9
Global supply chain integration

Prof. Dr.-Ing. F.-L. Krause
Fraunhofer-IPK, Pascalstr. 8-9, 10587 Berlin, Germany
phone: +49–30–39 00 62 43, fax: +49–30–393 02 46
email: Frank-L.Krause@ipk.fhg.de

Dipl.-Ing. M. Doblies
IWF / TUB, Pascalstr. 8-9, 10587 Berlin, Germany
phone: +49–30–39 00 62 65, fax: +49–30–393 02 46
email: Matthias.Doblies@ipk.fhg.de

Abstract

The migration to a global economy is accompanied by a rapid change in communication technologies. The WebProM collaborative environment (WCE) supports communication along the supply chain. The WCE consists of Internet-based product library, multimedia email and conferencing system. The main focus is the product library which is used for information distribution to a broad audience and for data exchange in virtual teams with members of different companies. The overall goal of this product library application is to enable easy integration of as many companies as needed into one digital information exchange network. Therefore the application addresses issues like common data formats, data security, heterogeneous platforms, and simple maintenance of contents, users and access rights.

Keywords

Global Product Management, EDM, Internet

Computer Applications in Production and Engineering. F. Plonka and G. Olling (Eds.)

1 INTRODUCTION

Migration to a global economy is taking place everywhere. The technologies accompanying this process are changing rapidly and keeping up with them is expensive in terms of money and time. Especially small enterprises do not have the resources needed to accomplish this challenge. As with every commercially viable technology the relation between costs and benefits has to be right. This means the technology used must not be too expensive, and it has to be easy to implement in business.

Therefore several industrial and governmental research projects concentrated on developing technologies for a global and cost effective supply chain integration. This leads towards Virtual Product Development, a technology that all companies will be confronted with in the near future (Spur 1997). It goes along with the establishment of several regional centers across Europe where small companies receive support for the introduction and operation of relevant technologies.

The multimedia working environment consists of a product library, multimedia email and a conferencing system including components for video/audio conference, shared whiteboard and application sharing. The main focus is the product library. The product library serves two purposes. It is used for information distribution to a broad audience as is associated with the term *product library*. Furthermore it is used for data exchange in virtual teams with members of different companies.

The network infrastructure is scaleable from analog modems to bundled ISDN lines and up to ATM to allow the network connections to be as powerful as required and as inexpensive as possible.

2 COMMUNICATION ALONG THE SUPPLY CHAIN

The players in today's manufacturing business become more and more global. Looking for example at Fiat (Vio 1997), a remarkable increase in globalization can be seen, where in five years the amount of components delivered from outside Italy has risen from 17% to 38%. The absolute value of components delivered from Italy has decreased slightly, so the growth has taken place only outside the OEM's country.

This shows the trend towards global project teams devoted to creating a product. Since these teams are working together while being physically dispersed across different nations and even across different continents they are called virtual teams. Fast and reliable communication in these virtual teams is crucial to success but proven techniques like phone, fax and personal visits fail to deliver. They are simply incapable to distribute the amount of required information fast enough to all communication partners and in useable data formats.

Information gathering

The first problem being addressed by the WCE is the time required to gather all relevant information for the business process. The task of information gathering is

only one of the five basic activities of product development processes (Krause 1995a) but it is very time consuming (figure 2). Engineers spend a lot of their time with information gathering, figures vary between 30% (Noble 1986) and 70% (SMAC 1994). The exploitation of modern communication technologies like video conferencing or Intranet information systems can reduce this time drastically.

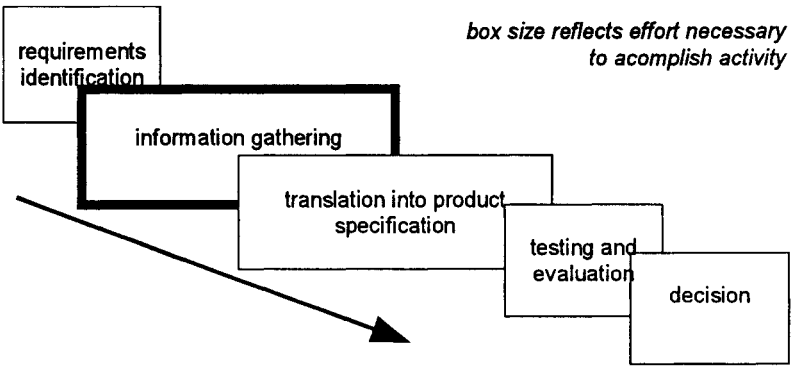

Figure 1 The five basic activities of product development processes.

