



The Prospect of Digital Transformation



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The U.S. Air Force's new T-7A Red Hawk aircraft is a sleek, efficient pilot training platform with fighter-like capabilities. Using digital twin and digital thread technology to model and manage the design/build process, development partners Boeing and Saab were able to take the plane from concept to wheels-up in just 3 years—that's 2 years faster than the industry average of 5 years.

While that's impressive, the partner companies also reported that their use of digital tools in the process enabled a 75% increase in engineering quality, an 80% reduction in assembly hours, and a 50% reduction in software development and verification time on the Red Hawk project.

Taking the digital leap in the design, build, test and maintenance of complex products and systems, like aircraft, can transform the development process from beginning to end and can allow significant benefits in productivity and ROI across the business model. From aerospace companies to construction firms, organizations across industries are finding that digital transformation can do the same for them.

In a recent study focused on aerospace companies, industry consultant Accenture noted that "Companies that embrace digital at the core of their business achieve up to four times improvement on their digital investments than other industry players. Their digital returns even beat the industry average for returns on overall invested capital."

When implemented correctly, the move to digital can drive efficiencies that solve short-term problems while providing a foundation to achieve long-term business goals. A well-planned digital roadmap can allow for incremental system improvements along with their resultant gains. This approach can reduce the risk involved when companies attempt to take on too much change at once.

One area ripe for the benefits of digital transformation is the aerospace product development process. Incremental improvements achieved by the move to digital, like the Red Hawk example, have shown concrete results in the ability of companies to get products to market faster, maintain product quality, achieve design goals, and simplify requirements traceability.

Digital Twins and Digital Threads

There are two primary areas where digital transformation is helping to streamline the product development process:

- From a design perspective, engineering departments can create virtual products, known as digital twins, that mimic the characteristics of a physical object or system. This permits the manipulation and testing of design and performance specifications prior to manufacturing, saving time and prototyping costs.
- From a traceability perspective, a digital product development process also establishes a digital thread, which is a data and communications framework connecting the various elements of a product's lifecycle from design, test, and manufacturing, through maintenance and even de-commissioning or disposal. This enables productive communication and collaboration among the various lifecycle participants and allows for full traceability in audits.



Digital twins and digital threads form the backbone of the modern product development process. Their features and benefits have led an increasing list of companies to explore their use across the aerospace industry, however, the move to digital reinvention can be a challenging decision for some. In fact, in a recent study co-sponsored by McKinsey & Company and the Aerospace Industries Association (AIA) just 35% of aerospace companies reported the use of digital technology to refine their product designs or improve their engineering function. While the digital transition effort can look sizeable at the outset, the rewards can be impressive.



A Bit of History

The design of modern aircraft has been somewhat paperless since the 1990s with the growth and acceptance of model-based CAD systems in engineering and CAM systems on the factory floor. The early adoption of digitization in R&D and design departments was largely due to the complexity of the systems being developed and the need for speed-to-market while simultaneously meeting increased demand for system performance.

As Dale Tutt, VP of Aerospace and Defense at Siemens Digital Industries Software noted in a recent SAE International article, “Aerospace programs are increasingly more complex, and products are highly integrated and dominated by software and software-hardware hybrids. Addressing the rise of electrification, new technology, and new business models also contributes to growing complexity.”

The next steps in the complete digitization of the development process, however, have already been taken by some future-focused companies, as in the Boeing/Saab partnership on the Red Hawk trainer. Design and production numbers like this demand attention, and that attention is being given by companies seeking system-wide improvement. As professional services firm Deloitte noted in a recent report, “Digital technologies can open new opportunities for innovation in the aerospace and defense industry by not only reducing the time to design, develop, and commercialize new products, but also by providing insights and ideas from different stakeholders that feed back into the development cycle”.

