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INTEGRATING DESIGN PROCESSES IN AN SE-ENVIRONMENT

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1. Introduction

For decades the design process and product development have been subjected to growing time pressure due to market conditions such as shrinking product life cycles, strong competition, growing customer demands and the need to offer a broad variety of products. In the early 1990s the principle of Simultaneous Engineering (SE) established itself in engineering design. The objectives were a sharp reduction of development time and a wider product portfolio. The basic idea was that instead of departments working in sequence in the development process, they would all work in parallel, with regular meetings for co-ordination [see e.g. Ehrlenspiel 1991]. In most cases this led to faster and more flexible access to market.
However, this approach has generally reached its limits. Quite often deadlines, in combination with high quality requirements and strict cost limits, are becoming the critical factor. The start of production is determined years in advance, and SOPs are decisive for the overall marketing strategy, but as schedules get tighter and tighter, there are more and more cases where starts have to be postponed. The present trend is not so much determined by further reductions in product development time. On the contrary, many automotive enterprises, for example, now accept that development will take longer. Today the issue of process security is central in product development. And its importance is even growing, as not only production of parts but also design work is frequently outsourced. In a significant number of enterprises more than 50% of the overall design work is already done externally, so the complexity of the design process will grow, too.

1.1 Objectives

The aim in this paper is to:

- take a close look at interdependencies between design processes and other processes in product development, e.g. production, quality assurance, purchase, controlling;
- show how simultaneous engineering (S.E.) processes can be shaped to minimise friction by a combined effort of the entire S.E. organisation;
- give an example of how agreement was reached at an automotive enterprise on project phases and milestones.

2. The dilemma of design departments in product development today

Since the introduction of Simultaneous Engineering, a design department can no longer work on its own schedule. Today, design work should take place between the SE team, where solutions are sought for all aspects of a product, and the design department, where specific elements are handled. This principle is now widely accepted in many enterprises. Nevertheless, in some design departments the attitude still prevails: “We own the product development process”. And at first sight, this seems to

have several advantages:

- It gives higher status to the engineering designers as the “heroes of the development process”; others are considered just as “auxiliary functions”.
- It grants a lot of autonomy in defining features and properties, determining schedules and quality gates. In some enterprises the engineering department even acts like a castle with a closed drawbridge.
- Other departments cannot accuse them of shortcomings or delays, because the design process is more or less a black box to them.
- At first sight, all communication with other departments is time consuming and therefore often cut short when work loads are rising.

However, it is usually the lack of integration between the different departments that causes additional work load and consequent delays. With an attitude of engineering designers as described above, the other departments often have to work in the dark and their processes are poorly integrated with design work.

Experience shows that in practice the processes of the participating departments often fail to dovetail. The designer obtains essential information, documents and decisions later than necessary, prerequisites for design work are not complete when needed. Interfaces to other functions (who has to do what and until when) are often not clear enough. To name just two examples of mutual dependencies that might lead to delay and/or improper market appropriateness:

- The integration of suppliers cannot be handled by the design department alone. Supply chain management, including calls for tender, price negotiations, delivery deadlines etc., as carried out by the purchasing department, takes time and requires qualified input by the design department as soon as possible. This is especially critical if the suppliers are not only expected to manufacture a designed part but, as it is the case more and more frequently, to carry out at least a part of the development on their own. So if the bidding process is not carried out by a joint effort of design and purchasing departments, either a second best solution has to be accepted or several time consuming loops are necessary.
- If the cost-controlling department is not directly involved in developing and choosing design options, it either tends to result in unnecessarily expensive solutions or, when costs get out of control, it is necessary to restart the design process.

Analogous difficulties can be caused by insufficient synchronisation of the design department with production, quality, logistics, sales/marketing and IT departments. This lack of synchronisation means that many problems involving design will not be tackled when they emerge but only later when they become evident to the design department. This means a lot of improvements and revisions still have to be carried out at a very late stage of product development, a time when undivided attention should be paid to preparing the start of production.

