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Case Study

Dassault Aviation

Using a Collaborative Workspace to Design and Develop the Falcon 7x Business Jet

By Geoffrey E. Bock
March 2004

Prepared for IBM Corporation

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Executive Summary

A major player in the global aviation industry with more than $3.9 billion in sales, Dassault Aviation—headquartered in Saint-Cloud, a suburb of Paris—does business in more than 70 countries on five continents. In the highly-competitive markets for both military and executive aircraft, the company is at the cutting edge of technical innovation and aviation system expertise.

Faced with continuing competition to develop a high-performance executive aircraft, Dassault Aviation launched the Falcon 7x, designed with a range of 5,700 nautical miles and a top speed of mach 0.9. To gain market share and capitalize on the new airplane's advanced features, the company needed to begin deliveries of the Falcon 7x by 2006. To reduce the time required to develop the aircraft—typically a seven to nine year effort that the company had to reduce to four to five years—Dassault Aviation had to transform the ways in which it designed, developed, and delivered a next-generation aircraft. The conventional method of building components serially, physically testing them, and then moving on to the next set of components was too slow and expensive. Rather, Dassault Aviation elected to work closely with selected business partners to collaboratively co-design entirely new components and subsystems in a cost-effective, parallel, and fully digital way that eliminates physical prototypes. In what amounted to a major paradigm shift, the company needed a new approach for the design and deployment for the Falcon 7x that would provide Dassault Aviation and its worldwide partners with a strong, resilient collaborative platform for component and subsystem design.

To accomplish its goals, Dassault Aviation turned to IBM and Dassault Systèmes. Working together with Dassault Aviation, this extended team produced and delivered a Product Lifecycle Management (PLM) platform that integrates a collaborative workspace with core engineering systems. This approach allows Dassault to collaborate with its partners in real time, minimizing design/development errors and decreasing costs associated with physical component design and business travel. Major productivity gains are enabling Dassault to decrease the time-to-market plan by approximately 30 percent.

IBM provided the hardware and middleware (WebSphere® and DB2®) for the technology infrastructure. Capable of managing the lifecycle of a complex product such as a business jet, the PLM platform was developed in conjunction with Dassault Systèmes and Dassault Aviation. It includes Dassault Systèmes products: CATIA® and ENOVIA™ VPM for collaborative product development.

A Major Player in the Global Aviation Industry

Company Background

Dassault Aviation is a major player in the global aviation industry with more than US$3.9 billion in sales and 12,000 employees. Headquartered in Saint-Cloud (a suburb of Paris), the company does business in more than 70 countries on five continents.

In the competitive markets for both military and executive aircraft, Dassault Aviation is at the cutting edge of technical innovation and aviation system expertise.

Launching the Falcon 7x: Pushing the Limits of Aviation Engineering

A New Aircraft Platform

Faced with continuing competition to develop a high-performance executive aircraft, Dassault Aviation announced a new initiative in May, 2001—the Falcon 7x. Rather than enhance and upgrade its existing product line, Dassault Aviation concluded that it needed to produce a "next generation" airplane, one that would incorporate superior avionics, cockpit controls, safety, and performance.

The company decided to introduce a state-of-the-art business jet—featuring a stronger, yet lighter, air frame; an advanced technology wing design; and (in a first for an airplane in its class) a fly-by-wire control system. Dassault Aviation would target the most promising segment of the executive aviation market by producing a high-end, very long-range business jet. The Falcon 7x would have a maximum range of 5,700 nautical miles and a top speed of mach 0.9. It would ensure that Dassault Aviation remained a premier supplier of business jets for the coming decade.

Twin Business Challenges

To gain market share and capitalize on the new airplane's advanced features, time-to-market was critical. Dassault Aviation needed to develop the Falcon 7x in the record time of four to five years. The airplane would begin its test flights by mid-2005, and the company would begin deliveries to customers by 2006. The company planned to ramp up production quickly in 2007 to deliver about 20 to 30 aircraft per year for the remainder of the decade.

