Distributed and collaborative product development with workspaces

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How do we combine creativity and systematics in product development without throwing the baby out with the bathwater? This is one of the central questions for all companies which live off the motivation and creativity of their engineers. CONTACT has developed an architecture which paradigmatically unites creativity and systematics in the distributed, collaborative product development process. Its main focus is on the separation of work in progress – personal working documents – from the team, project and company context, represented amongst other elements by the PLM backbone.

Figure 1: *Example of the quantity structure of a development project in vehicle construction*

From system to tool

With today's 3D CAD and CAE systems designers possess powerful, highly specialised tools. As a result of this, they expect to be able to use these tools as much as possible for their tasks. At the same time, the noticeably condensed development process and the integration of increasing numbers of participants into the product development value chain demands a large amount of systematic and efficient cooperation (Fig. 1). This is where product lifecycle management (PLM) systems come in, to create order and support the developers.

However, PLM systems have a reputation amongst their users for being complicated and cumbersome. Where this isn't the case, unreliable simplifications, such as a lack of coherence between CAD models and different views of the product, often come into play. In the end, consistent processes and reliably usable data are out of the question. Why are PLM systems not accepted by users? With PLM solutions – as with ERP software – the idea of an integrated system is at the forefront. Here, users are part of the system: their role is limited to entering data and making punctual decisions regarding predefined processes. This view is underlined by the PLM idea that the product development process should be integrated across roles and development steps "from the cradle to the grave".

Is the ERP system concept, with its focus on factors such as accounting or materials management, immediately transferrable to product development? PLM systems achieve impressive results as "single source of truth" and through compliance with external rules. In doing so, they open up new dimensions for transparency, accountability and attainability of goals. However, product development differs from "classical" processes in two key areas: firstly in the uniqueness of the proposal in the sense of a project. Secondly – in contrast to construction projects, for example – the actual goal, the blueprint of the solution, does not exist at the beginning of the project. The focus of the development process – a creative process – is to "invent" the

product itself. A system idea which accompanies users at every turn – guiding them based on best practices – and which measures everything by the same yardstick, would thus not only get in the way of the users themselves, but also of the success of the company with regards to originality and distinction.

Today we have authoring tools on the one side and PDM/PLM systems on the other. Of course, users require both for product development: systems and tools. Tools support the user in their role as a creator. However, there is more to developing products than simply defining their geometry. Product development is collaborative, sets new cross-disciplinary priorities in the fields of E/E and software, runs from the abstract (e.g. functions) to the concrete and contains many different views of the product.

In light of this, how can users and teams organise their multi-tiered work in progress, i.e. their personal working documents, without being dragged into the wake of the proprietary solutions of individual authoring systems and the final results demanding PDM/PLM systems?

New paradigm

Together with practitioners from the industry, CONTACT has developed an architecture which paradigmatically combines creativity and systematics in the distributed, collaborative product development process. Starting point were ideas borrowed from software development, which has been intensively searching for better methods and tools since the late 1960s. Well-known results are e.g. the Eclipse platform, the Capability Maturity Model® and version control systems such as Subversion and Git.

The main focus of the architecture is on the separation of work in progress from the team, project and company context, represented amongst other elements by the PLM backbone. Each user has his local repository for personal work, which can be accessed from anywhere and also used offline. Set up as a tool, it supports the user in structuring his work according to his individual requirements – a self-organising system.

This is one side. On the other side, the architecture supports collaboration in a universal context, allowing the participants to synchronise with each other. The fundamentally open architecture does not specify fixed parameters which define this context. This allows for scenarios which are not restricted to specific configurations of involved systems and, for example, include a multi-CAD data management as well as integration into PLM environments or mapping of cross-company collaboration scenarios. The key to this concept is to challenge the idea of the single source of truth as a concrete connection between a certain piece of content and a certain system. The notion of powerful PLM systems also making their content available locally on a high performance basis and in an intercontinental network as required can be followed through to an even more fundamental level: there are no originals, and the network is the single source of truth. Based on an arbitrary collaboration context such as a certain project, only modifications are propagated (event-triggered or requirement-triggered) between the involved nodes via the network (the internet).

Sandbox workspace: Local content management

Repositories for self-organisation are workspaces. An individual workspace represents and structures the content of a user, consisting of background information such as designed space data and the actual work items such as the components in an assembly which require modification. Users can create and use as many workspaces as they like in order to distinguish between customers, products, projects, variants or other characteristics, and so they can always work in a dedicated personal context.