In such a situation, to avoid delays, all resources (and in particular all available manpower) will be allocated to this project, absorbing so much personnel that other projects with a later SOP become difficult to control, too. It is increasingly common for enterprises to face a “bow wave” of uncompleted project tasks [Fischer 2001, see Figure 1]. It tends to be accompanied by the hope “If we can just cope with this crisis, then we will have sufficient capacity again”, but this moment will never come. Therefore process security aims at two objectives: at a flawless SOP on time for a specific product and also at obtaining a basis for realistic long-term planning for all products of the portfolio.

3. The Standard Product Development Process

"Simultaneous Engineering“ in a restricted sense is not sufficient. Product development processes not only have to take place in parallel. The way they are combined has to be determined carefully and all participants have to be fully aware of the connections. It is common for individual departments to draw up plans of their own processes. However, these are usually “island solutions” and not connected to the plans of the other departments. It is not sufficient just to join up all these single plans. Only a precise determination of the interdependencies enables realistic estimates to be made of the duration of project phases.

A most powerful tool for this can be the description of a standardised product development process

("Standard PDP"). This Standard PDP is a reference plan for the development of an "average" product. In it

- the processes of the design department are described and linked (as well as production, quality, purchase, sales/marketing, controlling, logistics, etc.) and related to each other; interfaces and interdependencies have to be clarified and described in detail.
- internal design milestones / quality gates have to be compared and adjusted with processes of other departments. A clear description of all milestones has to be worked out, preferably in form of checklists, to assure that all parts of the organisation know which interim results have to be completed at which time.
- an overall time schedule should be set up including all milestones, possible interim checkpoints and all phases of the development process.

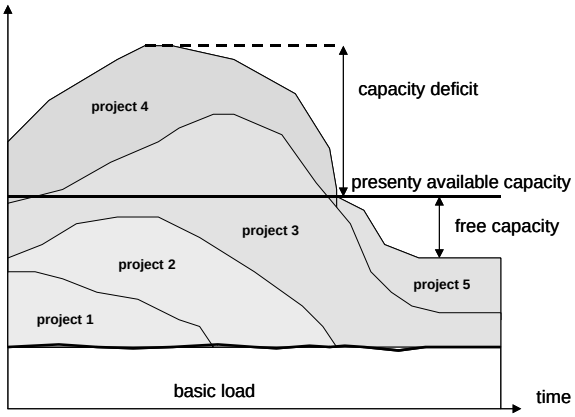

Figure 1. The "bow wave" caused by delays in product development

3.1 The importance of the early phases

Special attention has to be paid to the early phases because any confusion at this stage leads to work having to be repeated, either because other departments did not deliver their input on time or had been working in different directions. During the elaboration of this Standard-PEP, the resource requirements and decisions to be taken by the board of executives as early as possible can easily be underestimated.

A lack of resources and decisions causes an undefined start into the late phases with the consequence that at very late stages plans have to be changed and spot decisions have to be made that were due long before. On the other hand, this indicates a possible solution. What is needed is "front loading" (see Figure 2), the shift of resources and consecutively interim results into the early stages of the product development process. This will not usually shorten the process as a whole, but it will reduce the extreme work load common at the end of a project as well as the overall quantity of work required. In addition, the overall development risk will be reduced.

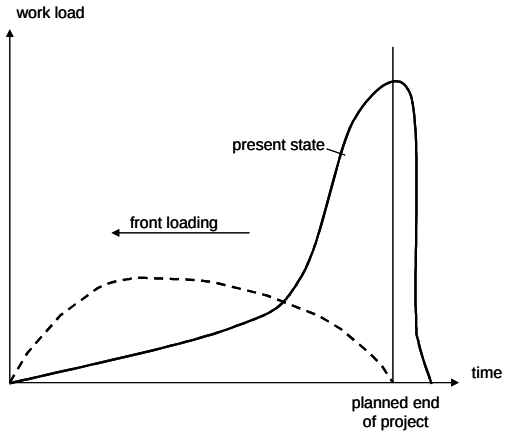

Figure 2. Shift of work load

3.2 Advantages for the design departments

As stated above, a design department can draw some benefit from a situation in which it "owns" the product development process, especially a stronger position and more autonomy. However, the development of a Standard-PDP as described above brings other significant advantages with it apart from a general reduction of work load peaks, e.g.:

- it can serve as an internal guideline for the design department, describing all necessary steps and offering good support, for instance for new personnel;
- the description of milestones including the necessary decisions to be made by the board of executives strengthens the chance of obtaining top level support when needed;
- by determining clear interfaces it provides a base to demand punctual inputs and other interim results from other departments;
- delegation of some tasks and responsibilities e.g. prototypes can be tested by the quality department;
- change management becomes easier if the procedures have been clarified;
- knowledge management will be facilitated because the access to the experience of other departments is easier;
- the precise determination of "What has to be done at what time" reinforces the position of the head of the department when it comes to hiring additional design staff.

Of course, the openness of a Standard-PDP is two-way, i.e. other departments are also in a better position to demand interim results, but this always turns out to be a win-win situation, not only for the product development process in general but also for every department.

4. Producing the Standard PDP

4.1 The Standard PDP as a flexible framework

This Standard PDP must not be a rigid scheme but a flexible framework that can be adjusted to the given project. Practical experience and empirical research [Zika-Viktorsson and Pilemalm, 2001] shows that a highly complex model of product development projects is not functional if it has not been developed together with the project members who have to work along with it. Externally developed models are considered rigid and inflexible and following their routines becomes a burden.

So the Standard-PDP does not show how every single project will be run. If it were supposed to fit all projects it would become so superficial that it would not be of real help. Instead the Standard-PDP provides a pattern that is the foundation and the reference point for planning individual projects. A project manager can then adapt it to the special conditions and constraints of a forthcoming project, but all deviations have to be explained and justified to the board of executives.

4.2 The way is the goal: The elaboration of the Standard-PDP as a means to its implementation

Beside being flexible and operational, the Standard-PDP needs broad acceptance throughout the organisation. Its elaboration requires a common understanding of all those involved. If it were developed and implemented top-down,

- a lot of experience from the working level would be lost,
- there would be a high risk of missing critical issues, and
- a lot of resistance from project members should be expected because they were not involved and they will feel they are not taken seriously.

Therefore the elaboration of a Standard-PDP should take the form of a workshop or a conference with all stakeholders present, or at least representatives of all of them, i.e. all the departments involved, management, "project world" and line-organisation. In this workshop all points of view can be heard. While listening to others, their conditions, needs and constraints will become apparent and, if the workshop is facilitated carefully, a mutual understanding can emerge together with a shared, holistic view of the entire product development process. This mutual understanding is a powerful experience that can carry entire teams through their daily project work. So once a Standard-PDP is installed it allows the designers to fully exploit the expertise of the S.E. team.

4.3 Developing a Standard-PDP: A practical example

"Falkenstein", a renowned company in the automotive supply chain, is taking the step from producer of components to a tier 1 systems' supplier. More and more suppliers are called on to develop and deliver complex systems just in time. So the new system projects of Falkenstein were far more complex than their component projects, in terms of number of participants, project requirements, development risks, need to purchase certain components themselves, etc. On top of this, these system projects can have very different structures, derived from a broad variety of possible product levels and car producers. Taking all this into consideration, a flexible set of procedures and rules was needed that could be adjusted to the unique conditions of the given project.

To let the Standard-PDP benefit from the skills and experience of all employees connected to the projects, the widest possible spectrum of participants was involved: managers and working level, "project world" and "line world", from all relevant departments. The overall method of elaborating standards to the system projects was "Whole Scale Change", providing a set of tools to handle large groups [for a general description of this method see Dannemiller Tyson 2000, for its application to project management of product development processes see Koetter and Longmuss 2002].

