

Towards Collaborative Engineering in the Aerospace Industry

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Abstract

This paper reports on the experiences and lessons learned from the implementation and utilisation of collaborative engineering applications that address the increasing demand for richer and faster communication in product development between different partners and locations in the aerospace industry. The paper outlines MTU's Collaborative Engineering Initiative and highlights the requirements analysis and tool selection process for a first step towards engineering collaboration. Two web-based applications that were implemented and tested at MTU Aero Engines are presented and the experiences with the chosen tools are discussed. An outlook into the future of collaborative engineering at MTU is given.

Keywords

Collaborative Engineering, Web-based Conferencing, Groupware, Computer Supported Collaborative Work, eBusiness

1 Introduction

It is well understood that most of the problems during the product development phase are due to communication problems. These problems can be particularly far-reaching as 80% of the due dates, 70% of the quality and 60% of the product costs are fixed at the end of the engineering phase [Herbst, 2000]. Roughly one third of the product development costs can be attributed to avoidable changes. Ensuring high-quality communication during product development has therefore become an important strategic goal for virtually all aerospace companies.

In order to reduce development and manufacturing costs and to shorten time-to-market, aerospace companies have been spreading their efforts in product development (engineering) and manufacturing to globally distributed partners. This has led to long-term partnerships in which both the risks and revenues are shared across the entire life cycle of the products and along the whole value chain [Schultz, Jansen, Böttge, 2000]. This new quality of collaboration has brought about the need for innovative organisational approaches, new methods of work and state-of-the-art Information Technology (IT) support infrastructures [Thoben, Hribernik, Kirisci, Eschenbächer, 2003]. Being the key enablers for more effective communication and co-ordination across the new value chains they are being tested, implemented and utilised by many companies in this sector of industry.

2 Existing Theories and Work

2.1 Collaborative Engineering

Collaboration is the ability to communicate verbally, visually, or otherwise to share information and ideas so as to create a shared understanding or co-operation among two or more people to accomplish a common creative objective. The application of collaboration in product

development is getting a high degree of attention because it offers the potential to reduce costs and speed up time to market [Mills, 1998].

Gartner Group defined Collaborative Engineering or Collaborative Product Commerce (CPC) as a means of allowing multiple divisions to share engineering resources globally and involve both customers and suppliers in the creation of new product [Reese, 2001].

In order to achieve this highly effective engineering collaboration between distributed organisations, the individual companies must be enabled to interact by means of IT applications. Tool providers have come up with solutions that support the corporate efforts to improve efficiency, reduce costs, strengthen customer service and ensure flexibility. Generally, these applications can either function in real time (synchronous) - requiring all parties to participate simultaneously - or at different times and in different places (asynchronous). Examples for asynchronous communication are the exchange of engineering data between individuals via eMail or between different Product Data Management (PDM) Systems or Engineering Portals [Bullinger, Eberhardt, Gurzki, Hinderer, 2002; Karcher, Knarr, Jungkunz, 2002]. Synchronous communication usually takes place when people want to discuss about engineering data utilising collaboration tools such as online conferencing applications [Rupp, Steiner, 2003]. The goal is to bring both means of communication together in one holistic tool set [Blohm Dahl, 2001].

2.2 Engineering Collaboration in the Aerospace Industry and at MTU Aero Engines

MTU Aero Engines - the world's fifth-largest engine manufacturer - develops and produces large modules (e.g. turbines and compressors) for civil and military aircraft engines at its Munich, Berlin (Germany) and USA locations and is the world's largest independent provider of commercial and military engine services with locations in Hannover, Germany and its subsidiaries and joint-ventures in China, Malaysia, Canada and Brazil. Additionally, MTU develops, manufactures and repairs industrial gas turbines. It has been the company's strategy for many years to team-up with partners (both customers such as Pratt & Whitney, General Electric and Rolls Royce and suppliers such as Volvo Aero and Fiat Avio) in the development and production of civil and military engine programs. The partnerships and supply chains vary from program to program so that flexibility in terms of communication and engineering data exchange is an important prerequisite for successful collaboration both within the company and beyond the company's borders.

In autumn 2002 MTU Aero Engines launched its Collaborative Engineering Initiative. The goal of this project is to lay the technological foundations for improved engineering processes for aero engine components development in terms of speed, quality and costs by integrating different engineering tools into one project-oriented engine design system that

- standardises handling
- makes the development process more transparent and manageable for the user
- supports team work even if the team is distributed across several locations
- accelerates development times of the design processes
- ensures data consistency for different engineering disciplines at dispersed locations
- controls the access rights for critical data consistently and comprehensively
- limits servicing efforts
- can flexibly be adapted to new requirements and developments and
- reduces co-ordination and travel expenses.

