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Session 6B: Development Process and its Improvement

Title: **Process Improvement and Assessment in the Automotive Business**

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The department 'Software and Engineering Processes' of Siemens Corporate Technology is existing since 1993 supporting the units of Siemens in defining, improving and assessing their development processes (system, hardware, software, supplier, ...).

Marion Sperle, born 1968, has a major in computer science with minor theoretical medicine at the Munich University of Technology. Graduated as Dipl.-Inf. Univ.

During her studies she worked at Siemens Information and Communication developing public network systems. At Taurus GmbH and Vereinsbank she developed application systems with graphical user interfaces and database applications.

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Keywords:

Process, Methods, CMMI, best practices, business goals, process improvement, requirements engineering, project planning, architecture





Abstract:

The article shows the benefit of systematic processes for the development of embedded systems. Based on the example of automotive supplier business, it shows some important factors that should be considered in processes to be efficient (chapter 2.1 and 2.2), the impact of the factors on the processes and how these factors can be considered in the processes (chapter 2.3).

0 Introduction

In the automotive business the variety of features is increasing constantly and they are increasingly implemented as embedded software.

The SW projects increase dramatically fast (up to 30% of the vehicle cost in 2002 will be electronics, Financial Times automotive report by Eric Harkness). The German research and prognosis institute „Marketing Systems“ has evaluated in 2000 that 40% of all automotive suppliers are in risk as their rate of return is below 1 percent. So they are forced to increase their productivity. The article talked about possible savings of multiple millions of Euros by increasing the quality of planning (Handelsblatt, 5th april 2000).

Increasing productivity and reducing problems with a simultaneous dramatic increase of the complexity of projects and involvement of multiple disciplines requires systematic and efficient processes.

1 Why systematic and efficient processes?

Experiences of companies world-wide show that productivity and quality can be increased significantly by improved descriptions and implementation of the proceeding in development (development processes).

The following table (figure 1) about changes through Software Process Improvement (SPI) shows an interesting benefit (an investigation done by the Software Engineering Institute (SEI) of the Carnegie Mellon University in 1994).





Category	Range	Nr. of organizational data points	Detailed data per organization
Years engaged in SPI	1-9	13	
Yearly Cost of SPI per Software Engineer	\$490 - \$2004	5	<i>SPI-years</i> : \$ 6:2004; 2:490; 6:858; 3,5:1619; 2:1375
Productivity Gain per Year	9 – 67 %	4	<i>SPI-years: (LOC/unit of time in %):</i> 3:9; 1: 67; 4:58; 5:12
Early Defect Detection Gain per Year	6-25 %	3	<i>SPI-years: (Defects detected early in %)</i> 9:6; 5:25; 3,5:22
Yearly Reduction in Time-to-Market	15-23%	2	<i>SPI-years: (development time reduction per year in %):</i> 3:15; 6:23
Yearly Reduction in Post-Release Defect Reports	10-94 %	5	<i>SPI-years: (defect reports reduction per year in %)</i> 9:39 / 1,5:94 / 1:70 / 3,5:10 / 3,5:11
Business Value (Savings/Cost of SPI)	4:1 – 8:1	5	<i>SPI-years: (business value ratio)</i> 3,5:4,0 / 6:5,0 / 6:4,2 / 5:6,4 / 3,5:8,8
Investigation by SEI, Carnegie Mellon University (CMU), USA, at 13 organizations (e.g. Bull HN, GTE Government Systems, HP, Motorola, Siemens Stromberg Carlson, Texas Instruments, ...)			

Figure 1: An investigation about changes through Software Process Improvement

2 How can a process become systematic and efficient?

2.1 Common success factors

There are some common success factors for process improvement. Similar to other projects, process improvement needs realistic and measurable goals and a strict monitoring and controlling to become successful. Changes in processes means changes in behavior of people and this needs special attention. It is important to motivate the people to change their behaviors (e.g. to show the reasons for changes, periodic communication of benefit, reward, ...). A clear and periodic communication of the goals, the planning and the progress for instance supports the continuity of process improvement. Additionally the management needs to support the changes in the process, for instance in recognizing that changes in the beginning need time and investments.

