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A HIGHLY FLEXIBLE PROJECT MATURITY MANAGEMENT METHOD FOR THE EARLY PHASE OF PRODUCT DEVELOPMENT

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ABSTRACT
The development process of innovative systems, especially in the very early phase, is characterized by high uncertainty and has high influence on the succeeding development tasks. But still it lacks of harmonized methods and criteria for project evaluation and maturity controlling [1]. In particular, the very dynamic development process of innovative systems needs an efficient integration of project maturity controlling, objective controlling, knowledge transfer and decision processes. To cope with the increasing number of cross-organizational and cooperative development projects, the maturity information is used as a controlling parameter, a project performance indicator and an input for risk assessment. At the project decision points, maturity reporting is used for decision support. Especially the maturity controlling for innovation projects needs to be highly flexible, lean, and with adaptable controlling intensity for a broad scope of project ideas. This paper discloses an iterative project maturity management process for innovative early phase projects on the basis of a refined stage-gate process [2] that fulfills the early phase requirements. The maturity controlling method has been put into practice in 2007 to optimize the multi-project management of the pre-development phase of the German car manufacturer BMW.

Keywords: Innovation management, project maturity management, automotive industry, early phase

1 INTRODUCTION AND PROBLEM DEFINITION
The automotive industry faces a steadily increasing number of car models and derivates. At the same time these derivates come to market in shorter intervals. Customers demand fast a new generation of energy saving car models. As life cycles shorten and the technological and competitive environment becomes tougher, there is special interest on converting new technologies into innovative products and processes quickly with high quality and in a way that customer needs are met. A study by Koen et al. identified the early phase to play a key role in the product development process for large numbers of really new products introduced each year [3]. An extensive empirical study showed, that "greatest differences between winners and losers were found in the quality of execution of pre-development activities" [4]. Consequently high failure rates have often been related to insufficiencies at the early phase of product development. At the early phase of product development quality, costs and schedules are mostly defined. The effort to optimize project outcome is low and effects on the whole innovation process may be disproportionately high.

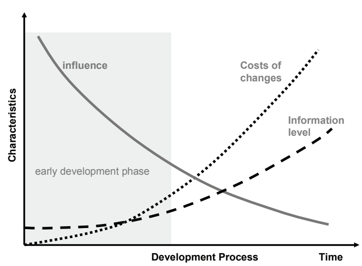

Figure 1. Characteristics of the "Early Phase" [3]

Figure 1 shows the typical characteristics of the early phase. The degree of freedom in design and the influence in project outcome are high, whereas costs of changes are comparatively low. This early phase advantage is limited by the fact that the amount and quality of information is low compared to the later stages. A focal point of the early phase project controlling is therefore the optimization of the information transfer from former project outcomes to the upcoming projects. As idea generation and concept development are typical tasks of the early phase, there has to be sufficient room for creativity. Also, there is the need to systemize activities to enhance the efficiency of the pre-development activities. With the early phase project maturity controlling an integrative approach to control the predevelopment phase of technology-based industries is proposed.

The objective of the early phase project maturity controlling is to provide an overview of the maturity of the innovation pipeline and to optimize resource allocation to the projects at a multi-project controlling level. Controlling a single project, the maturity information is used to synchronize development with upcoming vehicle projects, to provide an organizational learning framework, to improve product development, to provide a framework of project goals and milestones, and to increase the integration possibilities. These benefits allow an increase in the transfer rate.

2 DEFINITION AND DIFFERENTIATION

The term "early phase" is used to describe the development range from the generation of an idea to either its approval for series development or its termination [5]. The underlying development process is split into the vehicle development process and the development process of innovative systems and components as charted in Figure 2. In this example, the early phase period starts with the pre-development of vehicle components and ends with the concept phase of the vehicle project.