In order to move forward and to gain experience with collaborative engineering applications, a project was initiated to select, test, implement and utilise collaboration tools with internal and external engineering partners. The results are presented and discussed in the following sections.

3 Collaboration Tool Selection

The tool selection was undertaken in a three-step approach (cf. Figure 1) [Rupp, Steiner, 2003].

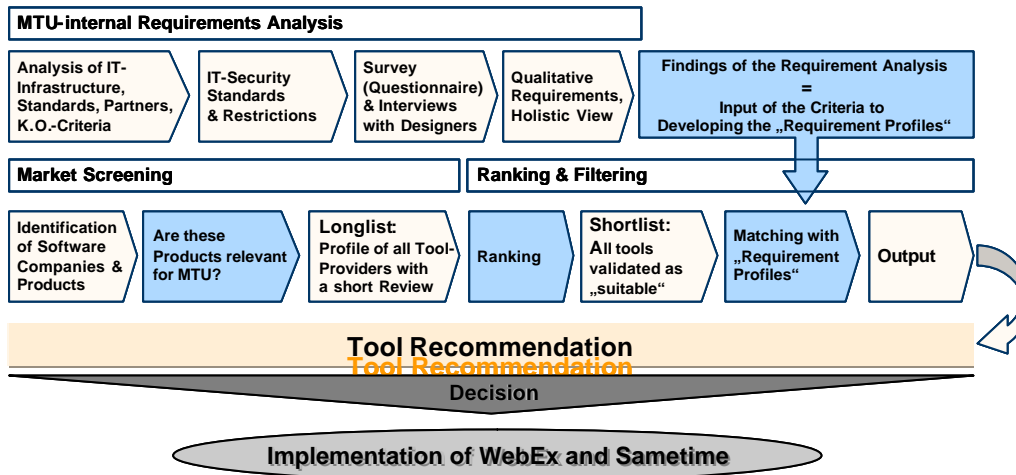


Figure 1: Collaboration Tool Selection and Implementation Process

At first, both a general business requirements and a specific user requirements analysis was performed. For this purpose, a questionnaire was developed and in-depth interviews with design engineers and IT experts from different hierarchical levels were performed based on the findings from the questionnaire. The most important business requirements were security, performance, scalability and ease of usage.

The most important functional requirements and the distribution of communication across different locations are illustrated in Figure 2. While whiteboard sharing, CAD viewing, application sharing and file transfer were seen as the most important functional requirements, two-thirds of all engineering communication take place within the company’s boundaries and one third with external partners.

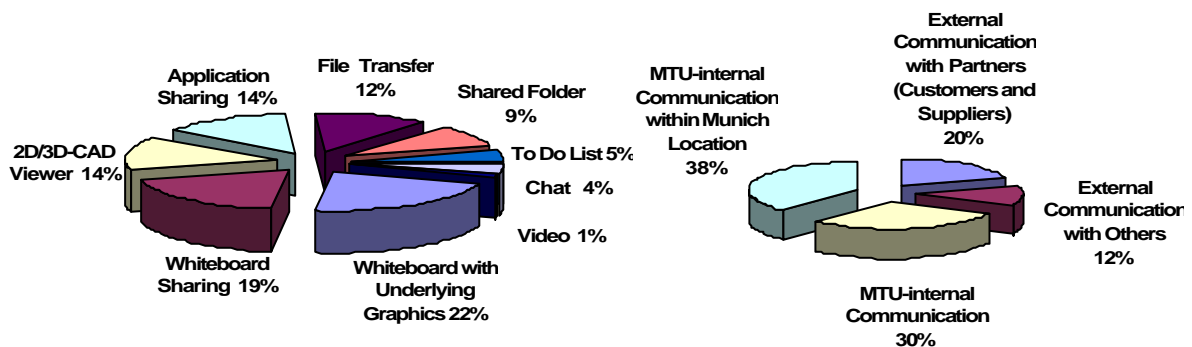


Figure 2: Functional Requirements and Distribution of Communication across different Locations at MTU

From the requirements analysis, requirements profiles (the design engineer, the engineering team leader and the engineering manager) for different tool usage were derived. These formed the criteria for the ranking and filtering process.

In a second step, an extensive Internet research was conducted as a market screening activity that led to a longlist of collaboration tools that were applicable to MTU Aero Engines.

Finally, a ranking and filtering process left a shortlist of eligible tools that were matched with the requirement profiles to leave a tool recommendation for MTU.

