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Ingenuity for life

Siemens Digital Industries Software

Product realization facilitates a collaborative approach

Driving profitability, reputation and more successful execution of aerospace and defense programs

Executive summary

Aerospace and defense companies are being confronted by the twin challenges of unprecedented competitive pressure as well as understandably demanding customers who are seeking greater accountability on program performance. To compete successfully, aerospace companies need to rethink their program execution strategies. To gain greater clarity on program decisions and their impact on cost, timing and quality, they must make manufacturing a core part of the program development process.

Introduction

In the aerospace and defense industry, programs are becoming more complex, bids are more challenging and customer priorities are changing. The need for newer technologies, such as composites for more fuel-efficient aircraft, will continue to grow. Aerospace companies also have to manage regulatory requirements to make sure design and manufacturing practices are documented and traceable. The need for greater program performance has never been so critical for aerospace and defense companies. To win business in today's highly competitive environment, aerospace companies must submit attractive bids that also include the demonstrated ability to deliver on program targets, requirements and production schedules. This is not an easy task and requires reinventing the way programs are managed from initial concept all the way through delivery.

Aerospace and defense companies are trying to find a more efficient way to enhance collaboration between design and manufacturing. The industry needs a process-driven product lifecycle management (PLM) approach to include manufacturing engineering in every aspect of program development. This can drive profitability, reputation and prove the firm's ability to drive successful program execution.

Siemens Digital Industries Software's Product Realization solution for the aerospace and defense industry provides a process-driven approach to shift product and manufacturing decisions to early in the lifecycle so you can validate the manufacturing feasibility of aircraft systems during the design stage.

The changing global aerospace and defense industry

Program complexities

Increasing program complexity is one of the reasons most aerospace companies suffer delays and financial losses during the execution of major programs. The issues arise because aerospace systems are becoming more sophisticated and challenging. Large programs are managed on a global scale with original equipment manufacturers (OEMs) and suppliers finding it difficult to efficiently manage systems integration. Poor program management, shortages of skilled labor and lack of understanding of requirements are some of the key contributing factors that lead to program failures. Also, aerospace customers are demanding greater innovation and fuel efficiency in products. With increasing regulation in greenhouse gas emissions, the need for lighter materials and advanced propulsion techniques will continue to grow in the near future. All these issues drive product and program complexities and, therefore, new approaches to program execution strategies are necessary to win in the current aerospace industry environment.

Poor program performance

The aerospace and defense industry is under a tremendous amount of change. A majority of those programs across the industry are either over budget, late or both. Poor program performance will weigh heavily as new opportunities may be penalized based on past performance. There are a greater number of competitors both foreign and domestic competing for a fewer number of programs. This makes winning or losing the next program even more important. Nowadays, aerospace defense contractors are required to demonstrate cost and risk mitigation abilities to win business. The advantage will also go to those who are nimble and opportunistic in recognizing changing defense priorities and pursuing the resultant opportunities. All these require a fundamental change in terms of pursuing programs and manufacturing strategies to operate profitably at lower production rates. All elements of program cost, such as direct labor, material and overhead, should be accurately predicted and managed to demonstrate program affordability to government customers.

Increasing global competition

The global commercial aerospace sector is the key growth sector, and is driven by increased production demand at the platform level as well as for retrofit components. Increasing passenger travel demand and the replacement cycle of older generation aircraft will contribute to the biggest growth in the aerospace industry. However, competition is intense with the entry of new, lower cost and more responsive providers, including the migration of companies from defense to commercial markets. To win bids and deliver successful programs requires aerospace companies to maximize resource utilization, aggressively pursue program bids and make sound investment decisions in design and manufacturing capabilities.

Strategies for profitable growth

The implications of a changing customer base and program performance requirements will impact aerospace and defense industry practices in the upcoming years. Aerospace companies must revisit their strategic imperatives to stay competitive and capture value.

Cost containment

The pressure on established providers to become dramatically more efficient at reducing costs while increasing production flexibility will be unrelenting. These cost and flexibility needs include not only capabilities for managing more build variations in production, but also the need to evaluate and adopt alternative or new materials and manufacturing processes to reduce costs. Today traditional cost management approaches are not enough, and in an era of growing demand for more innovation in the industry, just slashing the operational cost is not a recipe for success. Good investment decisions should capture efficiencies from existing resources. This requires aerospace companies to perform a strategic evaluation of their cost structure. The idea is to reduce cost drivers by proper program planning. Poor program management and late stage cost buildup are the most significant contributors to inefficiencies. Such cost drivers are completely avoidable.