Another common problem is the status of information, i.e. whether the information is up-to-date or obsolete. At least partially this problem can be solved when all users access the same data on-line via one common data pool. Having on-line access to the data is not enough, the use of this facility must be ensured to maximize its value.

Even when the user knows where the data he is looking for resides, it can take him a week to exchange it via a tape. Furthermore many companies are unwilling to release emerging drawings and other project documents. So a central networked repository for all these data would be very important.

Table 1 gives an overview of the requirements for an environment to distribute and exchange information (TEAM 1996).

Table 1 List of requirements for application addressing information gathering

- simple to use, especially no special knowledge like HTML necessary;
- low cost;
- availability, i.e. data must be available to all authorized users all the time;
- fast access to data, i.e. minutes instead of days;
- data formats that can be viewed and processes by all users;
- documents organized in net-like structure;
- revision control for documents;

- gateways to existing databases and engineering data management systems;
- high security, that includes access control, secure storage, and secure transmission;
- directory services for all virtual team members, i.e. directory services across multiple companies;
- workflow support to ensure the right person performs the appropriate action;
- support for multiple languages.

Problem solving

Another problem is the amount of time being devoted to problem solving. Especially the delay between problem detection and actual problem solving can be reduced. This delay consists mostly of the time

- to identify the people who have to be involved in the problem solving process,
- to find a common time slot for a meeting, and
- to travel to the meeting pace.

The travel time vanishes if it is possible to set-up a virtual meeting. Without the necessity to travel the common time slot necessary for the meeting is reduced and therefore easier to find. Identification of the important people can be facilitated by directory services and by the right composition of virtual teams. The latter increases chances that all necessary people are already in the relevant virtual team.

The functionality required to solve or at least ease the problems mentioned above should fulfill the requirements listed in Table 2 (SMAC 1984).

Table 2 List of requirements for application addressing problem solving

- simple to use;
- low cost;
- directory services for all virtual team members, i.e. directory services across multiple companies;
- scheduling of conferences;
- invitation of users or virtual teams to conferences;
- ability to join and leave a conference without restarting or terminating the conference;

- multi-point conferences, i.e. conferences between more than two persons;
- whiteboard for general discussions, preferably with multiple pages and the ability to save these to disk as minutes;
- sharing of CAD applications, spreadsheets, word processors.

The sharing especially of CAD applications requires fast connections. It is not really a necessity, an acceptable alternative is (1) to capture the view describing the problem, (2) put it onto a whiteboard, and (3) to discuss the problem using the whiteboard.

Heterogeneous Environment

The lack of interoperability of software applications in heterogeneous environments is a common but nevertheless important problem. And in a supply chain a heterogeneous environment is rather normal because companies who supply more than just one manufacturer will have their own software and hardware environment.

Therefore a general requirement is the availability of the connecting software application in a variety of software and hardware environments (see table 3).

Table 3 List of general requirements

- support for all major operating systems,
- support for all major types of computers, i.e. workstations and personal computers, and
- support for all important types of networks, like Ethernet, Token Ring, ATM etc.

3 WEBPROM COLLABORATIVE ENVRIONMENT

Two problem areas have been identified in the previous section, i.e. information gathering and problem solving. The WebProM Collaborative Environment (WCE) addresses the former by a Web-based Product data Management (WebProM) system (Krause 1995) and the latter by a conferencing environment including audio/video conferencing and application sharing. The technical problem of interoperability is addressed by the overall architecture of WCE, which relies on standards and de-facto-standards as far as possible.

The conferencing environment

The conferencing environment is made up of *MBONE* conferencing tools and application sharing is performed using Team Solution's Team Conference. Interoperability between different conferencing systems is achieved by relying on the ITU-T recommendation H.320 (ITU 1996). But interoperability of application sharing systems is currently hard to achieve because the ITU-T recommendation T.120 (ITU 1996a) provides not enough functionality for full-fledged application sharing.

Web-based Product data Management

WebProM meets two major requirements. On one hand, WebProM gives enterprises the ability to publish up-to-date product catalogues and to grant public or restricted access to these data. On the other hand project partners from different companies can store, retrieve and maintain required information in the project library.