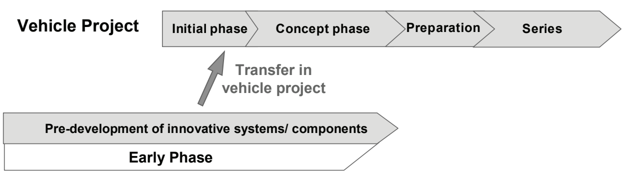

Figure 2. Development Process Synchronization

The upwards-pointing arrow indicates the transfer of the pre-developed components to an upcoming vehicle project. The new technologies or functionalities need to be matured enough to give evidence about the realization probability, cost and quality. The decision of further development activities or project hold/ kill is made at this point.

In the literature several terms for the description of the "early phase" are used, e.g. "pre-development", "pre-project activities", "fuzzy front end" and "pre-phase 0" [4],[6]. In this paper the terms "early phase" and "pre-development" are used since this jargon has been widely established in the development process of the automotive industry.

A project is defined in DIN 69901 as a plan which is characterized through the singleness of the conditions. These conditions imply aims, limitations including those of a temporal, monetary, and personal nature, and the separation from other intentions and project specific organizations [7]. Projects discussed in this paper are used to gather information about undiscovered or new technologies or to develop new functionalities for vehicles. Project maturity implies therefore all intra- and extra-organizational efforts that lead to a successful completion of the target settings within all boundary conditions.

Different from the term project, maturity is not defined consistently in the literature from a technical point of view. Therefore, there is the need to clearly define and differentiate the meaning of the term "project maturity". As a basis, maturity is described as the completion of development [8]. Derived from this statement the claim of a maturity stage is to create transparency of the project progress [9]. The degree of maturity is coupled with the achievement of specifically defined project goals – a defined final state [10], [11]. If a defined final state has been achieved, the reference maturity is reached. The whole complexity of a project is represented in the maturity indicators.

The term maturity can be seen as a state as well as a process value (Figure 3 left). In the case of maturity seen as a state value, the final state varies with the milestones. The progression of the project maturity is in this case not identical to the project progress. When the term maturity is used as a process value, it represents the gradual approach to predefined final project goals. This can be seen as the onward project progress [11].
If the measurement criteria constantly change during the project progress, the project maturity is seen as a state. The maturity remains in the optimal case over the whole project duration at a horizontal line of 100 percent. The reporting is at all times measured against the 100 percent reference maturity. This means that the reporting is done in reference to the actual valid maturity criteria. The reported measure is therefore the amount of actual valid reference criteria already reached. This type of reporting makes it difficult to compare the overall maturity of a project, since the maturity is only significant in the context of the actual project phase and therefore the actual criteria set.
If - in contrast to the state value - defined as a process value, project maturity takes the course of the project progress. The project progress takes a course of progressive or declining slopes which start at 0 percent at the beginning of the project until it finally approaches asymptotically to a maturity of 100 percent (Figure 3 left). The maturity criteria remain the same during the project duration. The degree of fulfillment of these criteria steadily rises.

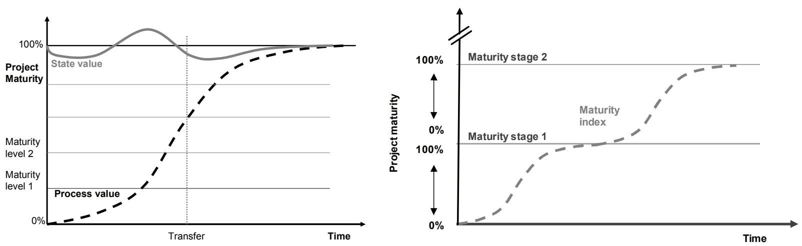

Figure 3. Maturity as a state and process value [according to [12]]