But Dassault Aviation had to meet twin business challenges—an accelerated schedule for a technologically sophisticated airplane, designed at an affordable cost. The company could no longer operate as it had in years past. It needed to transform its design and development processes and also reduce its engineering design costs. In effect, the company needed to reduce total design costs and production time by 50 percent over established Dassault Aviation norms.

Rather than relying on existing technologies and procuring off-the-shelf parts from suppliers, Dassault Aviation needed to work closely with selected firms, its business partners, to design and develop entirely new components and subsystems. The companies needed to work together, in parallel, to co-design and co-develop entirely new components and subsystems. Dassault Aviation also needed to increase the reuse of standard parts for cost savings, where appropriate. There was no place in the schedule—

and certainly not in the budget—for building each component of the Falcon 7x one piece at a time.

To win in the executive aviation marketplace, the Falcon 7x would push the limits of aviation engineering. It would be based on promising new technologies, produced by Dassault Aviation and its key business partners, who would be able to cost-effectively collaborate with one another during the design process.

Becoming a Resilient Aircraft Manufacturer

Dassault Aviation needed to develop extensible, collaborative business processes, supported by an underlying open-standards-based information infrastructure, for co-designing and co-developing aircraft components and subsystems with business partners. In effect, Dassault Aviation needed to become a resilient executive aircraft manufacturer.

The company had to focus on its core competency for assembling and manufacturing executive aircraft. It needed to leverage the expertise of its business partners to deliver the advanced component parts and subsystems that would ensure the success of the Falcon 7x. Dassault Aviation needed to create a fully digital engineering environment where design teams from many partner companies could easily work together to design the components and subsystems for the Falcon 7x. These design teams would engineer and test their components and subsystems electronically, without building the physical models. In so doing, they would be able to complete their development tasks more rapidly, saving both time and money.

Key Components

SOFTWARE

- IBM WebSphere Application Server
- IBM WebSphere Business Integration
- IBM WebSphere Portal
- IBM WebSphere Studio Application Development
- IBM WebSphere MQ
- IBM DB2 Universal Database™
- CATIA
- ENOVIA VPM

SERVERS

- IBM eServer™ pSeries™

IBM BUSINESS PARTNER

- Dassault Systemes

Product Lifecycle Management

Specifically, engineers from different firms needed to collaborate with one another on the detailed design for the Falcon 7x. They needed to easily simulate and test the parts and components they were designing digitally, in a virtual work environment, without investing time or money in physical models. These engineers had to share complex

technical information, in which design parameters for component parts were likely to change. Dassault Aviation needed a Product Lifecycle Management (PLM) platform that included both powerful 3-D computer-assisted design (CAD) tools for aviation engineering and an integrated, collaborative workspace where the company could manage the interactions and dependencies among its different business partners.

Dassault Aviation engineers needed to be able to quickly determine how a modification to one component would affect another using the digital mockup capabilities of a digital, virtual design environment. When there was a conflict, they needed to be able to communicate rapidly with design partners, to exchange relevant information and to resolve the conflict. Dassault Aviation engineers needed to keep track of all the changes and ensure that the project remained on schedule. To do this, they had to work closely with technical specialists in partner firms to coordinate design activities.

Moreover, Dassault Aviation needed to protect both its own intellectual property and the intellectual property of its business partners. Business processes and operational procedures had to be in place—supported by the underlying information infrastructure—to ensure that the design expertise and technologies of one business partner would be shared with others only on a need-to-know basis.

Transforming the Business Processes for Engineering the Falcon 7x

From Supplier Relationships to Partnerships

To get the Falcon 7x into the air and begin flight tests in an accelerated timeframe, Dassault Aviation had to transform its business processes and engineering design methodologies for producing executive aircraft. The company no longer had the luxury of time to design and specify the various components and subsystems, then develop the technical requirements definitions, and finally seek bids from suppliers. Instead, Dassault Aviation needed to form business partnerships with selected firms, to co-design and co-develop the required components and subsystems. Neither Dassault Aviation nor its business partners had a complete definition of what was required. All needed to pool their knowledge and expertise and share the development risks.

