Dassault Systèmes SIMULIA Analyst Event 2019

Simulation for Lightweighting as Part of a System of Operations

SMS_ThinkTank™ Commentary

Key takeaways:

- *SMS_ThinkTank™ believes, that Dassault Systèmes with this strategy, will make a major step forward in providing business value added prediction capabilities*
- *SMS_ThinkTank™ believes that Dassault Systèmes and its SIMULIA brand understands that proper enablement of systems thinking, democratization of simulation and collaboration can only be achieved if the solution ecosystems reaching across domains is made mandatory.*

SMS_ThinkTank™ recently attended the Dassault Systèmes' SIMULIA brand analyst event 2019 at its headquarters in Waltham, MA. Subham Sett, who is the VP of SIMULIA Marketing & Strategic Initiatives for Dassault Systèmes, outlined in his opening remarks, the challenges and trends as they pertain to the virtual simulation space as well as how Dassault Systèmes is approaching them — focusing on its commitment toward using system modeling and simulation as foundational elements. Dassault Systèmes continues its journey in achieving its SIMULIA brand vision to *"Reveal the World we Live in*".

The major challenge solution providers are facing today is that the solution by itself will not win market share or business. Typically, the vendor's vision already often reflects this new environment, but the execution is missing. The challenges lie in the strategies and their execution. Dassault Systèmes' strategy is focusing on three areas:

- Social: Ease of use, online and mobile availability
- Industry: Highlights the business solutions and not just the tool alone
- Experiences: How the user is interacting with the software, services and content provided by Dassault Systèmes, as well as how the consumer is able to interact with and influence product requirements

To address these market challenges, companies and whole industries need to transform. Dassault Systèmes sees the transformation being addressed in:

- Continued industrial revolution with its next level of *Industry Renaissance*
- Digitalization in the broad meaning of business and day-to-day life

A variety of trends as shown in Figure 1 force this transformation to happen.

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Figure 1: Trends Forcing Transformation
(Courtesy of Dassault Systèmes)

Simulation is essential to enable this digital transformation. Simulation plays a key role in our virtual representation of the real world and the requirements to be able to predict and optimize performance and behavior supporting the above-mentioned trends. A holistic multi-physics, multi-domain and multi-scale systems approach is essential. This requires going beyond the traditional silos within an organization and, eventually, the operating environment. The underlaying enabling platform is not just merely a backbone for data and processes, but foremost becomes the platform for knowledge and know-how to allow for innovation (see Figure 2). It needs to be looked at as a "System of Operations" and applied like a "Business Model". The SMS_ThinkTank™ calls such a platform "Business Innovation Environment" as it contains different pillars and brings other platforms together in a collaborative way. One of the most important benefits of such a platform approach is the power of collaboration, linking the various domains accelerating innovation.

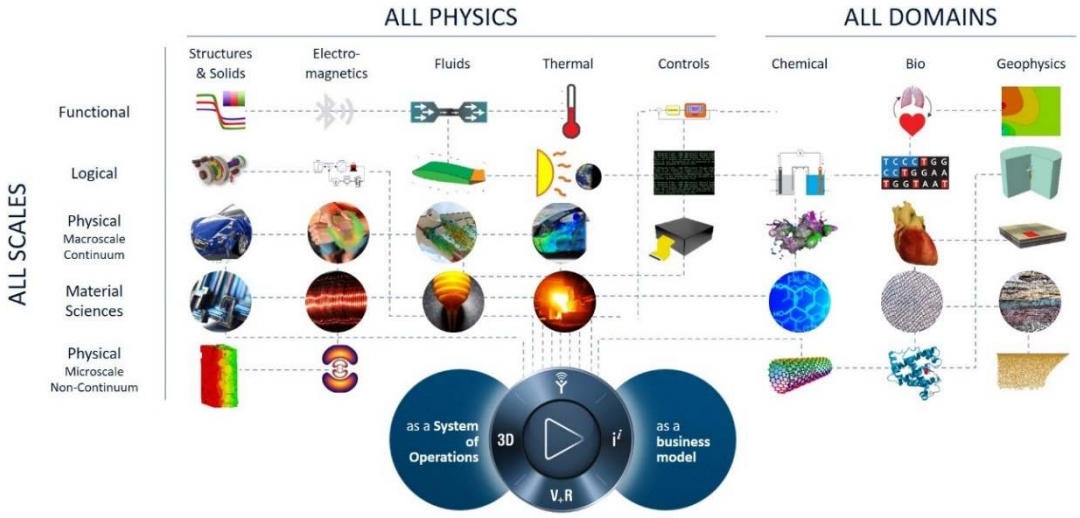

Figure 2: Simulation within the Platform
(Courtesy of Dassault Systèmes)

In this commentary, our focus will be in the context of “System of Operation” and a new “Business Model” thinking related to; modeling and simulation for lightweighting designs, in support of several of the trends as mentioned in Figure 1, and the use of simulation to reduce physical testing while meeting the requirements of light vehicle test procedure certification.