(1) Public static data, which is available to a broad audience, e.g. all potential customers. This information group includes e.g. national and international standards, design relevant regulations and laws, but as well product catalogues or service information for garages, etc. Furthermore always up-to-date company profiles and other general information can be made available.

(2) Company related static data, which is accessible by customers and sub-contractors. This includes engineering and design standards, company standards, company's interpretations of national and international laws and standards, or even phone directories.

(3) Project related dynamic data, which is available to a small group, usually the project team. This group includes product specifications, 3-d CAD models, 2-D design drawings, timing plans, old designs, test results, material specifications, data on human resources, standard parts, minutes of meetings or decisions. Some of the users may as well have write access and update this information.

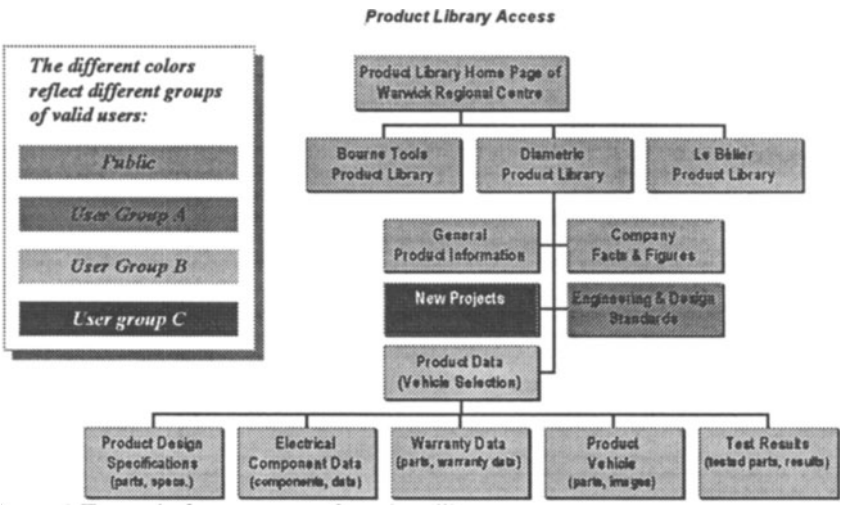

Figure 2 Example for structure of product library.

An information source like that not only gives external project partners access to current project data, but as well enables internal staff to access up-to-date information like engineering and design standards, where at the moment it is not always possible to guarantee access to the latest revision of a standards document. Figure 3 gives an example for a product library.

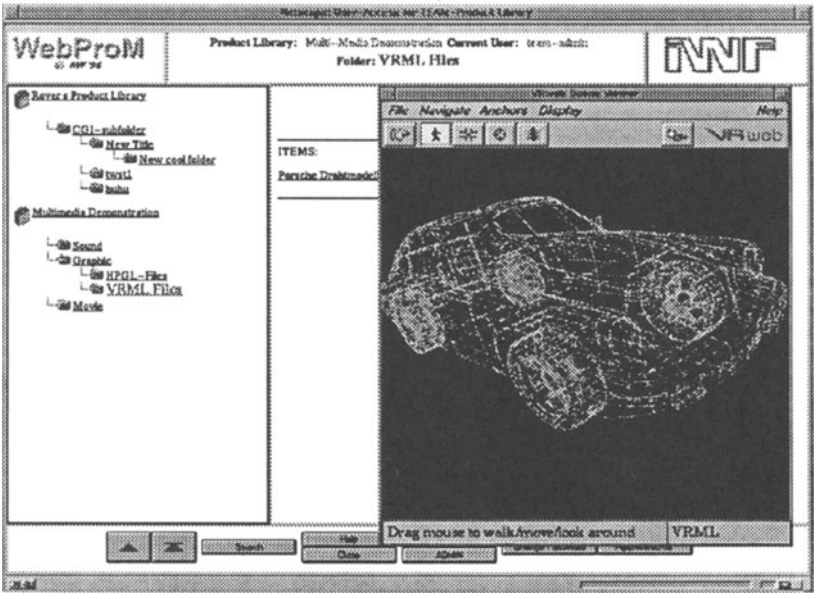

Figure 3 Navigation and viewing in WebProM. (Porsche by [ORC 1996])

An important aspect in the development of WebProM was the ease-of-use of the user interface, thus reducing training times to a minimum. So common user interface elements are used wherever appropriate. However the underlying technology poses limits to the interface design. For example drag-and-drop functionality is difficult to implement while retaining web-browser behavior. The user interface is split in three operating modes, one for browsing (Figure 3), one for contents editing (Figure 4) and one for administration of users and groups (Figure 5).