In the following, the maturity should be seen as a process value which is measured, traced and used as a controlling input. In contrast to the above drafted maturity measurement with high level overall project criteria, the criteria vary among the maturity levels. The degree of maturity is reported in each maturity stage from 0 percent to 100 percent (Figure 3 right). When monitoring a single project, the maturity fulfillment in relation to the maturity goal is reported. In multi-project controlling, the maturity stage measurement is reported. This maturity overview is used for the synchronization of the two development processes and for the innovation roadmap.
Besides the technical maturity indicators of the product maturity, additional project criteria are included which assure the market or customer needs, reflect the costs in context to the market and synchronize the development with the upcoming car series production programs.
The project controlling helps the project management with project planning and project monitoring and with the distribution of (cross organizational) information [13] in order to steer the project towards success. Controlling includes the project planning, monitoring and steering in a multi project environment. Maturity controlling includes feasibility of the project and readiness for management decisions through its maturity criteria. This ensures clarification and risk reduction in the early phase development process and thus higher development efficiency.

3 STATE-OF-THE-ART

Most approaches to maturity measurement that are found in the literature pertain to the software industry where they explicitly refer to the control of coding quality. The necessity for a systematic maturity assessment is mentioned explicitly, but possible implementations are only sketched rudimentarily.
The most widely known concept for the maturity tracing is the “Capability Maturity Model” (CMM) of the Software Engineering Institute (SEI) of the Carnegie Mellon University [14]. Derived from the CMM is the more generalized project management approach, the “Project Management Maturity Model” (PMMM) [15]. The PMMM is a method to describe the process maturity. It depicts the

development process itself and a company's ability to develop a product. The product itself is not considered at all by this method.

Another model to measure the degree of maturity, again from the software side, is the "business intelligence Maturity Model" (biMM), which is closely related to the CMM. The biMM treats the product in three main dimensions - business content, technology and organizational impact [16]. These three main dimensions are split into 94 sub-criteria. It only considers the end version of a (software) product and mostly disregards the development process with its different development steps.

A similar assessment can be made for the established method from Deelmann and Loss from the e-Business sector. The maturity indicators judge the maturity of solutions based on different views in a company (organizational view, data view, function view, performance view and the external view). Again, the development process is not well integrated and therefore for an early maturity assessment in the automotive industry not practical.

Fischer [17] proposes a method that derives maturity indicators from the specification, but he associates these specifications with the layer of the vehicle as a whole and does not separate them or break them down into their components. The chosen criteria are weighted to produce a single indicator that refers to the overall project. The evaluation and reporting is done in a predefined cycle (e.g. monthly) where the indicators are aggregated by their weights. The project progress is depicted in a diagram and prognoses for the project end are derived from prior project data.

Another academic effort to this issue is from Pfeifer [9]. His method represents, like Fischer's method, only the overall project layer with no further details. But he distinguishes between different kinds of maturity like economic-, time- or product maturity. Like in Fischer's method the indicators are valid for the overall project, and the group indicators are then split into single criteria for each group indicator. The group indicators and the sub-criteria are weighted to indicate the influence in respect to the project.

A very adequate method is published by Wissler [11], who focuses on the requirements of plant engineering and construction. The product is split into components but the level of detail is not explicitly mentioned. After the selection of success critical components, the main indicators are defined (functionality, quality, costs…), which are derived from the product specification. Then the main indicators are split in sub-indicators (e.g. quality in FMEA-execution, safeguard analyses…). The evaluation of the indicators is performed at predefined dates by an expert team and modeled on the basis of a traffic light measurement system. Depending on the evaluation, actions are discussed and adopted to correct the possible deviations. For the reporting, the aggregated single indicator evaluations are presented together with the suggested actions. This method leads to a higher transparency of the development progress and uses expert knowledge. The method works for the entire product development process (PDP).

Weinzierl introduced the broadest approach [12], which consists of a holistic maturity measurement system for vehicle projects in the automotive industry. The emphasis is on transparency of maturity management throughout the whole development process with the goal to minimize time consuming and expensive development loops in the series production. This method is designed for maturity controlling of the operative product ramp up. The front-loading idea with problem solving far ahead of the actual ramp up can be implemented with this method. But as yet, the method starts only after the pre-development activities.