The objects and work items in a workspace are files and documents of any type, such as CAD models, specifications and calculations etc., which exist in the form of office documents. As required, these may also include product and process-relevant

data such as extracts from the specification, function and product structure which do not exist as documents.

Workspace management provides functions which help the user to manage this content easily. The functions can be roughly divided into interaction with the authoring system, collaboration/ synchronisation and local content management. An example of such functions are snapshots: the option to freeze the current status of a workspace with the press of a button, thus allowing the user not only to document situations such as the exchange of an assembly with a supplier, but also to use the documentation for comparison at a later date, when commissioned modifications flow back. With an open architecture, new functions such as the automatic creation of mirror- parts can easily be integrated via a defined interface using plug-ins. This makes the workspace management flexible to the demands of particular industries, disciplines and authoring systems.

Of course, workspaces can also be used as an integral part of an overall PLM solution within a company. The key factor in this is that workspaces communicate asynchronously. As a result, workspaces can, as a rule, be used offline without a connection to another context such as the central PLM system. This capability supports scenarios and situations such as on-site engineering at far-away sites for plant construction, or generally working "on the road", where mobile connections are often not powerful or reliable enough. An online connection is only necessary for synchronising modifications.

One focus of workspaces is content management for authoring systems. The characteristics of the system in question are encapsulated in its workspace interface. Companies thus profit from a uniform interface, less time and money spent on training and function expansions with immediate widespread effect, especially in multi-CAD environments. Users of a specific CAD system profit from being able to expand the product view in their workspace with office documents, product structures etc.

Collaboration

Workspaces are thus autonomous and, in principle, synchronise modifications with another context of their own accord and in chronological order, triggered by requirements or events. The precise meaning of this can be shown in three examples of typical collaboration scenarios:

- Teamwork on a common task within a company
- Synchronisation with the company's PLM system
- Cross-company cooperation

Teamwork within a company

Teamwork – work on a common "product" – requires a common context. This can be, for example, pre-defined requirements and specifications, an existing solution which requires modification or an designed space as a geometry context. The general supervisor for the task puts together a workspace with objects from the PLM system and declares this as "shared". This forms the base for the work and the work in progress of all team members (Fig. 2). As a rule, the architecture does not restrict how each individual in the team receives its copy of this shared workspace. If all team members are part of the same company, they generally receive the shared workspace via "self-service" over the PLM system in which the shared workspace is stored. At the same time, this also serves as the central hub for the propagation of modifications made by team members in their personal workspaces to the workspace group. In principle, peer-to-peer communication is also possible, though this does not offer any real advantages in this scenario.

PLM and ERP integration

Workspaces are especially suited to communicating work in progress within the team. Making this available outside the realms of the team in the company-wide PLM or ERP system is not strictly necessary if a qualified status has not been reached, and