To accomplish these critical objectives, Dassault Aviation turned to IBM and Dassault Systèmes (a company of Dassault Group and also an IBM Business Partner) to architect, design, and deploy the PLM platform that enables aviation engineers from Dassault Aviation and its worldwide design partners to collaboratively design the Falcon 7x. Consequently, Dassault Aviation needed to build the Falcon 7x, not through contract-driven supplier relationships, but rather through collaborative, process-driven and information-driven partnerships with leading manufacturers of aviation components and subsystems. As the prime aircraft manufacturer, the company had to manage and synchronize the engineering activities among partner firms. Dassault Aviation needed to ensure that its aviation engineers and those of its business partners could easily communicate, coordinate, and collaborate with one another on all aspects of the Falcon 7x design.

A Virtual Platform for Product Lifecycle Management

The key to success revolved around the aviation engineers' abilities from separate firms to share detailed design information on a timely, need-to-know basis—as if they were working for a single (albeit virtual) company. Dassault Aviation decided to invest in a collaborative information infrastructure, based on an extensible PLM platform.

Dassault Aviation decided to automate the workflows that supported the aviation design processes to ensure that engineers from multiple firms could easily co-design components and subsystems. Dassault Aviation decided to rely on an information intensive, collaborative workspace that enabled engineering teams to communicate remotely on the design of aircraft components, across the network, and to share information as required. The virtual PLM platform ensured that engineers could work together from a distance, at their own business locations, and not have to be co-located in a single place to access and exchange mission-critical information.

Focusing on the Information Infrastructure

Dassault Aviation focused on providing the enabling information infrastructure—together with appropriate computer-based tools for Product Lifecycle Management—to define and implement the multi-company business processes based on industry-leading best practices. The PLM platform ensured that Dassault Aviation could:

- Manage security and protect the intellectual property of the separate firms in a rigorous and systematic manner
- Automate the business processes for managing the interdependencies among the component and subsystem designs produced by engineering teams in different companies
- Automate the process of sending PLM changes to partners, only sending the changes to minimize network costs and elapsed time
- Automate the business processes for maintaining and updating the bills of materials that define the parts within components or subsystems of the Falcon 7x

Resolving design conflicts and managing the dependencies in parts and components definitions—business processes that heretofore took weeks or months to complete—could be accomplished in a matter of days. All of the essential data and information required for co-designing and co-developing the Falcon 7x was maintained by the collaborative workspace, based on the PLM platform.

Delivering the Collaborative Workspace

The Need for a Distributed Work Environment

The design and development activities for the Falcon 7x project began in September, 2001. For the first eighteen months, 210 engineers from Dassault Aviation and 170 engineers from partner firms worked together in Saint-Cloud on the initial design phase of the aircraft. They used a collaborative workspace in which they could readily communicate and share the results of their design activities.

Dassault Aviation required a solution that enabled technical information sharing, one that could track the exchange of data among partners. Since much of the information was confidential, Dassault Aviation needed a highly-secure work environment. In addition, the company required a reliable solution with high availability, one that was capable of managing large data files (1GB to 4GB in size).

Furthermore, to reduce travel and lodging costs, to leverage the expertise of its business partners, and to accelerate aircraft design activities, Dassault Aviation needed to create a distributed, albeit virtual, collaborative workspace. This workspace enabled engineers within partner firms to access technical information on the Falcon 7x project from their home offices. Dassault Aviation began to deploy a distributed version of its collaborative workspace in March, 2003, when the detailed design phase for the Falcon 7x began and when many more engineers within partner firms became involved in the project.

No longer co-located, engineers in different firms continue to work together at a distance. Rather than logging onto the central environment maintained in Saint-Cloud over an extranet, engineers in partner firms are using comparable PLM platforms in their home offices; these platforms provide access to a replicated portion of the shared repository.