González proposed a method for project maturity measurement for the automobile manufacturer Peugeot. She defined project maturity as a state, in which a project is capable to achieve its targets in an optimal way. The maturity is measured through the development process stages and through development steps for project planning and realization [22]. The model has two dimensions that are referring to the PMBOK and CMM standards. Again, the work concentrates on the comprehensive reproduction of the project maturity over the complete product development process, but lacks the special requirements of the pre-development phase for components.

There are several methods that deal with the later phases of the PDP to optimize the operative ramp up management. An example is described by Gentner [18], who has created development performance indicators to optimize product planning and steering in respect to cost, time and performance. He addresses the interfaces between series development and series production and suggests performance indicators to describe this changeover.

More methods can be found in the literature under the headings of logistics and time-to-market management. They mention maturity explicitly as an important steering value, but introduce no approaches for measurement.
Blau et al. recently introduced an approach to determine the maturity of a software product on the basis of the reference method "Reifegrad-Absicherung für Neuteile" from the German car manufacturer association (VDA) [25]. The goal of the method is to make the product quality measureable and transparent. The evaluation subject of this method is therefore not – like many other approaches – the development process, but the product itself, the software.

Mostly, companies from the automotive industry have maturity-based project management set into practice. A driver for this method is the high efficiency potential, which is seen in the interface between supplier and OEM as well as in the development process [12].
An example is the Mercedes Car Group, which put the method from Fischer into practice [17].
VW tracks the product maturity with software called RGS-Online. The maturity is measured with a set of predefined criteria and reporting occurs at given quality gates [12]. Again, experts judge the maturity.
The company Magna Steyr monitors the maturity from their suppliers on the bases of checklists at defined report cycles. The supplier and the customer agree on common criteria, which are then used to report the maturity.
All these methods have in common that they represent the overall project from the project management view and deliver decision support in terms of a report system [12].
The new maturity safeguard guideline for new component development from the German car manufacturer association (VDA) was released in November 2006. Throughout the PDP, maturity milestones are defined that contain maturity indicators and responsibilities. The maturity controlling process is driven from the quality department of the VDA and is used only for new product developments. The criteria become more detailed with rising maturity. A focus is on the interaction with the suppliers [19].
In practice the identification and evaluation of the product maturity degree during a development project is done cascading over different reporting levels (e.g. component level, module level, product level) on the basis of mandatory check lists. These check lists provide criteria, which are evaluated individually form the responsible project members according to the project situation. Single and cumulated evaluations are prepared manually in Excel or PowerPoint documents as standardized management status reports to communicate results to the next reporting level [23].

4 TARGETS AND DEFINITION OF THE TASK

All methods, presented in the literature as well as those implemented in practice, address the maturity in the actual series development process and not in the early project phase or pre-development. Therefore, the problem with high project failure rates is not addressed in new product development.

As the most innovative systems in the automotive industry are developed in the form of a project, accurate project planning can significantly increase the effectiveness and efficiency of a pre-development project. Several studies point out the importance of project planning. A key element of project planning is the determination of goals [1]. These project goals are called milestones when tied to a specific completion date. The maturity controlling method provides commonly agreed milestones for the project planning.

With increasing project complexity and interdisciplinary development teams, the implementation of a common process language and transfer interfaces becomes more critical. The maturity information helps to create transparency of the different development stages and depicts points of contacts between the teams and projects to fully utilize all inter-project synergies.
The challenge of the early phase is to give as much guidance as possible, yet facilitate a creative development environment and to push the projects from a fuzzy, dynamic, iterative creation process to a controlled development that prepares the projects to meet the hard quality and integration requirements of the series development process in the automotive industry.

Often the development of innovative components happens outside the standard (series) development process. In this setup, it is important to synchronize the two development processes to be able to transfer the projects from the pre-development into the standard development process. Therefore a function of the maturity controlling in the early phase is to manage a smooth changeover from the creative concept phase to the requirements-driven integration process in series development.