As process improvement has impact on all the staff, it should follow a systematic way to assure a certain quality. Proceeding this way can be compared to a product development process: to analyze the requirements, to plan the development of the process, to develop a design/structure of the process, to assure its quality, to manage the process items and their versions, to test the process before releasing it and so on.



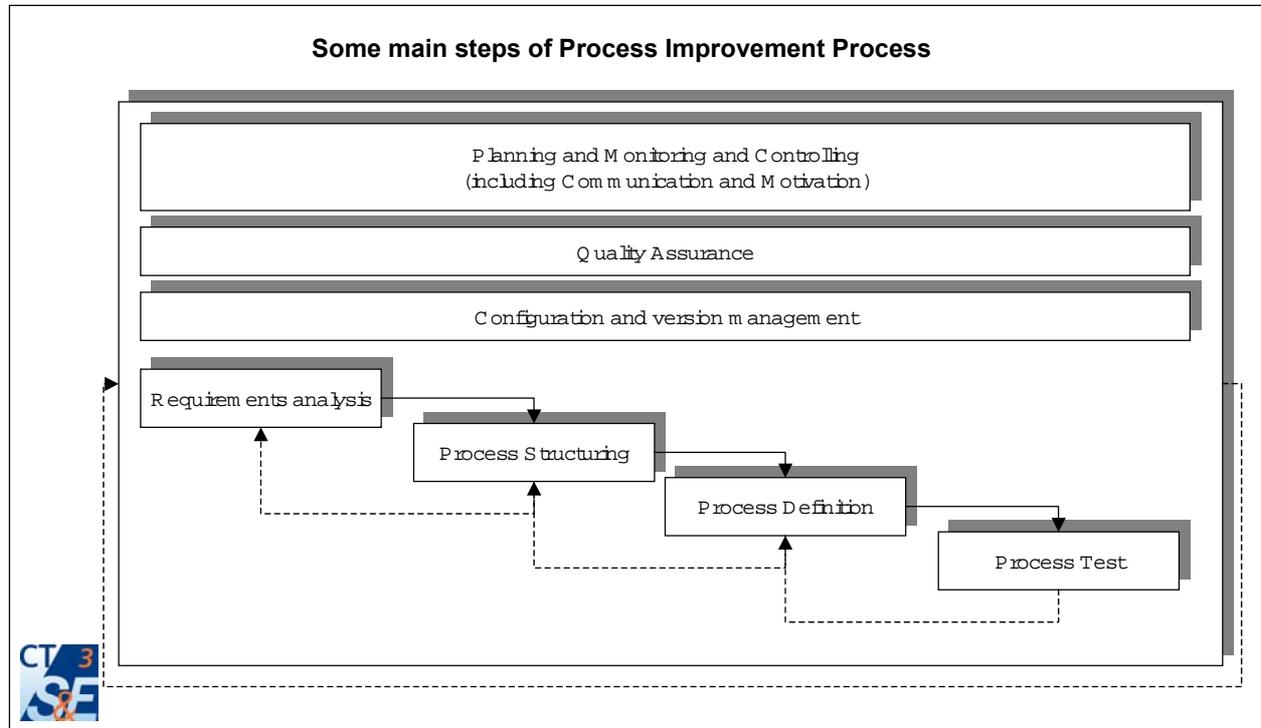


Figure 2 Main Steps of a Process Improvement Process

These steps can be implemented as follows for process improvement:

- An example for analyzing the requirements of a process will be shown later in the article.
- It will not only be helpful but necessary if the process will be described simultaneously by different groups, to describe the structure of the process. The structure should describe what process areas will be affected, what topics are covered by what process areas and how the interfaces between the process areas are defined. This is similar to the architecture of a software program. The management of the items supporting the process (process descriptions, intranet pages, templates, slides, etc.) and their versions will be based on the process structure.
- To assure the quality of the process different methods can be implemented. A well-known one is a systematic review of the process items by experts. The advantage is that it can be used already during the definition of the process.
- By piloting the process in some representative projects before releasing it for the whole organization, the process can be tested if it is easy to use, consistent and fitting to the needs of your organization.

