

Mastering the mandate - Quest Global's strategic approach to MBSE in Aerospace and Defense



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Introduction

Model-based systems engineering (MBSE) is revolutionizing the aerospace and defense (A&D) industries by offering a more integrated and efficient approach to the design and development of complex systems. As the U.S. Department of Defense (DoD) now mandates the integration of MBSE into Request for Proposal (RFP) submissions, the industry is recognizing its potential to optimize resources, enhance system interoperability, and increase agility and adaptability within A&D operations.

The adoption of MBSE in aerospace and defense is particularly crucial due to the complexity and safety-critical nature of products within these sectors. Traditional document-centric systems are becoming inadequate for the sophisticated engineering tasks required today. As the aerospace industry strives for greater efficiency, environmental sustainability, and safety, the design and development of aircraft and other aerospace components have become increasingly complex.

MBSE is a systematic approach to engineering that leverages models to support all stages of a system's lifecycle, from requirement gathering to design, analysis, verification, and validation activities. Here are the anticipated impacts of the adoption of MBSE.

Streamlined communication across teams: MBSE introduces a unified modeling language that enhances communication between all parties involved in a project, from engineers to stakeholders, by providing a clear visual representation of systems and their interconnections.

Proactive issue identification: The ability to simulate and analyze various scenarios within MBSE allows for the early detection of design conflicts and system limitations, enabling proactive resolutions that minimize downstream costs and introduce predictability of the impact of change.

Resource efficiency through modularity: Modular design and hierarchical structuring in MBSE support the reusability of components in different system configurations, which can lead to more efficient use of resources and a reduction in the time required for development.

Enhanced traceability and verification: The traceability features inherent in MBSE facilitate the mapping of requirements to specific design elements and testing protocols, thus improving the overall verification and validation process and compliance with regulatory standards.

Seamless system integration: The use of MBSE promotes interoperability between various system components by identifying interrelated systems and their interdependencies that ensure that they function together as a cohesive unit; which is particularly crucial in complex defense systems requiring high levels of synchronization.

Responsive project evolution: MBSE enables robust, iterative design capabilities, crucial for navigating the fluid landscape of aircraft development. As small modifications in the design can have outsized effects on development timelines and certification processes—both mission-critical aspects—MBSE stands as an indispensable tool. It enables engineers to anticipate and adapt to changes effortlessly, ensuring the aircraft's design evolves in tandem with evolving mission requirements and emerging technological innovations, without compromising on safety and performance standards.

Efficient management of design modifications: Integration of MBSE into the engineering workflow, organizations can significantly mitigate financial risks. It facilitates earlier detection and more precise identification of potential issues, thereby reducing the high costs traditionally associated with defect management in aerospace projects.

Enhancing engineering throughput: Amid a skilled labor shortage in engineering, MBSE can automate routine and redundant tasks, significantly boosting efficiency. MBSE allows existing teams to handle increasingly complex projects effectively, maximizing the output per engineering hour. This efficiency gain is particularly valuable, as it helps overcome workforce limitations without the need for expanding the team size. MBSE's intuitive visualization tools/UI are intuitive for upcoming engineers of this generation, simplifying complex concepts and facilitating quicker onboarding and integration into projects.

Enabling digital handover: MBSE is pivotal in the digital evolution of organizations, significantly improving engineering productivity. It provides integrated, easy-to-use tools that enhance teamwork and deepen the understanding of complex systems. Unlike traditional documentation of requirements, which can be cumbersome and less accessible, the digital models provided by MBSE offer a more coherent and understandable representation of complex systems. This clarity not only eases the handover process between teams but also ensures that every member, regardless of their experience level, can contribute more effectively and efficiently.



The inevitability of MBSE

The DoD's mandate for the implementation of MBSE is a strategic move to mitigate the risks associated with vendor lock-in. Vendor lock-in occurs when a customer becomes overly dependent on a single supplier for products and services, unable to easily switch to another vendor without substantial costs or inconvenience. In the context of defense contracts, this can lead to a scenario where the DoD may be reliant on one OEM for critical updates, system upgrades, or maintenance services.

The central objective of the MBSE mandate is twofold: to build a competitive and dynamic marketplace and to ensure that the DoD retains operational autonomy over its technology and systems. Other anticipated outcomes from DOD's perspective include:

Intellectual property access: The mandate of including system models as part of RFP submissions ensures that DOD has access to the design and functional architecture of the systems it procures. This IP transfer is critical for understanding the intricate details of the defense systems in use, which include the operational, maintenance, and upgrade protocols.