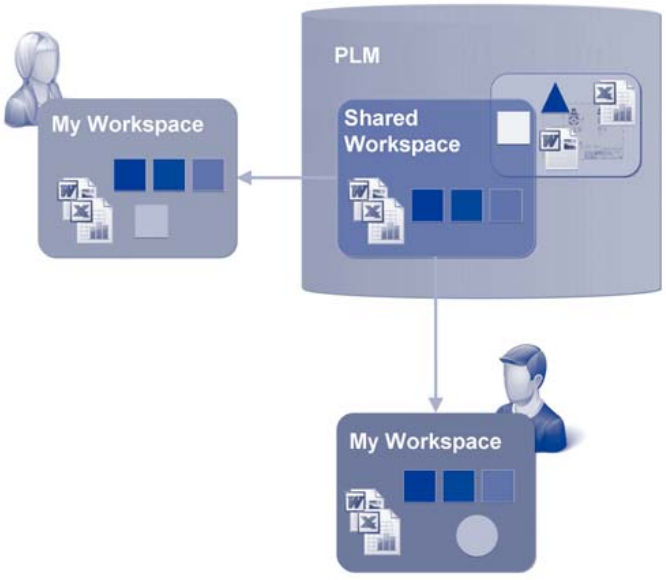

Figure 2: *Collaboration using shared workspaces*

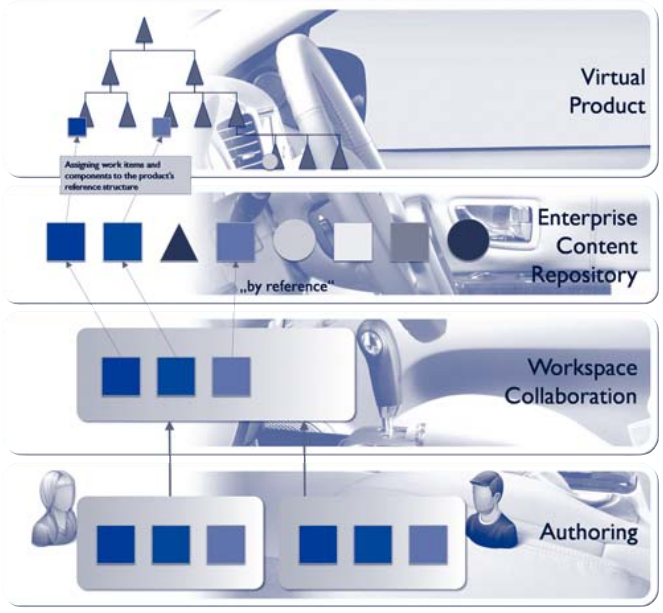

Figure 3: *Logical architecture: From the desktop to the central reference structure of the product*

should generally be avoided. If such a status has been reached, for example for a component, the relevant business objects must be created in the PLM or ERP system and associated with the workspace content, or the existing business objects must be updated (Fig. 3). As a result, these steps trigger successor activities such as release processes. Say, for example, a document and material or a new document version has to be created. To do this, the users are offered either the native dialogue of the PLM or ERP system, or special dialogue forms. The architecture is not restricted to specific systems, and integration with any system with a sufficiently open service infrastructure is possible.

Cross-company cooperation

According to a survey by sendler/circle published in August 2009, globally distributed, cooperative product development is the greatest challenge facing companies today. This affects not only cooperation between a company and its own development sites, but also increasingly cooperation with customers, suppliers and partners with significantly greater intensity. The supposed ideal situation, in which everyone works directly in the same central system, for example that of the OEM, only helps in exceptional cases. It requires rigid, inflexible procedures and standards and prevents partners from cooperating at eye level (Fig. 4).

Workspaces, on the other hand, are fixed neither to a specific collaborative context, nor to a specific type of communication with this context. Different companies can adjust workspaces according to their requirements:

- as a simple content container connected to workspaces management in order to use its special functions
- then, if required, to the company's own PLM or ERP system

Cooperation with other companies consists exclusively in the synchronisation of the workspace content. The options for creating scenarios are flexible: beginning with e-mail exchange, peer-to-peer support right up to using a central portal or SOA access point, behind which a PLM backbone is connected and serves as a global synchronisation point.

Business value

For the production industry, the number of options for reducing manufacturing costs is noticeably decreasing. In countries like Germany, innovation and thus more valuable and profitable products are the most effective instruments for competition. Workspaces as a tool and for the self-organisation of users' own work therefore strengthen the importance of developers as the foundation of a company's innovative power.

The open architecture of workspaces abandons the artificial divide between internal and external collaboration. The advantages of distributed, flexible value chains in product development can be put to much better use.

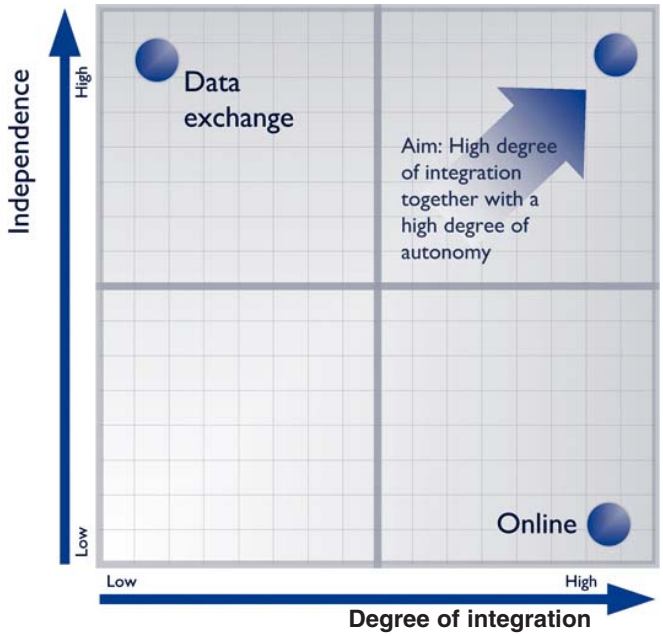

Figure 4: *Cross-organisational cooperation between independence and a high degree of integration*

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