Next to licensing models, implementation and hosting costs, security, performance and ease of implementation and support, the final decision for the tool implementation also had to consider with which external engineering partners the tool could be used and what tools were currently

being applied by the most important partners. Here, the fact that Pratt & Whitney (P&W) use Sametime (IBM) and General Electric (GE) use WebEx Meeting Center (WebEx) to communicate with MTU and other external partners, influenced the tool decision strongly. Therefore, it was decided to implement both WebEx and Sametime as pilot systems to test them with different departments from engineering, production, sales and marketing and supply chain management at different world-wide MTU locations and with external partners in a trial phase to gain experience with collaborative engineering applications.

4 Collaboration Tool Implementation

To be able to get together for engineering collaboration, a server that all parties can access via the Internet is necessary. Many companies have already implemented such collaboration servers either within their own network - usually in the Demilitarised Zone (DMZ) for security purposes - or on the Internet. The first step towards enabling MTU's engineers to engage in collaboration with their colleagues from within the company or with partners (e.g. GE or P&W) was to create the installation routines for Sametime and WebEx that install the browser plug-ins needed for collaborative sessions to work. This software made meetings on GE's or P&W's meeting servers possible. The second step, however, was to implement these collaboration servers for MTU. It was decided to initially support MTU-internal collaboration sessions by Sametime and to implement WebEx mainly to communicate with external partners. For the future, an external connection to the MTU-hosted Sametime collaboration server is planned (cf. Figure 3).

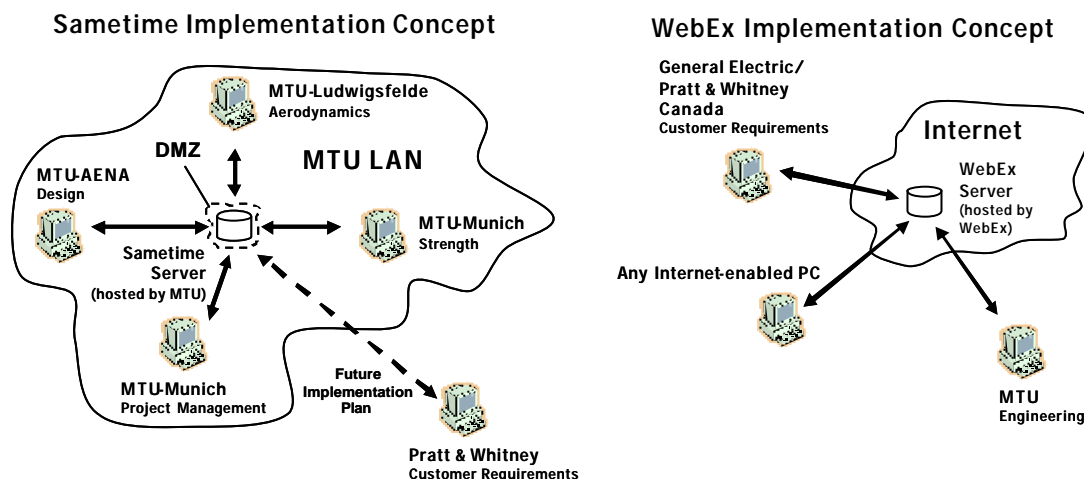


Figure 3: Sametime and WebEx Implementation Concepts

4.1 Sametime Architecture

As stated above, security was the most important requirement for the implementation of new collaboration tools at MTU Aero Engines. For this reason, the applications had to be operated either entirely on the Internet or in MTU's DMZ. A direct connection to MTU's Local Area Network (LAN) was not to be implemented. All client access had to happen via standard web browsers (Internet Explorer 5.x and Netscape 4.x) with additional Java plug-ins. The communication had to be performed via HTTPS only. Another prerequisite was that MTU's firewall settings did not have to be altered. Figure 4 illustrates the required architecture that had to be developed for the implementation of Sametime. As WebEx was not installed on MTU's servers but runs as a hosted Internet solution, these requirements did not influence its implementation.