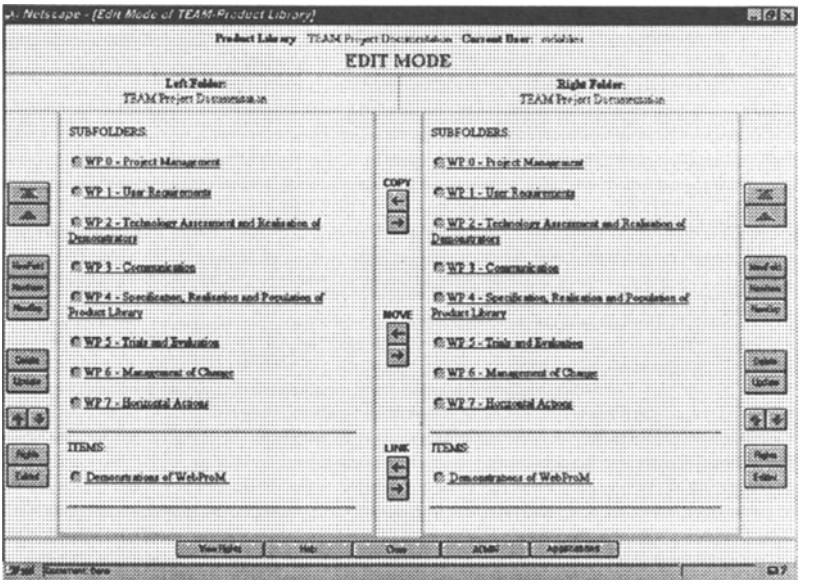

Figure 4 Maintenance of the information stored within WebProM.

Organization of information

Files are the smallest unit of information supported directly by WebProM. They can be combined to groups. Items, groups and folders can be combined into folders. Groups are helpful for example to build a product catalogue where information for one product may consist of several items like general description, data sheet, drawing and CAD model. If these items are grouped together they will be displayed accordingly in a grouped form. Furthermore there are references to items and folders. These are updated automatically when the object being referenced is moved.

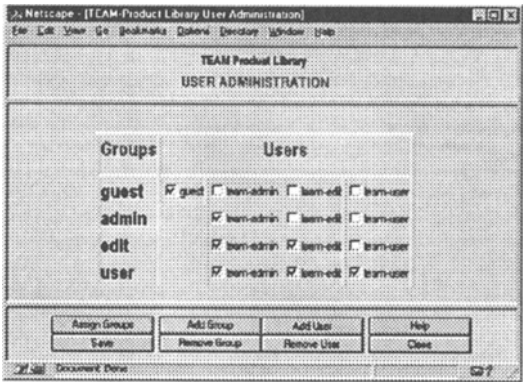

Figure 5 Administration of users and virtual teams.

Data Formats

By using widely available web technology to implement WebProM it is very simple to integrate new data formats. The following list gives the main criterias for selection of appropriate data formats for publishing.

(1) Information availability: The information must be available in the data format, either native or by means of converting. If a conversion is necessary, it has to be easy, preferably automatic.

(2) Viewer availability: The user has to be able to display the information. Therefore a viewer for that format must be available. For standard formats there are a lot of viewers available on various platforms. Viewers for CAD data are not that common, but even these are beginning to evolve because of increased demand and increased computing power available to the user.

(3) Convenience: Users must be able to use the environment without much effort. So selecting the native data to be published, converting it to the appropriate format and then publishing it must be effortless. Even structuring the data and setting appropriate access rights has to be easy. Last but not least the handling of the viewer must be quick and simple.

Using web browsers opens a new opportunity called plug-ins. Plug-ins are browser extensions that are capable to display one or more special data formats the browser normally does not support. They come from third-party vendors and are easily installed. They integrate so tightly with the web browser that the user does not notice them other than by the browser's sudden ability to display additional data formats like e.g. DXF files. Currently plug-ins are available only on Personal Computers but their availability on UNIX workstations can be expected soon.