In today’s world of ever evolving customer demands that directly contribute to the escalation of new very complex engineering technologies and processes, SMS_ThinkTank™ believes that Dassault Systèmes and its SIMULIA brand understand that proper enablement of systems thinking, democratization of simulation and collaboration can only be achieved if the solution ecosystems reaching across domains is made mandatory.

Modeling and Simulation for Lightweighting Design

Lightweighting is one of the major factors for many industries designing a product or system from a cost, performance, weight and user experience perspective. SIMULIA has spent significant resources building vertically integrated process flows with the proper associated simulation technology. Previous commentaries and other publications readily available on the internet discussed these capabilities to a great extent. And we learned again during this year’s analyst event that new capabilities are being added on a regular basis.

For lightweighting design, the overall Additive Manufacturing capability within the **3D**EXPERIENCE Platform is a central process that is enabled by supporting processes and capabilities, such as (Figure 3):

- **3D**EXPERIENCE Marketplace
- In Silico Material Engineering
- Function-driven Generative Design
- Process Definition & Production Planning
- Global Production System

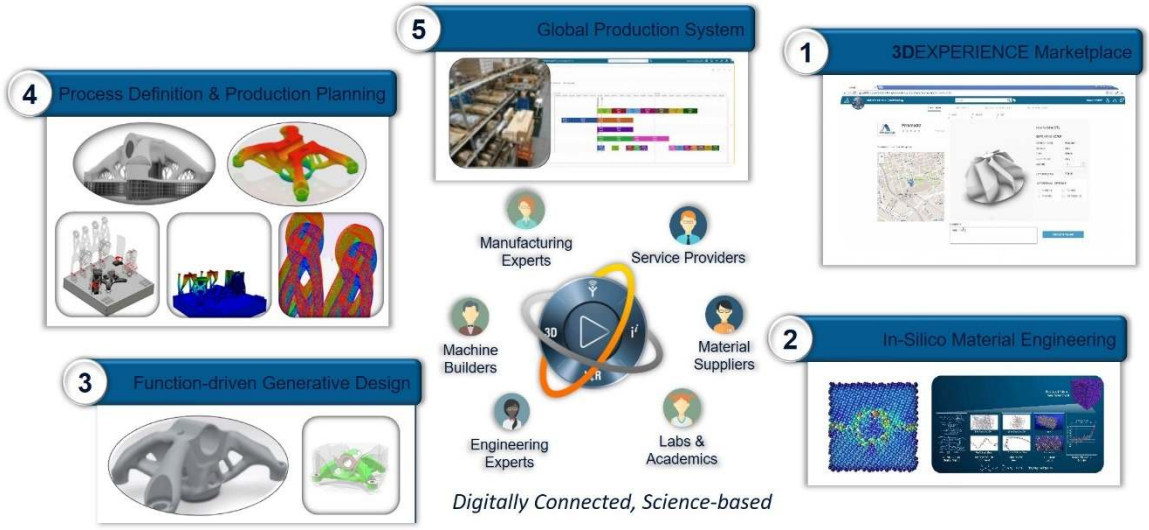

Figure 3: Additive Manufacturing for Lightweighting
(Courtesy of Dassault Systèmes)

While the various new simulation advances will definitely benefit the end user, companies are looking much more so nowadays at the overall engineering process from a business perspective. “Traditional” simulation focus (such as: mechanical and thermal behavior of a component or a system, endurance and performance while in operation, controls and their interactions with the mechanical system, etc.) alone is not enough. Companies are seriously looking into using integrated simulation, data management and associated collaboration applications to improve overall business performance.