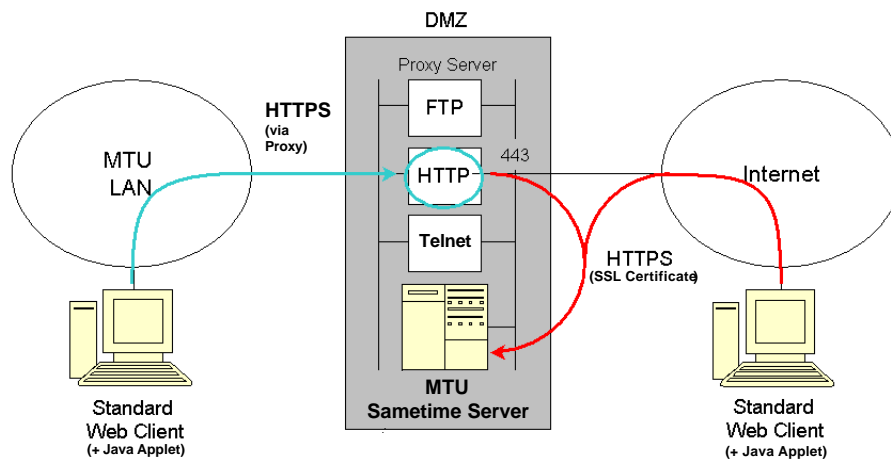


Figure 4: Sametime Architecture

4.2 Functionality of Sametime and WebEx

The functionalities of Sametime and WebEx are very similar. Both tools feature application sharing, whiteboard sharing, CAD viewing, document sharing, data transfer, video, recording, polling and chat and satisfy the functionality requirements that were established during the requirements analysis. Figure 5 shows the user interface of the WebEx Meeting Center.

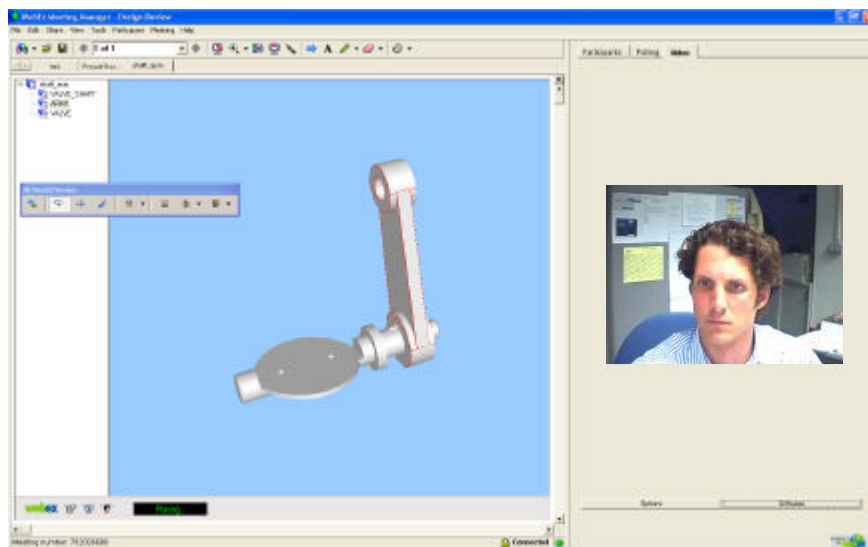


Figure 5: WebEx Meeting Center

Both Sametime and WebEx enable the user to either start an ad-hoc collaborative session or schedule a session in advance. As Sametime is installed on MTU's own server, a connection to the Lightweight Directory Access Protocol (LDAP) server - a server that can be used to look up contact information of registered users - could be implemented. Together with the Sametime Client - a program that enables users to chat with each other and that features an awareness functionality - Sametime enables users to engage quickly and easily in ad-hoc engineering sessions. However, being an IBM product that primarily supports Lotus Notes, Sametime has no functionality to schedule meetings via Microsoft Outlook (MTU's eMail software). While WebEx does not feature the look-up functionality via the LDAP server, it comes with a standard Outlook integration form that can be published on the Exchange server and allows for direct scheduling of meetings from within Outlook - ensuring that collaborative sessions are directly entered into the meeting host's and all participant's Outlook calendars. WebEx also features a customisable feedback form and weekly reports that enable the administrator to monitor the usage of the tool.

5 Findings

5.1 Experiences from Implementation and Tool Utilisation

The fact that Sametime was implemented on MTU's own server infrastructure brought about advantages in terms of performance and security but also the drawback of the initial investment and maintenance costs for the server. Sametime's licensing model is aimed at companies that want the tool to be rolled out to every computer in the network (personal license for each user). For companies with many users, Sametime is therefore the tool of choice [Steiner, 2003]. In the case of MTU, the tool implementation and maintenance was outsourced to a service provider. This can potentially bring about difficulties as the security concept and the company standards have to be taken into account by the external partner.

WebEx was purchased as an Internet service that is hosted by WebEx and required no hardware investment. The advantage of this solution are relatively little customisation and no integration efforts with company-internal systems. The licensing model of WebEx is based on concurrent licenses that can be used by any registered user but limit the use of the tool to a certain number of simultaneous users. As WebEx is externally hosted, the tool cannot be used for certain military projects where security does not permit data to be exchanged outside secure networks even if the information is encrypted and SSL (Secure Socket Layer) connections are used.