(4) Processing ability: Often simple viewing of the data is not sufficient especially when accessing data of a current development project. There is the need to work on that data and maybe even upload the changed data back into

the library. Most plug-ins and viewers do not allow this. Because there is more functionality necessary to work on the data being downloaded many users are only willing to work using their standard applications.

This imposes severe limits to the use of standard formats because in a business environment it is not applicable to download for example an IGES file, import it into CADDS 5, change the design, export it as IGES and upload it back into the library. This works on a regular basis only in special environments where only limited functionality is used (TEAM 1996).

Publishing data in multiple formats can be an interesting option. CAD models for example can be published in VRML because conversion to VRML is easy and viewer are widely propagated and additionally they can be published in at least one standard format like STEP where viewers are not as common as for VRML but the „value" of the transmitted data is much higher than with VRML.

All these requirements make the selection of appropriate data formats very difficult. Therefore two different strategies are proposed: For public information like product catalogues where the audience is not well defined only standard data formats should be used because otherwise the viewer availability is unknown. But for the exchange of project related information the audience is known and therefore the users' preferences in terms of applications and their native data formats is known. Here the environment becomes more productive when as many of the users' day-to-day applications are used thereby minimizing the learning curve. In such an environment the use of proprietary data formats is a viable option, because there is simply no point in distributing for example text documents in Rich Text Format (RTF) when all users are using the same word processor. Furthermore for many proprietary formats there is no alternate standard format.

Security

Access restrictions are based on virtual teams (user-groups) as well as folder structures for read and write access. Selected users can access the user administration and create new users or virtual teams.

Furthermore the use of so called security proxy servers allows a secure transmission of data through a 1024-bit SSL encryption 9 (Krause 1996). This is a very secure encryption in comparison to the usual 40-bit SSL encryption (Netscape 1995) used in commercial software packages. To provide maximum security this security proxy server has to be combined with a firewall (Antoine 1996).

Gateways to existing information

Gateways to Engineering Data Management Systems (EDMS) and Database systems are important to reduce redundancy by enabling the direct embedding of information held in private company systems.

Networks of WebProM servers

References allow the linkage of several WebProM servers. So users do not even notice which server they access.

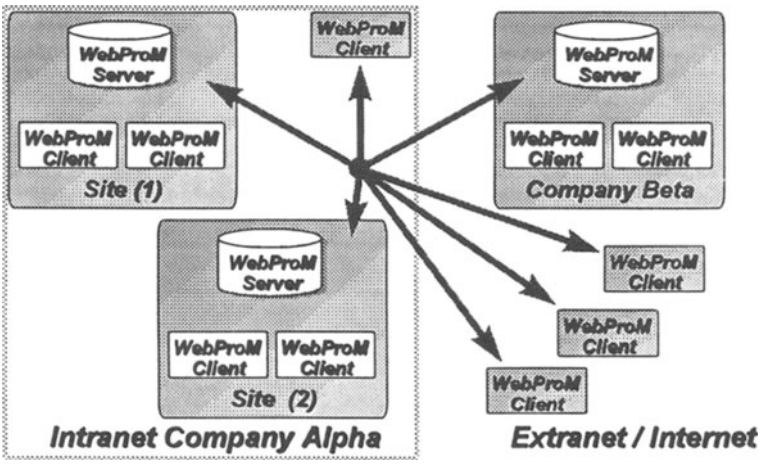

Figure 6 An Intranet / Extranet WebProM-Installation.

Architecture

WebProM is based on TCP/IP-networks and can therefore be used on the public Internet as well as on private TCP-IP-based Intranets. This ensures broad availability from the network point of view since TCP/IP network traffic can run on almost any network architecture.

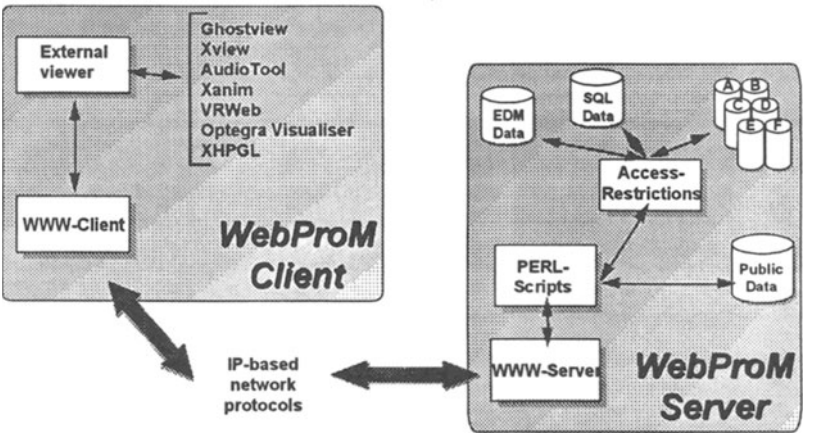

Figure 7 Software architecture of WebProM.