The overall Additive Manufacturing process within **3D**EXPERIENCE can and should be looked at from a business point of view. The “**3D**EXPERIENCE Marketplace” is a solution for an online and secured end-to-end business management environment that helps to connect sellers and buyers in an effective way based on their needs - which may be timing, manufacturing solution, volume capability, regional availability and much more. Each of the blocks represented in Figure 3 address the processes and capabilities of a complex system that typically interact with each other. And, most important, are represented in an integrated closed-loop process in order to take advantage of optimization routines that are driven by the top-level customer requirements.

The function-driven generative design environment (Figure 4) is a good example to explain this in more detail.

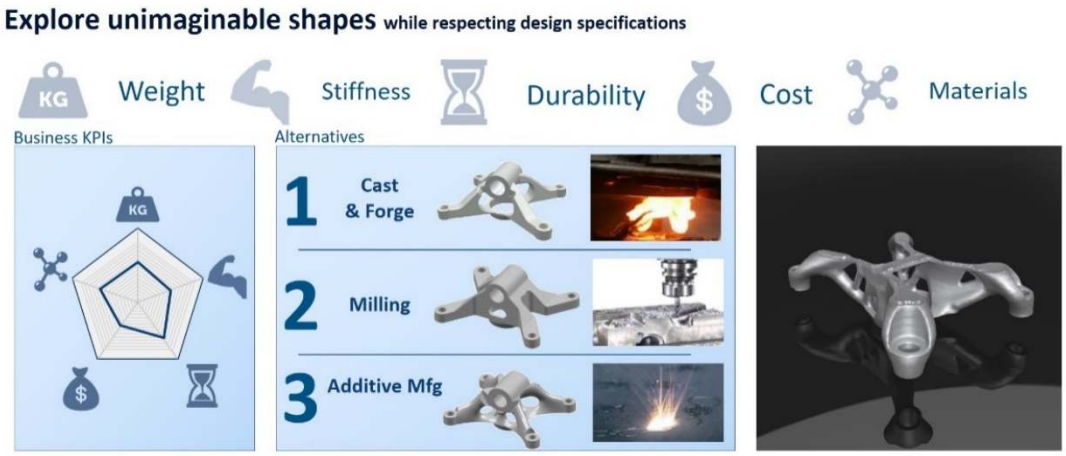

Figure 4: Function-driven Generative Design
(Courtesy of Dassault Systèmes)

When looking for an “optimal” lightweight design that is within the customer specifications (requirements), it’s not just the weight which is driving the design but a complex set of KPIs (Key Performance Indicators) that need to be met, such as:

- Weight
- Stiffness
- Durability
- Cost
- Serviceability

These characteristics need to be properly identified and associated with the design to be developed. They also define how the design needs to be validated against those requirements. Throughout the development process several steps need to be addressed:

1. **Define** (design space, simulation conditions – such as loading conditions, targets and constraints)
2. **Explore** design options (trade-off studies are already part of this evaluation step)

3. **Generate** the most promising design that will be put forward to the final stage
4. **Validate** against initial requirements

The above-mentioned steps and how they are being executed effectively describe a system engineering approach. Figure 5 provides a good illustration of systems thinking. It highlights that it is not only part of each steps throughout the lifecycle, but also has to be iterative and close-looped in order to make use of learned information and improve performance against initial requirements.