To keep the flexibility and the speed of the pre-development phase up high, an extremely adaptable and light weight maturity controlling process is needed. New innovation ideas are constantly added while others die or merge into other projects. The integration of innovation projects into the maturity controlling process must be fast and uncomplicated. Vice versa, each maturity stage has a specific exit strategy for the projects (e.g. transfer to another development department).

5 PROJECT MATURITY MANAGEMENT

In the preceding sections, the need of an integrated maturity control and the deficits of current maturity measuring systems were pointed out. For that purpose an innovation project maturity controlling on the basis of maturity indicators has been developed and a measurement method and reporting process have been created.

5.1 Requirements

Maturity criteria have to meet the following requirements to be a valuable maturity indicator. They have to be objective [12], non-ambiguous, complete, early indicating project goal deviations, allow the deduction of response actions and be economic maintainable [20].
Innovation projects are characterized by high diversity and that future project matters are not predictable. Therefore it has to be highly flexible. The contents in the maturity controlling system must be traceable and responsibility must be allocatable. In other words, the execution of the maturity criteria must be controllable. The system is not meant to work as a stiff bureaucratic checklist to kill tricky projects. It is meant as a decision support system and to plan an optimal new product development process derived from what was learned in former successful projects.

5.2 Maturity management concept

An early phase product development project runs through six maturity levels until finally transferred into a vehicle project (see Figure 4).

Figure 4. Maturity level of the pre-development process.

A project normally starts at maturity stage 0 and obtains successive maturity stages by processing the maturity indicators. Examples of maturity indicators would be “The test specification is finished and reconciled in the steering board”, “The risks of the geometric and functional integration are revealed and the impacts on the overall concept are quantified (coverage: acoustics, thermal management, materials, durability, energy, crash, aerodynamics and approvals)” or “A strategy for the component quality assurance is available, fallback solutions are known, the availability and cost of the test parts (hardware/ software) is resolved and consistent”.
There are no global time guidelines. The maturity stages get tied to a date for each specific project. This process enables a flexible milestone and maturity planning for projects with different development speed. The maturity stages are shortly described in the following:

Maturity stage 0 „Idea description“: All project suggestions which are not examined sufficiently regarding the feasibility and suitability for the automotive industry.
Maturity Stage 1 „Pre-development maturity“ (demonstrate feasibility): The checklist for maturity stage 1 contains those criteria that must be fulfilled in order to receive the appropriate resources for the

pre-development activities. The focus is on the fundamental technological economic feasibility on the generated customer use (also internal) and its marketing potential and on a plausible, challenging project planning and target agreement.
Maturity stage 2 „Proof of feasibility - qualitative": Alignment with the demanded requirements is completed for the focused, customer-oriented development.
Maturity stage 3 „Transfer maturity" (Proof of feasibility - quantitative): The questionnaire contains the goals that a project should reach to start the transfer into the vehicle project. For example, these can be quantified statements about electrical system loads, durability, changes in road performance, cost per unit estimation, etc.
Maturity stage 4 „Concept maturity": This maturity stage indicates a quantitative business plan with all business plan requirements. The business plan contains criteria to assess the economic and technological sustainability of the concept and consolidates risk estimations of the different releasing departments.
Maturity stage 5 „Integration maturity": The integration maturity is the last maturity stage of the early development phase. The main focus is the cost efficient and technological feasible integration of the innovation into the target vehicle under all hard automotive constraints.

A maturity level is defined through its maturity indicators. Therefore, each maturity level has a list with criteria which have to be met in order to reach the next maturity level - a checklist for the project manager. The maturity indicators can be seen as milestones in the project plan and are the key to a successful maturity controlling system. Therefore, the following lines draw special attention to the maturity indicator system.

5.3 Dimensions of the project maturity

As stated above, the early phase is a very dynamic and agile, yet creative development phase. Some critics even say that standardization should be excluded from this phase. However, when the research and exploration phase is over, the gap between having fancy ideas and efficient, cost saving realization has to be overcome.