Aggressive program pursuit

To win business in today's environment, contractors need to submit more attractive bids. Aerospace customers need to know that the program can be executed within budget, timing and performance requirements. This forces the industry to reinvent the way program proposals are pursued and bids are submitted. Winning bids are typically the ones that can prove that manufacturing capabilities exist to build the product as per the specifications. Conversely, aerospace companies must evaluate the program viability during the bid process and pursue only those that are profitable.

In addition, the established reputation of program performance is, and will continue to be, an essential requirement for a company to win new contracts. A strategic approach to pursuing programs with early analysis of manufacturing viability is critical for making the right investment decisions and winning larger and more profitable contracts.

Risk sharing with suppliers

In the aerospace industry, transfer of subsystem and component development to suppliers is growing. Considering the growing number of smaller contracts, this is a critical risk mitigation strategy adopted by most aerospace OEMs. Reliance on supplied parts helps to minimize capital investments, better manage inventory levels as well as share research and development (R&D) costs. On the other hand, complexities in aerospace systems present unique supplier integration challenges during product development. Successful supplier collaboration requires product data and manufacturing information, such as 3D design data, quality parameters and any tooling information, to be seamlessly shared. The need to accurately trace part numbers and bill-of-materials (BOMs) for compliance and regulatory requirements brings additional challenges. Therefore, using integrated processes to enable co-development of components between OEMs and suppliers can significantly improve program profitability for all parties.

Key enablers for driving program execution excellence

In order to contain cost, pursue bids more successfully and drive program execution excellence, aerospace and defense companies must embrace a more efficient way to enable collaboration between design and manufacturing. The need to fully understand the manufacturing implications of multiple design alternatives is an important element of program success. Enabling early involvement of manufacturing engineering in the assessment of design alternatives, accurate planning for on-time project launch and effective communication with the shop floor are all examples of opportunities for companies to shift left the integration of the manufacturing definition in the product development process.

With the shift-left strategy, the program team can make manufacturing decisions concurrently with the evolving aircraft design. Design and manufacturing gain early access to prerelease data so critical decisions are made in a collaborative manner. It is more efficient and cost effective when design and manufacturing engineers are given the opportunity to optimize program performance before investment decisions are locked in. The chart below shows that early in the lifecycle we have more flexibility to change designs with less cost impact. As we move forward in the program lifecycle, it becomes cost prohibitive to change decisions.

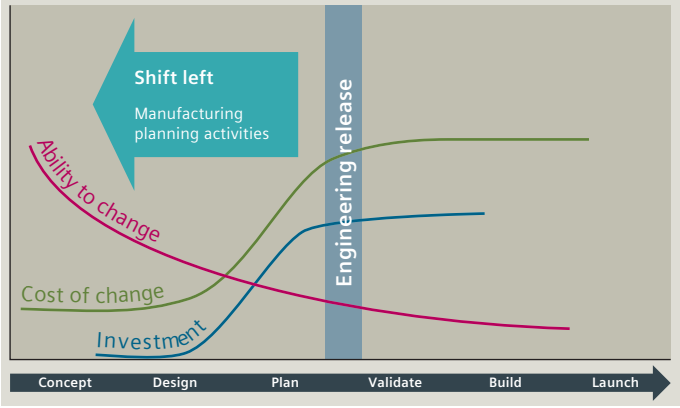

Figure 1: Shift left program decisions are a critical initiative for aerospace companies.

The opportunity to optimize the product design not only for performance but also for manufacturing requirements can help the program team better control unit costs, production rates and facilities planning for both the aerospace company and its suppliers. This consideration, or shift-left strategy, helps to reduce the number of program changes and ensures a smooth transition from development to production.

Program teams that consider manufacturing early on are more likely to take advantage of new materials and technologies such as composites, additive manufacturing, near-net shape forming and complex parts machining. However, aerospace companies still struggle to find a solution that is capable of providing a single collaborative platform for conducting design, manufacturing planning and production activities. Typically, design and manufacturing applications are separate tools representing data in different constructs and, therefore, real-time collaboration is never achieved. Aerospace companies try to connect the disparate systems with ad hoc integration modules, but that has been an inefficient approach.

Therefore, the question is how can next-generation PLM solutions for aerospace and defense help program teams collaborate more effectively during the product realization process?

Product Realization solution supports program execution excellence

For more successful program execution, the aerospace and defense industry needs a process-driven PLM approach to bring manufacturing engineering into every aspect of program development. This approach must start early in concept evaluation and continue all the way through production and delivery. When manufacturing is involved at every stage of the program and participates in decision making in an immersive way, the likelihood of program execution success increases exponentially. Therefore, integrating design and manufacturing during product realization is critical for aerospace companies to execute programs on a global basis.

The exhibit below describes a common approach to Product Realization in the aerospace industry. The intent is to include manufacturing at every stage of the program execution process. We can highlight key capabilities that the Product Realization solution provides for support at each stage.