The user accesses WebProM through a Java and JavaScript enabled WWW-browser like the Netscape Navigator or the Microsoft Internet Explorer. Data are enhanced by Perl-scripts and Java-applications and then published by a WWW-server.

Use in industrial environment

A supplier can use WebProM to publish his product catalogue. Interested users can access the public part of the catalogue through a guest account. OEMs can access more sensible information like CAD-models or individual price lists through a dedicated account. This flexible and cost effective way of providing up-to-date manufacturing information to every customer makes the information exchange by ordinary paper catalogues nearly obsolete. The same advantages are gained when company internal best-practice-, standard-, or similar documents are published in WebProM.

Project data can be managed, distributed and stored by WebProM. Dedicated user groups like external project partners and project managers can be granted specific read and, if needed, write access in different parts of the data structure. This structure can for example contain directories for test reports, milestones, inspection protocols, etc.

To implement a clearance mechanism, an *incoming* directory can be created, in which all project partners can write and store their data files. Project managers or dedicated supervisors can then move this data to an appropriated level of the project data structure.

4 REGIONAL CENTERS

For many small enterprises it is too costly to buy technology like the WCE because it is very time consuming to decide which applications and equipment to buy and to install and maintain it. So it is of huge interest for SMEs to have regional centers where they can get in touch with the technology. These regional centers can support the SMEs with expertise, workshops, demonstrators, consulting services, training and even the option of renting equipment to test the profitability. For example in the European TEAM project three regional centers have been established in Ireland, Great Britain and Italy.

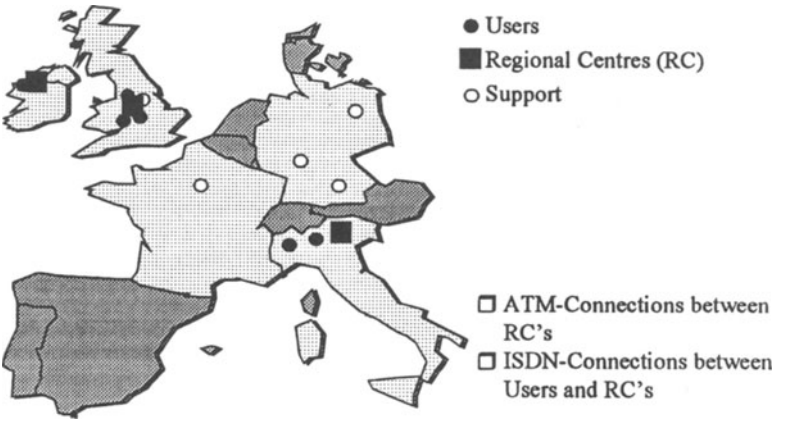

Figure 8 Regional Centers in the European TEAM project (ACTS 070).

4 REQUIREMENTS BEYOND TEAM

During the work done in several research projects and the extensive use of WCE in different companies several other important topics have been identified where more work is needed.

There is currently no ultimate standard format available, i.e. a format capable of replacing all proprietary formats and all other standard formats. An approach clearly requiring more research is automatic format conversion. Conversion between complex formats requires manual work; this includes formats for CAD data but as well formats for text documents.

There is a clear need of supporting more EDM systems across different companies to show companies the benefits of networked environments.

When a product is described by a product structure this product structure currently has to be replicated in several applications throughout the product development process. There is yet no way of accessing one unified master product structure.

During research on intranet applications at Siemens Automotive (Wartelle 1997) four major deficits have been identified:

- Virtual private networks are still difficult to set-up and maintain; but there is a real need to create secure Intranets in a cost-aware way.
- Security must be improved, especially the limitation of firewalls to IP traffic is a drawback in a network environment where ATM is gaining momentum.
- Network support for multimedia data streams like the ATM Adaptation Layers [N.N. 1996] has to be supported in other network environments as well. An approach to this problem is contained in IPv6 (Deering 1996) which will slowly substitute IPv4, the current Internet Protocol, during the next years.

