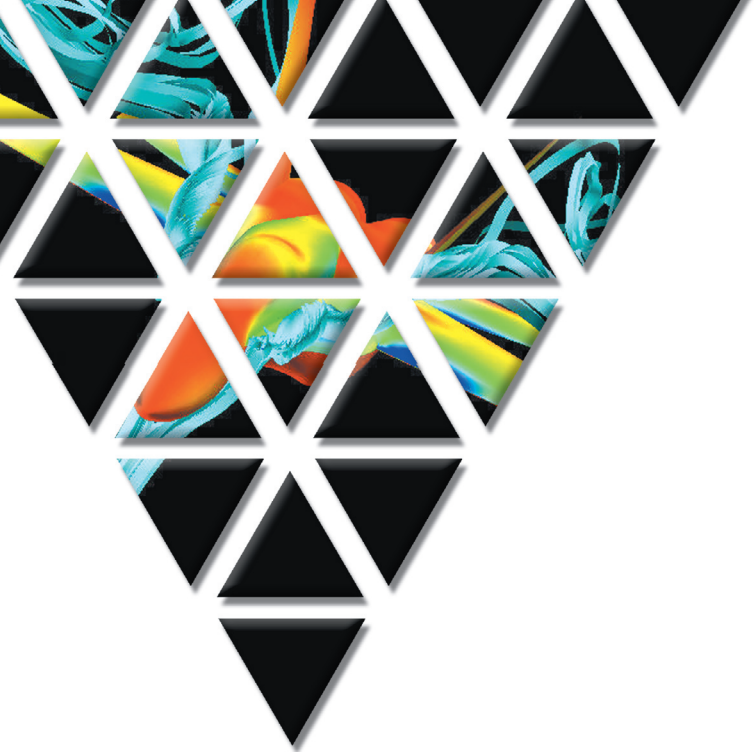

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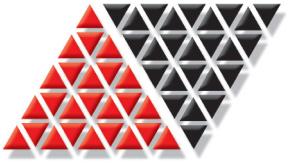

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