Program pursuit and planning

Pursuing program contracts efficiently is the most critical activity for aerospace companies. Rapid evaluation of different concept designs, validation of requirements and estimating program profitability is critical for submitting winning bids. Consider if a firm's manufacturing requirements, such as quality, timing, cost, tooling and materials, are evaluated for each concept design; then it can significantly improve bid quality. It gives customers the confidence that program objectives can be met on time and within budget. A solution must support this critical stage of program execution by providing the following capabilities:

- Evaluate alternative manufacturing processes, tooling concepts and quality schemes using a common environment for all manufacturing information
- Drive re-use of best practice processes, resource libraries and manufacturing expertise from previous programs
- Perform simulation of different production alternatives and validate if the customer delivery schedule can be obtained while considering capital investments
- Perform early factory layout planning, throughput analysis, tooling requirements and automation planning for concept viability

The objective of this stage is to provide program management with answers on how manufacturing can support budget and schedule during the bidding process. Using a single environment for design and manufacturing process management, aerospace companies can now evaluate design concepts and select the best alternative that meets program design requirements, costs and schedules, thereby increasing the likelihood of winning the bid.

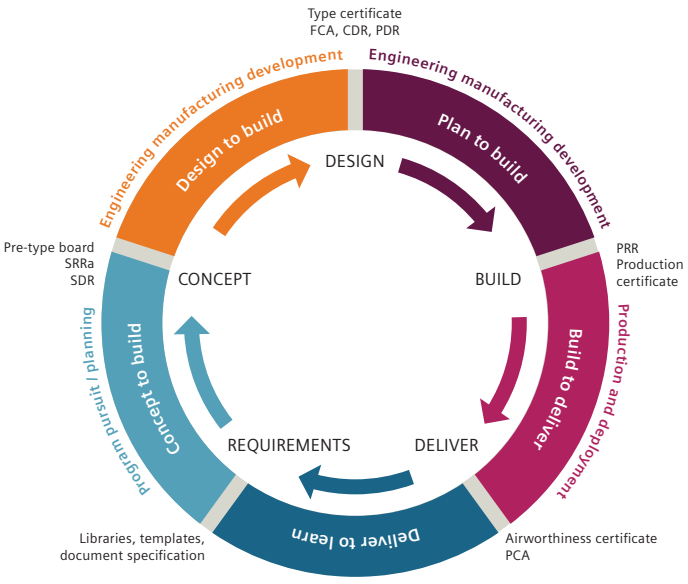

Figure 2: Product Realization process for aerospace and defense.

Engineering manufacturing development

Once the program is awarded and the decision is made to move forward with a particular design concept, it is time to begin detailed design of systems and subsystems, including manufacturing process definitions for building the product. During the design-to-build phase, design and manufacturing engineers collaborate on prereleased data and perform design-for-manufacturability tradeoff studies to identify potential design as

well as process or tooling issues. At this stage of preliminary design review (PDR), close collaboration between design and manufacturing ensures that released design data is ready for manufacturing planning.

The following plan-to-build phase is when detailed manufacturing planning of fabrication and the assembly process is performed in more detail. Aerospace companies define manufacturing BOMs, routings, numerical control (NC) programs and other automation planning. A single integrated Product Realization environment provides a transition from design release to detailed manufacturing planning with solutions capabilities that enable you to:

- Provide a common environment to manage engineering as well as manufacturing BOMs, providing full associativity between design and manufacturing information
- Capture manufacturing impact due to design changes using powerful search and accountability analysis tools, enabling you to take the necessary corrective steps in a transparent way
- Identify long-lead materials and components and align purchasing activities accordingly
- Configure 3D work instructions automatically based on the exact process steps

Production and deployment

When program execution reaches this stage, it is essential to enable a seamless transition from planning to shop-floor production. If data integrity is not maintained, design intent can be missing from production and quality parameters. Therefore, an integrated environment is necessary at this stage of transition from planning to fabrication and assembly. This ensures that as-designed, as-planned and as-built BOMs are consistent and reconciled. Managing planning and production in a single environment reduces shop floor errors and ensures traceability for the purposes of compliance and regulatory requirements. Solution capabilities needed in this stage include:

- Delivery of seamless 3D work instructions from PLM to manufacturing execution systems (MES) with capabilities to capture markups and review feedback from the shop floor to planning
- Integration of quality inspection using 3D design models, including coordinate-measuring machine (CMM) inspection programming, execution and analysis software
- Delivery of measured quality data from the shop floor in the same PLM platform. Support real-time collection, storage, management, reporting and analysis of shop floor quality data
- Shop floor access to current and released computer numerical control (CNC) programs, drawings and 3D models with browser-enabled applications. This ensures correct manufacturing data is used on the shop floor when CNC programs are delivered directly to the machine controllers.