- An assessment of the process helps to analyze gaps in your process definition or in your process implementation by mapping it to a process model that was developed by using the experience of many different organization (e.g. the process model CMMI of the SEI) and by considering the influences of your organization and your business.

The proceeding for Process improvement can be seen in figure 3:

The assessment - improvement cycle

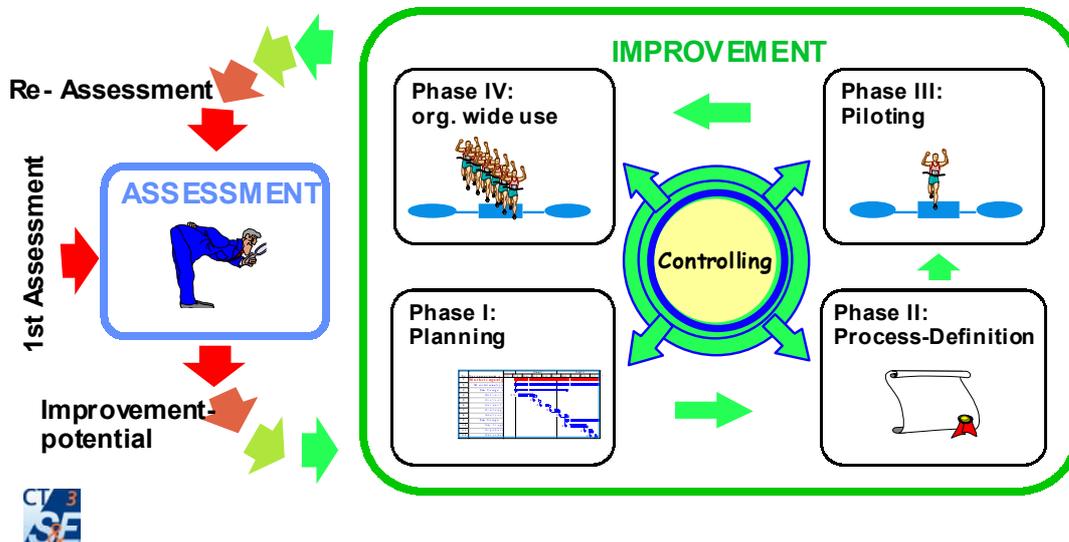


Figure 3: The proceeding of Process Improvement

2.2 Business analysis example

An analysis of your **business** and your **business goals** is a part of the requirements of your process: What are the specifics of your business? What do you want to improve? What topics influence your business and your business goals? What factors influence the topics to be improved? With this knowledge you will be able to design a well-fitting process for your organization that will support your business and your staff.

Referring to the article of “Marketing Systems” in the year 2000, it shows that automotive business needs to improve the productivity and the quality of planning. Both strongly depend on the specifics of the business. The goals of car manufacturers are also influencing their suppliers.



This chapter shows exemplarily how business analysis works as a basis for process definition by using the example automotive supplier business.

Automotive supplier business has a lot of specifics. These specifics must be considered in process definition. To give you an idea how the specifics have impact on the processes it is enough to look at some of the most specific:

- 1) Personal cars are mass-products.
- 2) The products are evolving a lot since 100 years, and have a lot of features and requirements.
- 3) More and more features are developed as embedded systems using standard hardware and software as well as specific hardware and software.
- 4) Most of the features have to fulfill real-time conditions.
- 5) The products often have different variants, e.g. low-budget vs. luxury cars, country-specific variants.
- 6) Often features are based on former products.
- 7) A lot of the features of vehicles are safety-relevant.
- 8) There are really hard target dates (SOP).
- 9) The products are composed of multiple disciplines (hardware, software, mechanics, etc.) .
- 10) Sometimes suppliers deliver a whole system (e.g. an airbag system), sometimes they deliver only a part of a system (e.g. only an airbag processor).