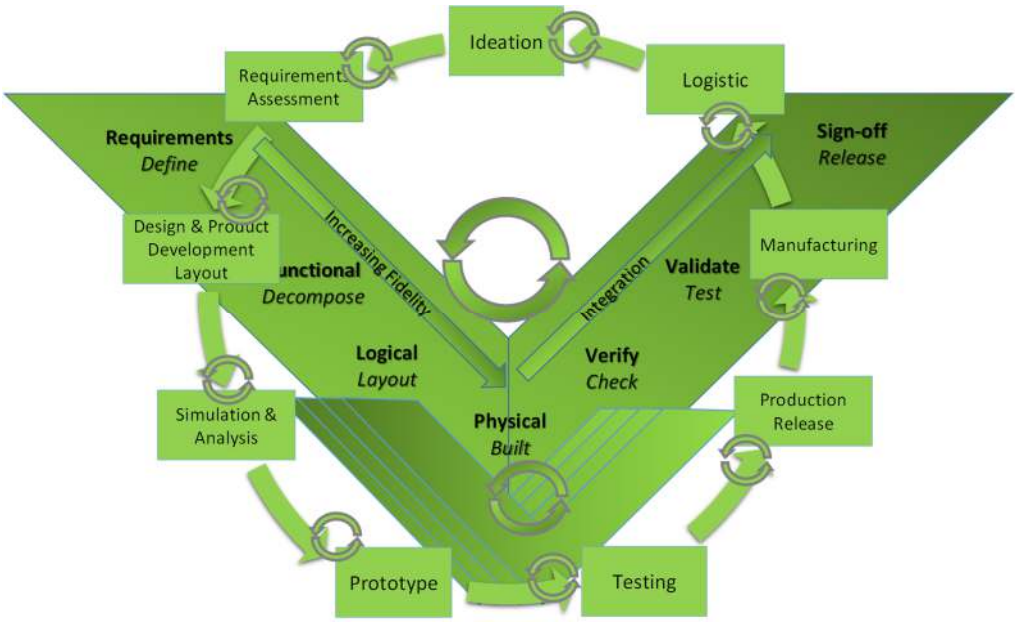

Figure 5: System Modeling and Simulation is an iterative Process
(Courtesy of SMS_ThinkTank™)

This is a complex approach that businesses are starting to embrace. For example, Airbus provided Dassault Systèmes with specific measurements based on their experience with the function-driven generative design environment:

- Reduced material waste - up to 10 times
- Development time reduced by 4 times
- Weight reduction from 30% using traditional manufacturing techniques to 70% using Additive Manufacturing techniques
- Currently there are 120 users for this environment. Airbus is targeting 500 users by year 2020.

These are significant realized business benefits. Companies are requiring their simulation groups to provide more upfront predictive performance data and the benefits realized through the virtual environment. This requires improving engineering simulation maturity with the solution provider as well as with the customer. This motivation drives thinking beyond the traditional engineering "V" as shown in Figure 5. Going beyond is needed when considering: [1]

- IIoT / Industry 4.0 / IoT
- Digital Twin

[1] Frank Popielas – SMS_ThinkTank, et all: White Paper "Digital Twin – Its Role and Structure within a modern Systems Engineering Approach"; February 20, 2019

- Deep Learning
- Predictive Analytics
- Cloud Computing
- Big Data

These traits are prerequisite to enable cognitive engineering capabilities. [1]

Dassault Systèmes is transforming traditional CAD to become Cognitive Augmented Design. This new way of thinking integrates 3D design, simulation, know-how, automation, and optimization technologies to enable functional driven generative and even, cobot generated design. This capability will not just improve the "Systems of Operation" capabilities of the **3D**EXPERIENCE platform but will also add to its business value prediction capabilities by creating a "value-based architecture". (Figure 6)

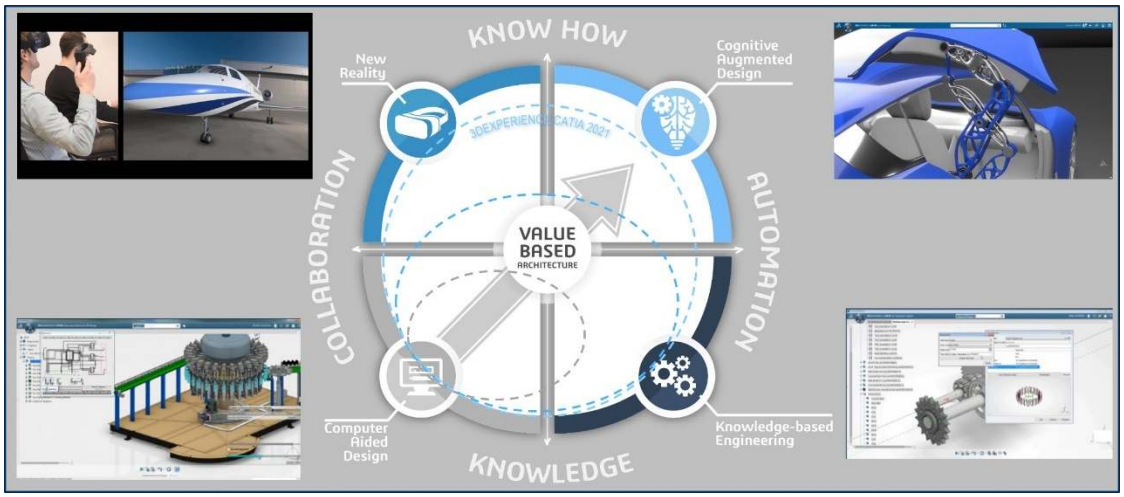

Figure 6: Cognitive Augmented Design
(Courtesy of Dassault Systèmes)

SMS_ThinkTank™ believes, that Dassault Systèmes with this strategy, will make a major step forward in providing business value-added prediction capabilities.