IBM and Dassault Systèmes

Dassault Aviation relies on a PLM platform jointly developed and delivered with IBM and Dassault Systèmes. IBM provides the technology infrastructure, including the hardware and middleware. Dassault Systèmes is the PLM solutions provider and delivers the specialized expertise for implementing and deploying the application environment.

Capable of managing the lifecycle of a complex product such as a business jet, the PLM platform was integrated by Dassault Systèmes and Dassault Aviation. It includes CATIA and ENOVIA VPM, products by Dassault Systèmes and IBM.

- CATIA provides the advanced, 3-D modeling tools for designing aviation parts, components, and subsystems. Engineers visually mock-up the parts, assemblies and components that they are assigned to work on, reuse previously designed items, and determine the design parameters for the resulting assemblies. Moreover they can produce designs based on predetermined sets of constraints.

- ENOVIA VPM provides a platform for collaborative product development. This is a platform for managing all of the component and subsystem designs that engineers working on the Falcon 7x project produce. ENOVIA VPM tracks changes, and automatically maintains the bills-of-materials that identify the parts within components or the components within subsystems. It provides a decision support environment that manages the dependencies of components and subsystems. It ensures that the entire aircraft design is under configuration control to retain product knowledge and to reduce redundancy of information.

- IBM WebSphere Business Integration, WebSphere Application Server, WebSphere MQ, and IBM DB2 Universal Database provides the secure flexible information infrastructure. IBM WebSphere Business Integration and WebSphere MQ, in particular, provide the integration infrastructure for synchronizing the frequent data

exchanges between Dassault Aviations and its business partners. ENOVIA VPM application manages data stored within DB2 databases. WebSphere Studio Application Development is used to develop the WebSphere applications.

- IBM eServer pSeries systems are used as servers and workstations. Servers are for application development, data management, business process execution, Web-based applications, and licensing. The workstations are used by the engineers for their product development and include embedded business processes for the virtual design activities. Compute-intensive activities run on the workstations at night, to maximize the use of hardware and software investments as well as to accelerate the exchange of design data between Dassault Aviation and its business partners.

The Business Value of a Seamless Environment

The PLM platform, as a whole, identifies, stores, and manages the product configurations and design alternatives for the components and subsystems for the Falcon 7x project. Together, CATIA, ENOVIA VPM, WebSphere, and DB2 ensure model generation, management, and the synchronization of design changes. In addition, Dassault Aviation relies on an extensive collaborative computing environment—including WebSphere Portal for organizing content from multiple information resources. Engineers within Dassault Aviation can readily communicate with one another, exchange messages, and collect information while working on their design tasks.

Through their close working relationship, Dassault Aviation, IBM, and Dassault Systèmes design, develop, and deliver a seamless environment to promote collaborative product design among all of the engineers working on the Falcon 7x project.

Managing Product Knowledge in Context

The PLM platform provided by IBM and Dassault Systèmes manages product knowledge in context, implementing the new business processes with the scalability, security, and performance needed for worldwide co-development. Dassault Aviation maintains all of the design information for the Falcon 7x project within collaborative workspace, based on a central, shared repository.

"What is new with the design of the Falcon 7x," Robert Goussault, Vice President in the Information Systems Division at Dassault Aviation explains, "is that we have a total view of the different phases of the project. We can anticipate the activities of the entire project and minimize the risks." Since Dassault Aviation can track and manage the dependencies among components and subsystems, "we can reduce the cost of design, production, and support for the Falcon 7x by ensuring that the engineering is done electronically," Goussault concludes.

The PLM platform supports concurrent design activities where multiple engineers can access the same component or subsystem, work on their separate parts, and automatically be notified about potential conflicts. As shown in Illustration 1, the PLM platform manages the product knowledge of the design engineers and captures the dependencies needed for virtually engineering aircraft components and subsystems.