2.3 How to react on these multiple constraints of the automotive supplier business in the processes ?

The following description shows some parts of processes that have to be defined or adapted in order to meet the business goals and business specifics analyzed above.

Ad 1) As personal cars are mass products the process should define how the purchase, the stock management, the tests before production etc. can be optimized. Be aware that these process areas have impact on the development and on the production, e.g. when a cheaper standard hardware may not support some features, the development has to react on it.





-> *mainly influence to the business goal productivity.*

Ad 4) The real-time conditions of automotive features should be considered for instance in the requirements, the architecture and the test of the components. In order to facilitate the consideration of real-time conditions during the development they should be described already in the requirements. It is important to analyze what components may consume what amount of time and what situation may have impact on the time conditions of the system. The real-time constraints should be tested as early as possible.

-> *mainly influence to the business goal quality of product.*

Ad 2, 5 and 6) As cars are existing since more than 100 years they have evolved significantly. Nowadays thousands of features are implemented and often a feature is evolving from product to product. That means that a requirement is implemented in different parts of a product and may use parts of former products.

Additionally a feature may have different variants, for instance it needs some country-specific adaptations or adjustments to different budgets (low-budget, luxury).

This requires a good structure of the requirements. You need to be able to trace the requirements throughout the whole product lifecycle in order to be able to answer the following: what requirements are depending others, where are they implemented, what impact has a change on the requirements and on the product components, are all requirements implemented, etc..

Consequently you need a stable change management and a consistent version management to be able to put together all the needed product components and the right version of them.

-> *mainly influence to the business goals quality of planning and quality of product.*

Ad 7) Safety relevant features of a product need special and intensive treatment. The safety relevance can be categorized depending on the impact of a malfunction of a feature (SIL- safety integrity levels). According to these levels different methods should be used. The safety-relevant parts of a feature have to be separated from non-safety relevant parts, and this throughout the whole product lifecycle: it has to be indicated if a requirement is safety-relevant, safety-relevant parts should be implemented in separated product parts, safety-relevant parts should be tested intensively according their SIL, and so on.

-> *mainly influence to the business goal quality of product.*

Ad 8) In order to meet the hard target dates you need a good planning considering all the risks of the project and defining mitigation strategies and a tough monitoring and controlling procedure. As projects in the automotive business generally are long-term projects (2 years) it is important to define several deliveries in order to be able to assess the progress. Additionally to the deliveries requested by the customer, you should define internal synchronization points, e.g. internal deliveries and releases. These synchronization points facilitate regular monitoring of the progress against the planning and the controlling of the technical consistency of the product components.





-> *mainly influence to the business goal quality of planning.*

Ad 3 and 9) Most of the features are implemented in software embedded in specific as well as standard hardware. Additionally “Standard Software”, e.g. a communication bus system, is integrated in the product.

The product architecture has to reflect on these aspects taking into account that the standard hardware and the integrated standard software may change from project to project or even within a project. Defining different product layers with only one hardware dependent one, might reduce effort when hardware changes. Testing must also be prepared to changes in hardware and software.

As many disciplines are involved, it is very important that the process defines the system engineering: how all the disciplines will develop consistently and in a synchronized manner. It has to assure that the different components will fit together (technical interfaces) and will be developed at the right time (synchronization points).

But be aware that this kind of synchronization will affect the whole product lifecycle, e.g.:

- the decision what requirement will be implemented by what discipline
- how the product architecture looks like
- when tests will be done separately and when with the integrated product. A simulation environment would be helpful to recognize the defects as early as possible, in order to be able to test the software even before the specific hardware is realized.
- last-but-not-least when spare parts production requires input from the different disciplines.

-> *mainly influence to the business goals quality of planning and quality of product and productivity.*

Ad 10) When only a part of a whole system is developed by an organization the technical interfaces and time constraints are of very important. They have to be well-defined to ensure that the components coming from different suppliers are working correctly together. Contract Management, Requirements Engineering and Testing will be very important.