Integrating Crucial Information at Critical Timepoints

Lockheed Martin integrates many diverse data threads from its connected systems, calling this process a “Digital Tapestry” that it uses to design and develop components and entire programs. One crucial aspect of making a system-wide “digital tapestry” solution work is the integration of outside data assets, like consensus engineering standards, that are an important part of design, development, certification and maintenance processes.

Engineering standards, the documents that provide accepted part and process specifications and requirements, are used throughout the course of product design and development and into maintenance, repair, and update operations. These standards have historically been disseminated as paper documents or PDFs. For digital threads and digital twins to achieve their full potential across the enterprise, this crucial information must be available on demand, integrated with accuracy, and presented in the most recent versions. The use of a robust digital standards system can meet these needs.

In current SAE International research on standards use across the aerospace industry, engineers noted these following shortcomings with their existing digital systems:

- There are too many transcription errors resulting from the manual extraction of numerical and textual data from standards.
- It is difficult to discover standard parts to drive down materials costs, remove redundancy, and limit low-volume orders.
- There is insufficient system integration to capitalize on cost synergies, especially in companies with high acquisition strategies.
- It is challenging to improve workflow performance and operational efficiencies dependent on the exchange of normalized data.

As an engineering participant in this SAE International research noted in an interview, “Use of standards and looking up guidance is a large part of the work we do. Mechanical testing, materials specification and comparison to proposed supplier standards is a common topic.”

The Benefits of a Digital System

Sikorsky Aircraft says that today, its design engineers interact digitally with maintenance personnel to share perspectives on servicing, accessibility, ergonomics and parts replacement for new designs. This allows for the development of maintenance procedures on aircraft at the design stage. The ability to reference applicable engineering standards data throughout a process like this can be critical to its success. A digital standards system, and the benefits it can provide, is the intelligent solution.

The use of a digital standards system as part of an overall digital design and development process can offer several benefits and significant productivity improvements to the enterprise, including:

- Increased efficiency
- Improved quality and compliance with easier change management
- Reliable accuracy
- Intelligent search
- Ease of integration

Let's take a look at each of these benefits in the context of a digital standards system.

Increased Efficiency

Engineering teams are challenged with developing, building and testing product designs that must meet internal requirements as well as requirements in one or more standards that are documented in static PDFs. The cross-referencing and traceability of requirements is difficult, and engineers may not be made aware when a standard is updated. A digital standards system offers the full benefits of the digital world, not just a static reference. Engineers can pull digital standards (text, figures, and tables) directly into their engineering tools and documents, reducing the number of cross-references to account for in design documentation. Directly feeding digital standards data into an existing ERP or PLM system can streamline workflow and minimize the manual task of searching for data, thus freeing time for users to focus on other development work. Users are automatically notified when a standard is updated, eliminating the need

to manually monitor for updates. Digital standards also significantly streamline the creation and traceability of test cases to requirements. Access to the newest standards covering emerging technologies can also save research time.

Digital standards data can be accessed anytime by the various business units in an organization with no interruptions. This real-time data access breaks down barriers and data silos and ensures access to consistent and most up-to-date standards data across all relevant business units, saving time and reducing duplication of effort.

Improved Quality and Compliance with Easier Change Management

When using traditional standards, engineers must either cross-reference requirements in standards documents or transcribe requirements into their existing documents, ERP, or PLM systems. This can lead to costly errors. Using a digital standards system can reduce problems due to transcription errors or using out-of-date standards, ensuring the accuracy of designs prior to manufacturing. Access to consistent standards data across an organization can also benefit quality improvement systems.

Digital standards can provide a more auditable record to ensure compliance to industry regulations and testing. During the lifespan of an aircraft (or any motorized vehicle), maintenance and updates may be numerous to keep systems viable and operations within safety specifications. Tracking changes over time and referencing the many standards used in the process can be difficult and prone to error. If the information from a standard is integrated in, or referenced by a secondary document, the information must be maintained. Service or repairs must be documented, and traceability in an audit is critical. A digital standards system includes automatic updates to the latest version, plus a history of document changes, so the data required is readily available.