According to a study performed by TechConsult [TechConsult, 2003], the greatest difficulties during the implementation of eBusiness solutions are caused by the employees' lack of knowledge (34%) and by the integration into the existing IT landscape (33%). The internal employee acceptance (15%) and the training of the employees (14%) were not found to cause the greatest difficulties. At MTU, however, the picture was vice versa. While the integration into the IT system landscape and the employees' knowledge did not cause great difficulties, the training of the users turned out to be both difficult and time consuming and the acceptance of the tool was relatively low compared to the great demand that was articulated during the requirements analysis. Possible explanations for this could be the tools' lack of integration into a common PDM system, performance problems when running the applications on UNIX and SUN workstations via Windows Terminal Server (WTS) or MTU's restrictive security concept that makes collaboration - especially across company boundaries - relatively difficult. The reluctance to work with the new tools possibly also comes from an underestimated fear of potentially giving away vital engineering information to outside partners.

5.2 Organisational Impacts

In order to be permitted to use both Sametime and WebEx, a special formal obligation has to be signed by every user at MTU Aero Engines. This is necessary as each conferencing user can take control of each connected computer via application sharing or via the remote control functionality when granted permission. This means that a computer that is located within MTU's network can be controlled remotely by an external collaboration partner (as it is intended). The remote user, however does not only gain control over the application but also over all other applications and network drives and therefore to the whole company-internal network. Even though this remote control functionality is an important feature of any collaborative application and can be revoked quickly and easily, it poses a potential threat to MTU's internal network. The user therefore has a substantial responsibility when granting permissions for application sharing or remote control of his computer.

5.3 Lessons Learned

The experience from the implementation and utilisation of WebEx and Sametime teaches that the following aspects should be taken into account when implementing collaboration tools:

- Security concerns (from users and security officers) have to be taken very serious.

- A slow acceptance in spite of a great need for support by new tools has to be reckoned with.
- The tool performance needs to be very good, otherwise the user acceptance is very low.
- An introduction campaign is very important.
- Tool implementation difficulties have to be anticipated in order to avoid time delays during the implementation phase.
- Professional training sessions (if necessary several times), user guides and user support is very important even if the tools are relatively easy to use.

5.4 Outlook

In order to simplify the existing engineering tool landscape and based on the experiences with WebEx and Sametime, MTU has recently decided to implement a new Product Lifecycle Management (PLM) system (cf. Figure 6). While WebEx and Sametime focus on the synchronous communication aspect of collaboration, the PLM system will provide an integrated database for engineering collaboration at MTU. Both Sametime and WebEx will either be integrated into the future system landscape or complement it in order to enable users to communicate with each other utilising a common infrastructure and database.

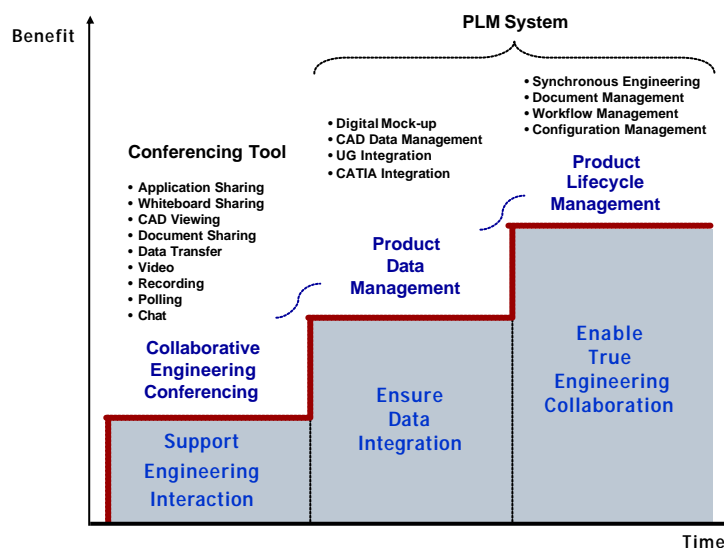


Figure 6: MTU's Roadmap towards Engineering Collaboration

6 Conclusions

This paper has reported on the findings of the implementation and utilisation of collaborative applications in the aerospace industry. An in-depth requirements analysis and tool evaluation process led to the implementation of both WebEx and Sametime. The described work represents MTU's first steps towards collaborative engineering that help to improve efficiency and speed up communication in distributed product development. The experience from the tool implementation and utilisation has shown that the technical implementation difficulties were much less critical than the human reluctance to use the new technology. Here, communication and training can support users in losing their anxieties and appreciating the advantages of the new functionalities. The new tools are being integrated into MTU's new engineering tool landscape that will take shape within the next years.

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