Each criteria set is assembled individually for different types of projects to satisfy the dynamics of the early phase and the novelty character of innovation projects. The project maturity has in all maturity stages six dimensions: 1. Project planning/ Responsibilities; 2. Technical solutions; 3. Integration aspects; 4. Market/ Sales; 5. Supplier/ Cooperation; 6. Legal.

The criteria of the maturity stages become more detailed with rising maturity. In the beginning of a project, the team works without hard constrains in a creative, dynamic environment. With rising maturity the criteria get more and more detailed. This gradual increase of the performance rigidity leads to the above requested transition from the unconstrained to the requirement driven development process. It must be pointed out, that the requirements do not prescribe how the targets have to be reached, but give guidance at what point in the development process statements of a certain quality are needed.

5.4 Evaluation and aggregation of the maturity

In a normal project progression, a project finalizes all maturity criteria of a maturity stage and then reaches the next stage. The project targets are the maturity indicators of the actual stage. Since pre-development is not predictable and other project influences like e.g. unavailable test benches may occur, a flexible maturity measurement system is needed.
Before the maturity measurement is explained in more detail, the differences of the maturity indicators itself are to be explained. Some maturity indicators are unique to its maturity level (e.g. customer's input has to be gathered mostly at the beginning of a project) and some are constituents of each other (e.g. first risks have to be analyzed and then fall back solutions can be worked out for the determined risks). The specialty of the constituent maturity indicators are that, with the fulfillment of a maturity criterion of a higher maturity level, all constituent maturity criteria of the lower levels are fulfilled at the same time. So, if all maturity criteria of the highest maturity level are fulfilled, it is not necessary to reconsider the criteria of the lower levels. This allows the lean integration of projects with different maturity levels in the process.

The second criteria type is characterized through the single occurrence in one maturity stage. These maturity criteria need to be completed in higher maturity stages or marked as not relevant any more. If a criterion of this kind is not evaluated at all, it leads to a maturity index below 100 percent.
In each maturity stage a maturity index of 100 percent can be achieved. The maturity index is calculated through the degree of the fulfillment of the maturity indicators.
Some experts believe that not all maturity indicators are equally important and therefore, a maturity indicator weight is needed. For the early phase maturity management all indicators have the same weight, since generally only the most important indicators are used in this system to keep the indicator database small and handy. Another reason is that because of the high diversity of project types, the indicators can be chosen project specifically. So each project would need specific indicator weights to reflect the most accurate maturity calculation. This effort does not add extra value in this early development stage, since evaluation information is uncertain as shown above. The formula to calculate the maturity is therefore quite simple:

$$MI_{MS} = \frac{\sum P_{I,MS,HL}}{N_{I,MS}} \tag{1}$$

The maturity index (MI) of a maturity stage (MS) is the sum of the performance (P) of each indicator (indicator (I) from maturity stage (MS) and hierarchy level (HL)) divided by the number (N) of the maturity indicators of that maturity stage.

The performance (P) is measured through a traffic light rating where red indicates that no action has taken place yet to fulfill this maturity indicator. Yellow states that the work has started but is not yet completed. And finally, green signals the criteria requirements are fully met. This representation was selected due to the confidence and acceptance that it enjoys within the enterprise. For the calculation the three states are coded so that green is 1, yellow is 0.5 and red is 0. A maturity stage is reached, if all maturity indicators of this stage are processed successfully.