The elaboration of a Standard-PDP took place in a three-day workshop. Before it started the fundamental project phases and milestones had been determined by a smaller project team and communicated to all participants so they were all familiar with the same terms. The first day was used for a careful look at the critical points in current and recent projects, at the positions of the stakeholders and their constraints. This prepared the way for the second day when, beginning with the foundation of a project, all milestones were scrutinised and their contents determined, divided into the contributions each department had to make. Together with this all processes were listed, indicating what had to be done from one milestone to the next. When needed, interim checkpoints were introduced to document nodal points where one or several departments had to reach decisive results. On the third day, the heads of departments had to check if they could agree on the description of the product development process. When this agreement was reached and they all committed to the plan, necessary steps could be taken towards its full implementation.

After that, in order to make it easier to handle, the PDP was divided into three levels (see Figure 3):

- The first level illustrates content and time of the decisions to be made by the board of executives. It includes "traffic lights", indicating at first sight whether the major milestones are passed on schedule.
- The second one shows processes and milestones at project management level, allowing the project leader to check the daily progress of the project.
- The third one visualises the work to be done at the operative level, with a specialised version for each department and SE-team, containing a detailed description of all milestones, interim checkpoints and relevant processes.

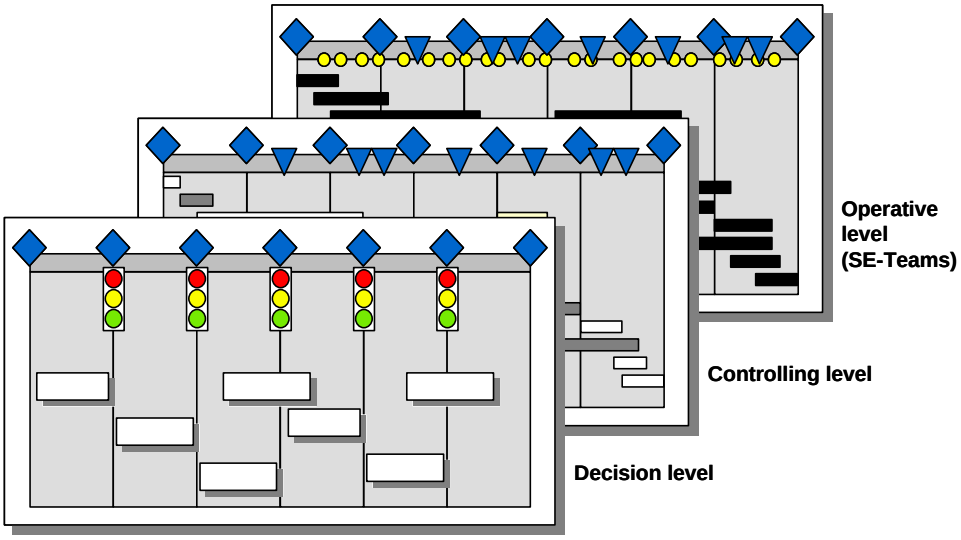

Figure 3. Three levels of a Standard-PDP

The joint elaboration of this Standard-PDP was considered extreme helpful by the participants. The completed set of documents has become an important tool to handle product development processes at “Falkenstein”.

5. Conclusion and outlook

Engineering design as a part of modern product development is subjected to too many constraints to be handled by a design department on its own. An example of best practise was shown of how all participating functions can be successfully involved in product development. The designer then has a clear orientation as to which input should be available when, as well as about which results have to be delivered to whom and when.

If the existing rate of product development is to be maintained or even speeded up, enterprises will have to work out a new Standard-PDP very carefully, with the participation of all relevant departments and hierarchy levels. Otherwise it will not be possible to secure process security as design processes become increasingly complex.

An interesting parallel to this proposal can be seen in a related field: The approach to the development of a Standard-PDP (participation of all stakeholders, focus on communication and co-operation) coincides with methods currently developed in the field of design methodology. They also emphasise a shift from a technological orientation towards a strategy aiming at a corporate culture of individual and organisational learning with the optimisation of co-operation and communication processes [Bender et al. 2001]. In the long run, the proposed approach might contribute to a revision of the paradigm of engineering design as a whole.

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