Facilitating alternative solutions: Access to system models empowers the DoD to seek alternative vendors if the need arises, such as when the original OEM is unable to meet its obligations due to financial instability, production delays, or any other failure to deliver as per contract terms.

Cost efficiency and negotiation leverage: When the DoD has the necessary system models and related IP, it can negotiate more effectively with the original OEM and other potential vendors for maintenance and upgrades, leading to potentially lower costs and better terms.

Ensuring continuity and readiness: In defense, operational readiness and system continuity are paramount. The MBSE mandate ensures that the DoD is not at the mercy of a single supplier for the functionality of critical systems. This continuity is vital for national security and effective military operations.

Long-term support and system lifecycle management: The DoD's systems often have long lifecycles. Having access to MBSE models allows the DoD to manage

these systems more effectively over time, including handling legacy systems that the original OEM may no longer support.

Enhanced security and risk management: Dependency on a single OEM can create a potential single point of failure, which could be exploited by adversaries or lead to mission-critical downtime.

Increased collaboration and industry partnership: The mandate can lead to increased collaboration between the DoD and a broader set of industry partners, building a more cooperative and integrated defense industrial ecosystem.

Quality control and system integrity: With the ability to review and assess system models independently, the DoD can ensure that all systems meet stringent quality and performance standards without being constrained by OEM assertions or limitations.





Eating the elephant - one model at a time

We, at Quest Defense, view the DoD mandate for model-based systems engineering as a significant turning point for aerospace and defense OEMs. While fully digitized manufacturing remains a goal yet to be realized due to the complex nature of supplier networks and processes, we see MBSE as a driving force for industry-wide transformation.

We also understand the reluctance and the perceived burden that this mandate may present for OEMs. The shift towards MBSE can seem overwhelming, like 'eating an elephant,' a massive endeavor that cannot be tackled all at once but rather requires a deliberate and phased approach. Here's how we deliver value to our clients in this transformative journey:

Strategic guidance: We serve as a strategic ally, guiding OEMs through the beginning phases of MBSE adoption. Our objective is to simplify the complexity into manageable segments, establishing concrete, actionable steps that are in line with DoD requirements and the operational goals of the OEMs.

Ensuring compliance and value: While adherence to the DoD's directive is a given, our strategy aims to surpass mere compliance. Our goal is to harness MBSE to generate real value, assuring that the OEMs' investments in this arena yield a substantial competitive edge.

Integrating MBSE into the digital thread: Our efforts are directed at weaving MBSE models into the OEMs' existing digital thread, thereby enhancing data continuity and process transparency. This integration is crucial for achieving a swift return on investment (ROI) through heightened efficiency, error reduction, and accelerated market entry.

Demonstrable value for immediate needs: We emphasize the importance of ensuring that the shift to MBSE manifests value in the immediate subsequent product release or iteration. We focus on providing distinct deliverables that OEMs can evaluate against their development efforts, confirming that the 'tax' of this transition is indeed a profitable investment.

Tailored solutions for diverse OEMs: We recognize the diverse resource bases and readiness levels for such a transformation among OEMs. Thus, we offer customized solutions that cater to each OEM's specific situation, whether they be industry leaders or smaller, more nimble entities.

Incremental approach: Our philosophy advocates for addressing the MBSE mandate incrementally. We encourage a step-by-step adoption, allowing OEMs to integrate new processes smoothly without disrupting their current operations, consistent with the 'one bite at a time' method for 'eating the elephant.'

Maximizing ROI: In our approach, we focus not merely on adoption but on optimization—guaranteeing that every move towards MBSE not only fulfills the mandate but also contributes to cost reduction, quality enhancement, and improved lifecycle management of products.

Transition support and change management: We offer comprehensive assistance during the transition, aiding OEMs in managing the technical and cultural shifts within their organizations.

In essence, our aim at Quest Defense is to clarify MBSE for our customers, turning a potential regulatory burden into a strategic advantage. In doing so, we position ourselves as catalysts, enabling A&D OEMs to meet DoD mandates efficiently while also reaping significant value from their MBSE efforts, ultimately leading to a fortified, competitive market stance.



For further information or queries, please reach out to us at info@quest-defense.com