Worldwide Harmonized Light Vehicle Test Procedure (WLTP) Certification

Another good example for using simulation in support of "System of Operation" to gain business benefits, is the recently developed WLTP (Worldwide Harmonized Light Vehicle Test Procedure) Certification. Let's first look at the background of WLTP, what it represents, and the challenges associated with its implementation. This is the key factor in why we highlight the topic of simulation in the context of this commentary.

The impact of climate change from the transportation industries due to pollution and resource depletion is a current very hot topic due to:

- Noticeable climate changes, especially with the worsening of air quality
- European emission scandals surrounding diesel engines involving "cheating" certification tests
- More conscious awareness of the consumer demanding "greener" technologies

One notable point is that the consumer still wants the freedom and flexibility to choose the "vehicle" based on personal preference.

The European scandals drove the European Union (EU) to develop better certification procedures to avoid such scandals in the future and ensure that the sold vehicles actually meet the requirements put forward in the laws. WLTP is meant to address this and went into effect in all UNECE member states on September 1st, 2018.

Other countries in the world started or will start their adoption over the next few years.

At the same time, this new Certification is creating challenges that will change the industry:

- Increased consequences for non-compliance
- Higher efficiency standards require more innovation
- The automotive industry is considering streamlining options to simplify certification (the question will be if the consumer will accept this)
- Testing resources for the certification process are not keeping up with demand. Even if the resources are available, it will be cost prohibitive to go through certification solely by using physical testing resources.

The WLTP is forcefully increasing the testing needs in comparison to the NEDC (New European Drive Cycle) as the requirements becomes more stringent and complex. Some of these are:

- Every vehicle configuration needs to be certified for:
  - Aerodynamics
  - Mass and inertia
  - Tire performance
- A more realistic representation of driving conditions will be adopted:
  - A realistic higher speed drive cycle will be adopted that will challenge the emissions
  - Realistic vehicle shift points
  - Realistic cold start temperature will be applied

Typically, Automotive OEMs have several models with substantial amounts of options. The testing demand will explode to a point that such a variety in offerings will not be sustainable with the existing “physical” testing approach.

Dassault Systèmes proposes a digital certification solution approach to overcome the constraints of the certification process to help maintain the flexible offerings for the OEMs while at the same time ensure financial sustainability.

- Digital Certification
  - Replace physical with virtual testing
  - Reduce testing bottlenecks
  - Satisfy WLTP requirements
- Design for Certification
  - Design for more stringent regulations
  - Achieve future emission targets
  - Compliance without compromise in design
- Plan for Certification
  - Track thousands of variants throughout the development lifecycle
  - Manage simulation and test information
  - Allow for traceability to ensure regulatory compliance

This approach requires that the entire virtual process at each OEM (who would like to take advantage of this virtual approach) must define all their related simulation processes and have them certified by the WLTP body. To properly define these processes, SMS_ThinkTank™ recommends that Model-based

Engineering (MBE) should be implemented to the full extent. All the underlaying steps as shown with the engineering "V" in Figure 5 need to be realized utilizing model-based approaches. Those not only include the actual simulation technique, but also the model and general data management as well as the management of the associated processes and information flow (digital thread). That part is utilizing the "system of operation" capability of a "Business Innovation Environment" platform.

SMS_ThinkTank™ believes that Dassault Systèmes has the foundational elements within their **3D**EXPERIENCE platform as well as the supporting simulation capability through their various brands to address:

- Digital Certification – replace physical testing with simulation (Figure 7)
  - Provide turnkey solutions
  - Reduce costs and complexity of compliance
  - Ensure on-time vehicle launch
- Design for Certification – Reduce Emissions using Simulation (Figure 8)
  - Reduce emissions
  - Meet performance targets
  - Avoid costly penalties
- Plan for Certification – Streamline the Process of Certification (Figure 9)
  - Optimize test assets
  - Streamline compliance
  - Accelerate certification

Figure 7: Digital Certification
(Courtesy of Dassault Systèmes)

Figure 8: Design for Certification
(Courtesy of Dassault Systèmes)