-> *mainly influence to the business goals quality of planning and quality of product.*

At least all these aspects (and many others) have to be considered in a process for an automotive supplier organization.

Figure 4 shows exemplary the process areas that have influence on 3 business goals:



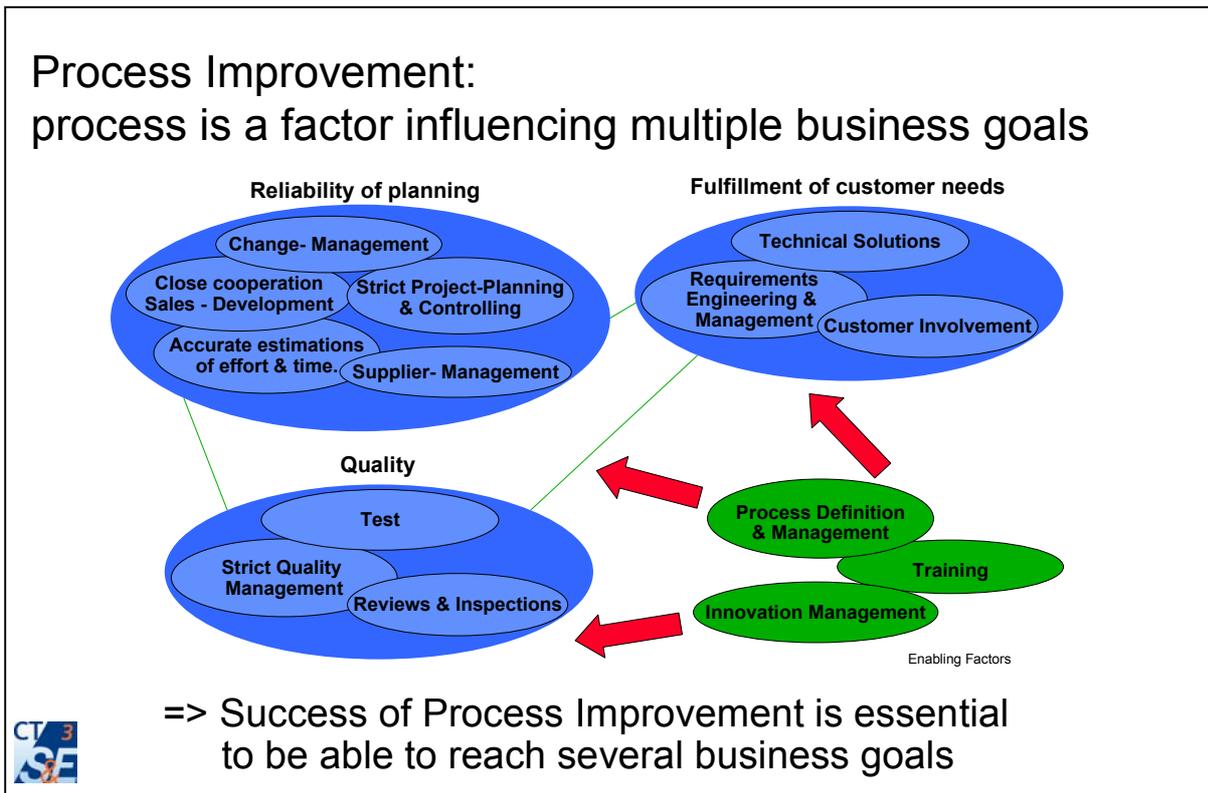


Figure 4 Processes influencing business goals



3 Conclusion:

All the given examples explain that processes, especially development processes, have to be adapted to your business and your business goals in order to define a useful, easy-to-use, supporting and feasible process.

Main steps of a successful process improvement are the analysis of your business, your business goals and your organization. These analyses will show you the requirements of your process. The structure of the process shows the process topics to be treated, where they will be treated and how they interfere. The interfaces of the process areas should be considered well.

An appropriate common process model, for instance the CMMI of the Software Engineering Institute of the Carnegie Mellon Institute can support you performing these tasks and additionally gives you a good and well-experienced means to assess your processes regularly.