5.5 Planning and monitoring process

Initially the project contents are analyzed to determine if the maturity controlling can be used for this specific project. If this is the case, the actual project maturity is determined through a short verbal description of each maturity stage. Next the maturity stages get tied to due dates according the time line of the targeted vehicle projects. There is no standard timeline how fast a maturity stage needs to be processed. Some projects need months, others years. The maturity milestones are scheduled project specific in a way, that the pre-development projects are synchronized with the upcoming vehicle projects and reach a maturity where reliable go/ kill decisions can be made. Furthermore, this leads to a project prioritization in respect to the urgency.
After the maturity targets are determined, the project specific relevant criteria are chosen out of the criteria lists of the maturity stages. Generic sub-targets are determined, which enables the early detection of goal deviations and documents a conscious selection or neglecting of specific project aspects when prioritization is needed due to budget constraints. The process and project goals are captured in a review plan which is the basis for the target-performance comparison of the project monitoring.
For project controlling the progress is determined in half yearly project reviews. During these reviews the project responsible person reports the project progress using the degree of performance of each maturity criteria. This assures a comparable revision of the engineering achievement across different projects. Additionally, the deadlines are checked in respect of the performance degree of the requirements.
Supplementary during the monitoring, the budget utilization of each project is checked, in order to reallocate resources between the projects. The degree of performance of the maturity targets is evaluated with a traffic light rating with a documented reason plus actions in case of target variations.
After the analysis of the project reviews, the decisions for target and resource adjustments to optimize the development performance over the whole project portfolio are made.

5.6 Efficiency aspects

Controlling complex products requires a lot of maturity indicators to be a helpful guide for the project members. To reduce the complexity for low risk and low budget projects, a hierarchic maturity indicator system has been created. The project designers have to balance carefully the benefits against the administrative effort and cost to keep this system up to date. The goal is to keep the steering intensity in the optimal zone [1].
At this point, the maturity indicators are aggregated on three hierarchic levels. The degree of detail rises from level 1 through level 3. Level 1 contains the high-level maturity indicators in a verbal description to allow a rough maturity classification. Level 2 indicators particularize the main maturity indicators in a way a project leader can use them to plan and control the project. The level 3 indicators are component, or department-specific, and draw attention to component specific challenges. Different interest groups need the information in a specific level of detail which can be represented through the hierarchies.

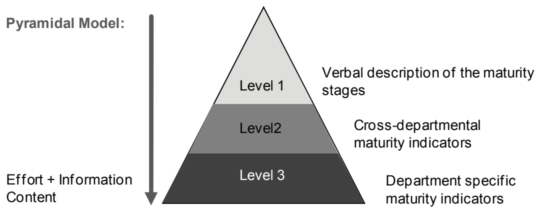

Figure 5. Levels of detail of the maturity indicators

6 PRACTICAL IMPLEMENTATION

The wording of the maturity criteria had been developed with representatives of the centers of competence (COC) involved in the development process and then tested with selected project managers. The criteria evolved out of a reengineering process of former successful and unsuccessful projects. First the success criteria were developed in each COC and split up into the different maturity stages, determining when information is needed for an optimal workflow. All COC criteria lists combined resulted in up to 100 criteria per maturity stage. After sorting out the doubles and combining similar criteria the most important were selected based on a holistic review with all COCs.
Based on the learning's of a study on 39 pre-development projects in 2006 [23], the maturity controlling system has been integrated into an existing web-based project management software. The project management software can be split in a project planning and monitoring module.

6.1 Project planning

A new software module called "Review Plan Generator" has been developed to provide support to the project manager for the preparation of project milestones and presentations. It is a tool which enables the project manager to pick project specific maturity criteria out of a criteria database, assign due dates to these targets and automatically generate a review plan for project progress controlling. This tool leads the project manager through the planning process by suggesting milestones based on the actual project maturity.

6.2 Project monitoring

The project progress and the performance are checked by a target-actual comparison. The actually achieved project maturity is calculated with the above shown formula.