- Support for the existing flow of information must become better by providing more inter-application gateways and broadening the use of standard data formats and protocols.

These comments should not lessen the fact that the technology is already very beneficial to real users; and the development is progressing rapidly.

5 REFERENCES

Antoine, P. (1995) Creating a Secure Firewall. [http://softway.com.au/softway/firewalls/parta.html]. Sydney.

Deering, S. and Hinden, R. (1996) Internet Protocol, Version 6 (IPv6) Specification. RFC 1883, 01-04-1996

ITU (1996) [H.320] Recommendation H.320 (03/96) - Narrow-band visual telephone systems and terminal equipment. http://www.itu.int/itudoc/itu-t/rec/h/h320_23397.html

ITU (1996a) [T.120] Recommendation T.120 (07/96) - Data protocols for multimedia conferencing. http://www.itu.int/itudoc/itu-t/rec/t/t120_35511.html

Krause, F.-L.; Doblies, M. (1995) An Open Architecture for Distributed Product Libraries. Proceedings of *Second International SMAC/TEAM Workshop on Integrated Broadband Communications and Collaborative Work in the Automotive Industry*. TIRAC, Sligo Regional College.

Krause, F.-L.; Golm, F.; Loske, B.; Raupach, C. (1995a) Simulation von produktentwicklungsprozessen. In ZWF 90 (1995) 3. Carl Hanser Verlag München.

Krause, F.-L.; Doblies, M. (1996) Verteilte Konstruktion mittels Internet-basierter Informationssysteme. In: VDI Berichte Nr. 1289. VDI-Verlag Düsseldorf.

Netscape Communications (1995) Netscape SSLRef 2.0. [http://home.netscape.com/newsref/std/sslref.html]

N.N. (1996) AAL - ATM Adaptation Layer. http://cell-relay.indiana.edu/cell-relay/FAQ/dictionary/A/AAL.html

Noble, C. E. I.; Cave, P. R. (1986) Engineering Design Data Management. Proceedings EMTA '86, University of Swansea, UK.

ORC – Ocnus' Rope Company Inc. (1996) VRML model of Porsche 911. http://www.ocnus.com/models/Vehicles/82_porsche_911sc.wrl.gz

SMAC (1994) Refined User Needs. R2112/REN/DIO/DS/R/004. University of Loughborough, UK, 1994.

Spur, G. (1997) Auf dem Weg zur virtuellen Produktentwicklung. In: ZWF 92 (1997) 3. Carl Hanser Verlag München.

TEAM (1996) Deliverable DRR003 – User and Organisational Requirements. University of Loughborough.

Vio, Roberto (1997) Managing the virtual enterprise. In: *Proceedings of Workshop „Towards the Virtual Enterprise: Tools, Technologies and Models"* on 03-24-1997. University of Trento.

Wartelle, Dominique (1997) Internet and Intranet: new ways of managing enterprise communication. In: *Proceedings of Workshop „Towards the Virtual Enterprise: Tools, Technologies and Models"* on 03-24-1997. University of Trento.

6 BIOGRAPHY

Prof. Dr.-Ing. Frank-Lothar Krause, born in 1942, studied mechanical engineering at the Technical University of Berlin. In 1976 he was awarded Ph.D. for his thesis: "Methods for the design of CAD systems". He has been head of the department of Design Technology at the Institute of Production Systems and Design Technology of the Fraunhofer Association since 1977. As a member of the Technical University of Berlin he has been professor for Computer Aided Design and Technological Planning since 1983. In addition to his position at the Fraunhofer-Institute he became professor at TU Berlin for Industrial Information Technologies in 1990. He is responsible for fundamental research as well as for performing projects in this area. He is member of VDI, GI, IFIP-WG 5.2, WG 5.3. Furthermore he is chair of the working group of VDI and GI concerning artificial intelligence for CAD. International activities are the associated membership in CIRP and the CIM-Europe planning team of the EC.

Dipl.-Ing. Matthias Doblies, born in 1965, studied aerospace engineering at the Technical University of Berlin. In 1994 he joined the department of Industrial Information Technologies at the Institute of Machine Tools and Manufacturing Technology of the Technical University of Berlin.