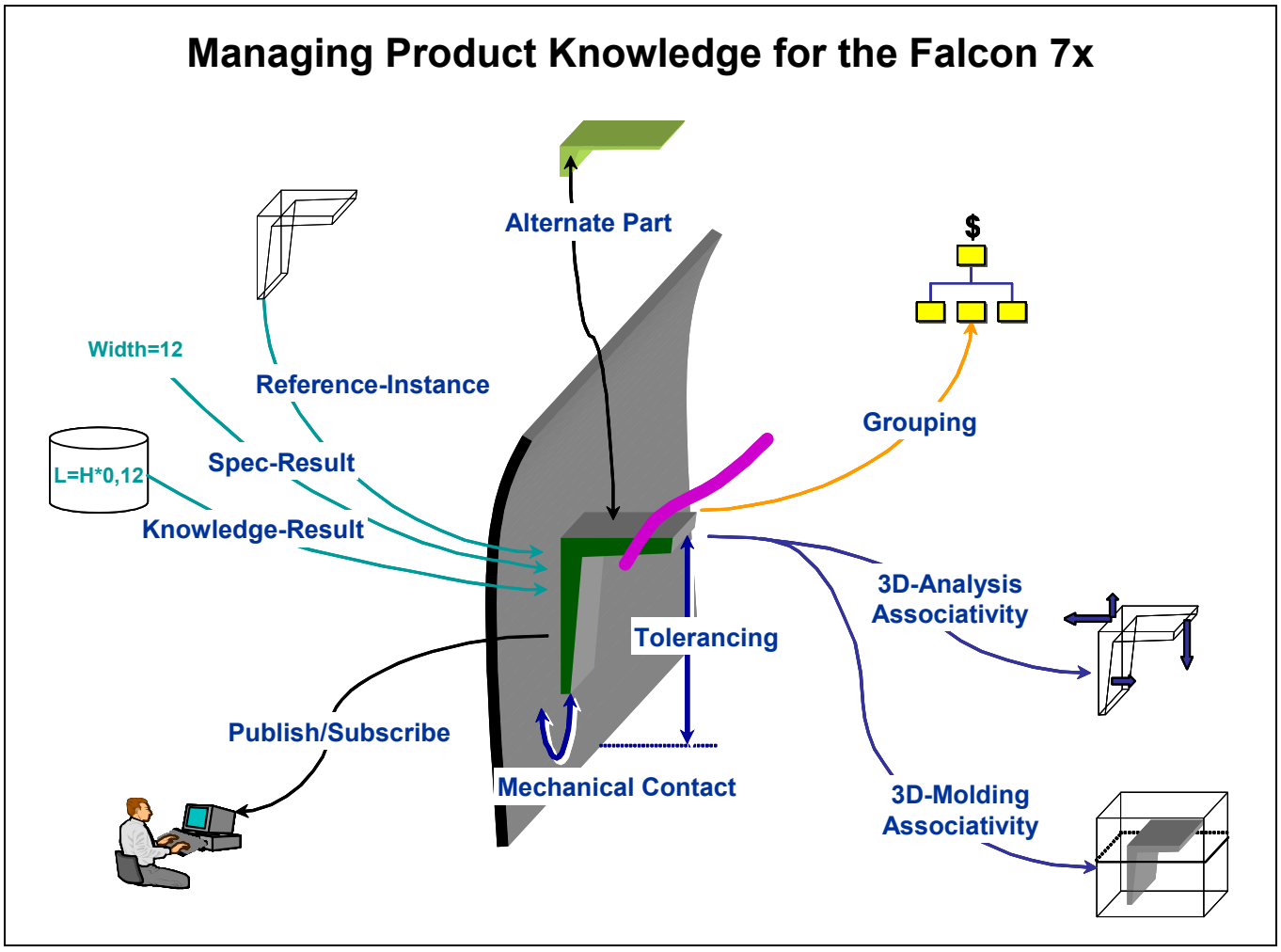

Illustration 1. Engineers working on the Falcon 7x use a collaborative workspace to access and share detailed design information.

Individual designers and design teams work on their separate components. When they complete their work, they submit their designs to a central repository, which in turn analyzes the submissions for dependencies and automatically identifies conflicts. Design engineers can then revise their designs to resolve the conflicts.