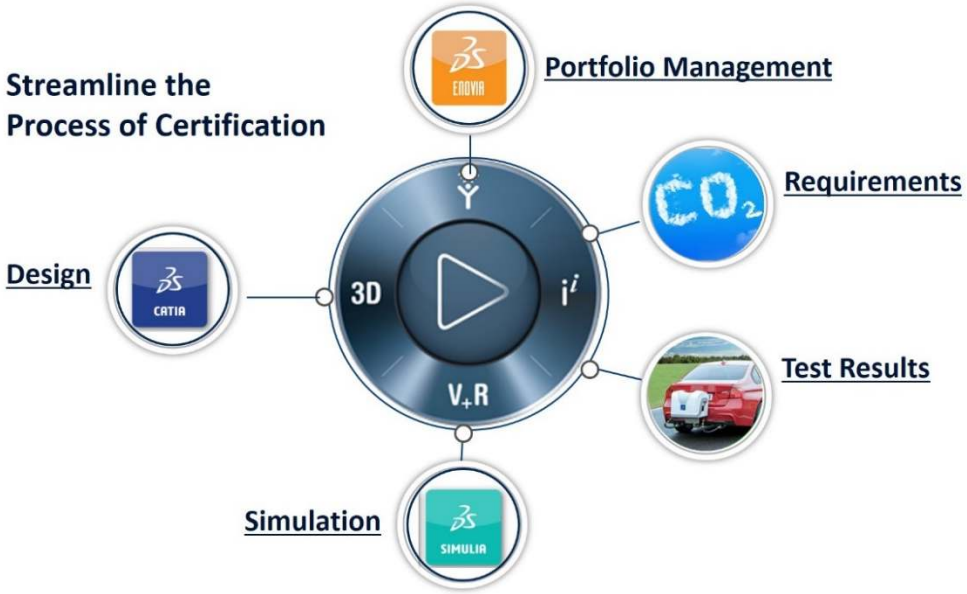

Figure 9: Plan for Certification
(Courtesy of Dassault Systèmes)

Companies need to realize that this only can be achieved by a gradual transformation. This requires a digital transformation of the entire organization and business. This involves all aspects of:

- Organization / people / culture of the business
- Processes
- Technologies

SMS_ThinkTank™ presented the various challenges associated with this transformation from management and deployment perspectives at various conferences and through webinars. [2] [3] [4]

Conclusions

Dassault Systèmes' SIMULIA brand continues to enhance its simulation capabilities to further support the growing complexity in our modern engineering world as well as driving the democratization of simulation. The shift is much more towards the overall system modeling and simulation workflows and capabilities. This requires that all brands within Dassault Systèmes collaborate effectively to deliver a comprehensive virtual "Business Innovation Environment". SMS_ThinkTank™ believes that Dassault Systèmes with the thinking of its **3D**EXPERIENCE platform as a "System of Operations", enabling new business models, can take a leading role across industries. Dassault Systèmes is taking steps to adjust their own business model accordingly and lead the market to a new level.

Organizations utilizing digital transformation methods need to determine their own ability to execute on the changes needed to successfully achieve their corporate defined goals. SMS_ThinkTank™ is dedicated to assessing and provide roadmaps related to the Organization/Culture/People and Processes needed for this digital transformation. Tools will fall into place once the above-mentioned categories are satisfied and a clear roadmap for this digital transformation is determined.

[2] Frank Popielas – SMS_ThinkTank, et all: Presentation "Systems Engineering – Challenges for Management (MBSE 105)"; COE 2018; April 15-18, 2018; San Diego, CA, USA

[3] Frank Popielas – SMS_ThinkTank, et all: Presentation "Achieving Sustainable Innovation – Business Challenges in the Age of Digitalization and the Path forward"; COE 2017; April 23-27, 2017; Orlando, FL, USA

[4] Frank Popielas – SMS_ThinkTank, et all: Presentation "Systems Engineering – Deployment Challenges"; COE 2019; February 24-27, 2019; New Orleans, LA, USA

About SMS_ThinkTank

SMS_ThinkTank™ LLC is the global resource and leader in system modeling and simulation, bringing the worlds of systems engineering and computer aided engineering together. The SMS_ThinkTank™ is a vendor neutral firm which provides strategic systems engineering and CAE management consulting to help enterprises embrace Model Based Systems Engineering (MBSE) to achieve sustainable innovation bringing higher quality products to market faster. SMS_ThinkTank™ helps enterprises in developing the methodologies to support these new technologies including emerging systems engineering and CAE standards. To learn more about SMS_ThinkTank™'s services, visit our website at www.smsthinktank.com or contact SMS_ThinkTank™ at +1-877-254-5171