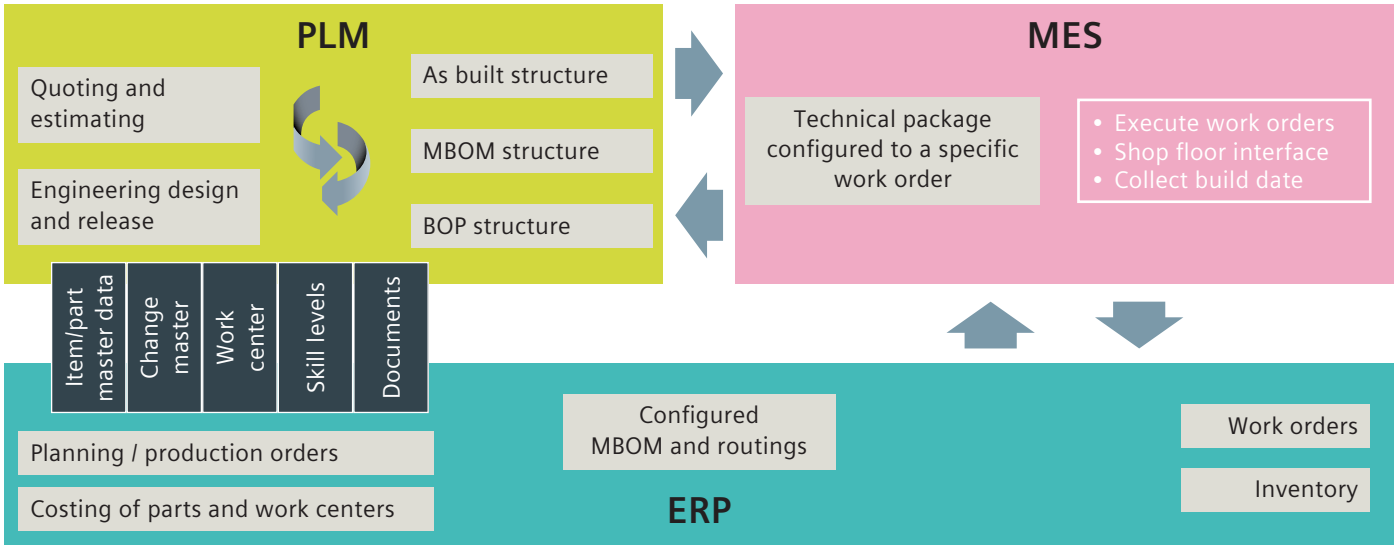

Figure 3: Leading practice, an integrated PLM-ERP-MES architecture.

The aerospace and defense Product Realization solution from Siemens Digital Industries Software

Siemens Digital Industries Software provides Product Realization, an integrated, industry process-focused solution for aerospace manufacturing. Product Realization is used in a single environment that brings together manufacturing processes to coincide with the design (concept to execution) to reduce the number of costly late changes and failures during the build cycle of a program. The early and concurrent involvement of manufacturing engineering in assessing design alternatives (shift left) drives accurate planning for on-time project launch and effective communication with the shop floor. By leveraging 3D design and simulation technology during the early phases of product design, alternatives can be efficiently managed to predict better manufacturing costs and durations.

Conclusion

Aerospace and defense companies are facing significant competitive pressure due to shrinking margins and a declining number of new programs. Furthermore, aerospace customers are becoming more demanding and seeking greater accountability on program performance. To compete and maintain profitability, aerospace companies need to rethink their PLM strategies. To gain greater clarity on program decisions and their impact on cost, timing and quality, aerospace companies must make manufacturing an integral part of the program development process.

Manufacturing must be involved from the very early stages of concept development to ensure bids are submitted based on sound information. Once the program is awarded, design and manufacturing teams must closely collaborate so program requirements can be achieved during production. Last but not the least, aerospace companies must strive to integrate planning tools with shop-floor applications. This will ensure as-built information matches as-designed and as-planned data.

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Siemens Digital Industries Software

Headquarters
Granite Park One
5800 Granite Parkway
Suite 600
Plano, TX 75024
USA
+1 972 987 3000

Americas
Granite Park One
5800 Granite Parkway
Suite 600
Plano, TX 75024
USA
+1 314 264 8499

Europe
Stephenson House
Sir William Siemens Square
Frimley, Camberley
Surrey, GU16 8QD
+44 (0) 1276 413200

Asia-Pacific
Unit 901-902, 9/F
Tower B, Manulife Financial Centre
223-231 Wai Yip Street, Kwun Tong
Kowloon, Hong Kong
+852 2230 3333

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