Reliable Accuracy

Engineering standards in a digital standards system are reliable, accurate, and kept up to date by authoritative sources (like SAE International) and by an established and accepted process of development and update. This helps support fully auditable digital threads by integrating the standards content into the product development tools that engineers use every day.

Intelligent Search

Digital standards systems must come equipped with robust search engines to find the right standard. The search criteria should be specific to the type of standard being researched and allow users to narrow down the results by adding detailed filters. The search functionality should be supported regardless of whether the user is interfacing directly through the product or through an API. Users should be able to quickly locate applicable standards for new designs, parts, materials, existing system upgrades, or ongoing maintenance.

Ease of Integration

A robust digital standards system is interoperable and can be integrated into any system to exchange and use information without restrictions, saving up-front programming time and cost. Digital standards systems should provide integration options, such as web interfaces with download of content or API integrations that interface directly with the tools engineers are using.

SAE International – A Leader in the Digital Transformation Movement

SAE International is a standards development organization that works closely with the aerospace industry to develop and maintain robust standards with highly integrated usage. SAE International is also leading the charge to leverage the power of a digital standards system by developing SAE OnQue™ Digital Standards System, a cloud-based, centralized digital standards control and distribution solution offering access to a library of SAE International digital technical standards. OnQue can also be extended to house internal standards for customers. It is compatible with multiple operating systems and can be available across the various functional departments of an enterprise. All textual content, figures and tables within the individual standards are included and are fully searchable.

OnQue Delivers on Digital Benefits

Some of the features and benefits of the OnQue system are outlined in the following table.

Feature	Benefit
Search functions for parts and materials, query by attributes	Easily find standards connected to renderings. Extract individual requirements.
Real-time updates and notifications of updated standards	Ensure information is up-to-date and accurate.
Flexible integration options	Use either intuitive web interface or leverage APIs so users can query OnQue from the tools they use every day.
Consistent content structure	Standards data is more structured in a consistent format to enhance searchability and referenceability
Similarity Search	Find parts or materials that meet specific attributes or requirements to find similar parts or materials that meet your specific needs.
Verified content	Content is backed by technical experience of SAE International.
Extensible	Internal company databases can be incorporated into the OnQue system allowing customers to leverage one source for traditional standards data and internal standards

Summary

Digital transformation technologies are available today to enhance the product engineering, production, and service functions of complicated systems, like aircraft. Teams using them can take advantage of task automation provided by the digital system to capture time for more creativity, innovation, and problem solving along with cost reduction and other increased efficiencies.

Industry consensus standards, like those developed by SAE International, are pools of knowledge, requirements, best practices, and guidance that are critical to all facets of the aerospace industry. Their broad usage also makes them an integral component of any digital thread strategy that aims to elevate productivity across an enterprise. The embrace of a digital standards system, like SAE International's OnQue, within and across an organization's digital product management system, can allow the critical information contained within standards to be efficiently located, searched, communicated, updated, revised, and tracked throughout the entire product lifecycle.

SAE International, a pioneer and leader in authoritative standards development and delivery technology, can function as a key partner in building a complete digital solution for every type of need. To learn more about SAE International's OnQue Digital Standards System, go to sae.org/onque-digital-standards.

Additional Resources

SAE International is a global professional organization serving the aerospace, automotive and commercial vehicle industries. It is the largest international body for aerospace and ground vehicle consensus-based standards development. In addition to consensus-based standards, SAE International also publishes technical papers, professional journals, digital document solutions like OnQue and SAE MOBILUS, and produces and hosts technical conferences and meetings throughout the world.

These influential tools are available to working professionals, academic members and related groups to aid in the dissemination of important research and provide practical solutions for the mobility engineering field.

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Toll-free: +1.877.606.7323
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Fax: +1.724.776.0790
Email: CustomerService@sae.org