Time is of the essence. "We would not be able to build the Falcon 7x on time, without the PLM platform," Goussault observes. "When you make a modification due to a test, the impact on the design has to be considered very quickly. You have to be able to make the design changes in days, rather than weeks, and weeks, rather than months."

Rolling Out a Common PLM Platform

In fact, rolling out the PLM platform to designers within partner firms and ensuring that engineers have a common collaborative workspace is critical for the success of the Falcon 7x project. Working with IBM and Dassault Systèmes, Dassault Aviation has installed an integrated information infrastructure within the engineering organizations of

its business partners. At present, the collaborative workspace is running within 17 of the 22 partner firms.

Key designers from the partner firms initially learn how to use the collaborative workspace when co-located with Dassault Aviation engineers in Saint-Cloud. When they move back to their own companies, these designers take this know-how and experience with them and help train their colleagues. "We developed the design methodologies and train the design engineers about how to use the system," Philippe Delphin, IT Systems Architect for PLM at Dassault Aviation reports. "We then create profiles for each company and identify what data the designers need to have in house."

Synchronizing Design Data

Dassault Aviation manages the design data with its business partners. The company maintains all of the data for the Falcon 7x within a central repository. Dassault Aviation identifies the data that designers at partner firms need to manage locally. Dassault Aviation defines and publishes predefined partitions (or sections) of the central repository to which partners can then subscribe. Dassault Aviation then synchronizes its central repository with the partitions maintained by its business partners.

As a result, designers maintain local copies of the repository. They update and synchronize design information two to three times per week to ensure they capture all the changes. When synchronizing their local repositories with the central repository, design engineers receive automatic notifications of design dependencies, which they can then work on to resolve.

Results at Dassault Aviation

A Work in Progress

The implementation of the PLM platform at Dassault Aviation is still a work in progress. The design and development of the Falcon 7x remains on schedule, and the business jet is on track to reach the critical milestone of beginning test flights by mid-2005. The company is reducing the time required to develop an entirely new aircraft platform by approximately 30 percent.

What is clear at this point is that Dassault Aviation has implemented its PLM platform in over two-thirds of its business partners, with additional ones coming online in a predictable fashion. Design engineers in these firms can effectively collaborate with one another on their respective component designs. They can easily communicate design changes across multiple geographies at a very granular level.

Synchronizing Innovative Design Activities

Dassault Aviation can securely synchronize detailed design activities with its business partners on an ongoing basis. The company can systematically manage the design changes and rapidly identify dependencies, resulting in significant time savings and productivity improvements, as well as a reduction in data process management and transfer activities for Dassault Aviation and its partners. The company can make product information visible across the enterprise and provide a rich data environment for

advanced aviation design, resulting in such operational benefits as enhanced innovation, reduced cycle time for design, improved quality, and improved manufacturability.

The IBM/Dassault Systèmes solution provides Dassault Aviation and its partners with ongoing collaboration capabilities and real-time access to data on the Falcon 7x from worldwide locations, enabling a significant reduction and/or elimination of travel and lodging expenses, as well as substantially improved productivity. All in all, with the collaborative workspace in place, Dassault Aviation and its business partners can ensure they are pushing the envelope for innovation when designing and developing the Falcon 7x.

Estimating Business Benefits

Accelerating time-to-market and being able to design, develop, and deliver a next-generation aircraft within five years, rather than the seven to nine required for previous projects, is only one way that Dassault Aviation and its business partners estimate the benefits from its investment in the PLM platform.

Second, there is an increase in productivity. From an operational perspective, partners no longer need to assign one or two people just to manually update the shared database entries. Rather, all data updates occur electronically, through the extranet connections. Dassault Aviation and its business partners can reduce their costs of operations. Since many routine tasks are now automated, they need to hire fewer people.

And, finally, designing and developing the Falcon 7x in a virtual work environment results in fewer errors, more frequent and thorough checking of product information, and a higher-quality product. Dassault Aviation expects to sell the very first plane it produces. The PLM environment verifies the aviation engineers' designs and identifies potential design conflicts relatively early within the design process.

This means that, with the virtual work environment in place, engineers have a systematic platform for identifying potential design conflicts up-front. They can then take corrective action and redesign component parts, without needing to produce a physical prototype. Hence, the use of the PLM platform and its virtual design environment substantially reduces the costs of developing and building innovative solutions. Almost all of the engineering can be done electronically. The key is having an extensive and flexible e-business infrastructure in place, one that can leverage the accelerated design for the Falcon 7x.

An Architecture for a Collaborative Workspace

The Capabilities of a Shared Repository

A Hub-and-Spoke Network Configuration

The collaborative workspace for the Falcon 7x business jet relies on a shared repository, deployed using a hub-and-spoke network configuration. Dassault Aviation maintains the master version of the PLM platform at its headquarters in Saint-Cloud. Supported by IBM and Dassault Systèmes, Dassault Aviation installs satellite instances of the PLM platform in the home offices of its business partners. Dassault Aviation provides all partners with a common PLM platform, consisting of CATIA for 3D engineering design and ENOVIA VPM for managing product configurations and facilitating distributed data exchanges.

The PLM platform is based on the capabilities of a central database. Working together, IBM and Dassault Systèmes leverage the capabilities of IBM DB2 Universal Database for the central database functions, running on an IBM eServer pSeries platform. They use WebSphere Business Integration and WebSphere MQ for business process automation, WebSphere Studio Application Development to develop and WebSphere Application Server to deploy a browser-based Web-centric environment.

Mapping Relationships

Dassault Aviation partitions the central repository into identified sections, related to the components and subsystems of the Falcon 7x. Furthermore, Dassault Aviation maintains sets of company profiles, identifying which business partners have what roles when designing and developing particular components and subsystems. Through the PLM platform, Dassault Aviation then maps the relationships between the business partners and the components and subsystems that they are designing.

Dassault Aviation publishes access to the repository partitions, to which the business partners then subscribe. Through this publish/subscribe mechanism, the right people get access to the right design information at the right time, while minimizing the potential for information overload. “When designing the exchange process,” Philippe Delphin explains, “we need to guarantee confidentiality and ensure that we deliver the right information to the right people inside our partner firms.”

The PLM platform manages the links and relationships among component parts. ENOVIA VPM records product data and dependencies and then tracks all of the links. It supports change notification, change impact analysis, and automated change propagation. It produces a graphical bill-of-materials to visualize and update the structure and context of links. ENOVIA VPM also provides powerful impact analysis for reliable project planning and estimating.

Managing the Exchange of Design Data

Business partners only get access to the information that they need—the PLM platform includes strong authentication where the data can only be accessed by the intended recipient. The PLM platform filters and manages access to information, so that designers can productively spend their time working on their particular areas of

responsibility and filter out unrelated content about which they are not likely to have any need to know. IBM WebSphere Business Integration handles the data exchange processes (including data encryption, transfer, and decryption). It leverages the capabilities of WebSphere MQ as the underlying messaging bus. These two IBM products provide the underlying integration infrastructure. They ensure the ongoing synchronization and updates of the separate repositories maintained at Dassault Aviation and at the offices of its business partners. This includes data encryption, transfer, decryption, import, and check-pointing of long-running update processes, often encompassing a 2 to 3 GB data exchange. Dassault Aviation is able to trace the information exchanges among partners and can determine who sent what to whom and when.

The PLM platform manages product design configurations and dependencies in terms of linked business objects, stored within partitions of the central repository. Every part within the Falcon 7x design is defined as a separate object with its unique parameters. The PLM platform maintains the knowledge of the links among related objects and can quickly calculate potential conflicts and discrepancies in the design elements. Ten business partners are working remotely with the complete virtual PLM platform. These companies are changing data about 1,000 to 2,000 parts per week. Thus, Dassault Aviation is managing modifications to almost 20,000 parts per week for these business partners.

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