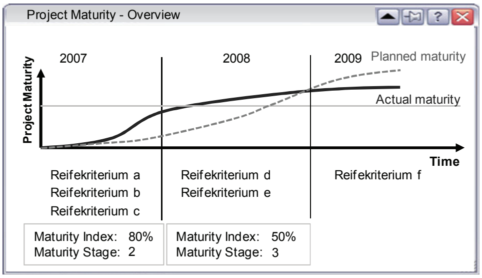

Figure 6. Visualization of the real and planned project maturity

The graphical visualization (see Figure 6) helps the project manager and the multi project manager to recheck the plausibility of the planning phase and to detect variations of the planed targets. To get an overview over the project portfolio, the number of projects per maturity stage is depicted in a graph. This graph visualizes the maturity of a complete project landscape and the variation with proceeding development (Figure 7).

Combining projects with the same target vehicle to a vehicle specific innovation program and animating over the time, the graphs would move like waves in direction of higher maturity stages. The peaks of the waves should be between maturity stage 3 (transfer maturity) and 4 at the start of the vehicle development process.

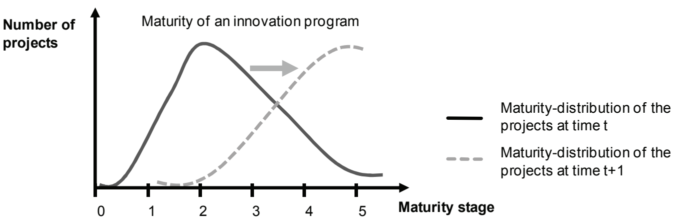

Figure 7. Maturity of project programs

7 RESULTS

The successful pilot implementation [23] resulted in the introduction of an enterprise-wide, web-based application with the focus on an efficient support for the project manager. During the time of mid 2006 until the end of 2007 maturity progresses and prognoses of 57 innovation projects were documented. Interviews with the project managers refined the information. This analysis lead to the conclusion that the indicator system has a sufficient preciseness to depict the maturity of innovation projects without exaggerating in effort. Due to the dynamics and the uncertainties of the early phase a more intense maturity assessment would only add value under proportionally.

Due to the purporting character of the project controlling system a familiarization period is needed. The needed time for reading and comprehending all indicators led to a similar processing time for first time users of the new review plan generator. After familiarization the succeeding project planning speeded up to about a quarter of the initial time.

The time benefit is accompanied by process reliability, comparability of the project maturity, consistent quality of monitoring criteria and increasing success chances plus increasing development efficiency through early assessment of risks. The increasing development efficiency could not be verified directly, but the distribution of the monitoring status moved towards more red and yellow in the lower maturity stages, which is an indicator of more critical monitoring in that stage.

The consistent documentation of the project progress allows a comparable evaluation of the engineering performance. Additionally a more precise prognosis of the future development outcome is possible. This is a great advantage especially in a multi-project setup with long planning horizons and review intervals.
Weighting the maturity indicators did not seem practically since the project managers select the most important maturity indicators out of a database. This selection is a prioritization process itself and sufficient for highly dynamic innovation projects.

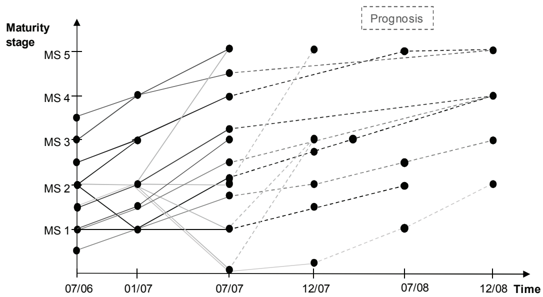

Figure 8. Comparison of 10 project progresses

The attempt to find similarities in the maturity progress and prognoses and assigning standard key events causing major changes (rapid increase or decrease of the maturity) was not successful yet (see Figure 8). This is not too surprising since innovation projects are per definition new and therefore in general on this monitoring level not often repeating.

Temporarily failures that are shown as a decrease in maturity are common in the course of the development of highly technological products. But seldom these temporarily failures are documented in a comparable way. A study of a greater number of projects could lead to at least company specific success and failure factors in the new product development process.

The method highlights potential reasons for deviations of the actual maturity from the planned maturity through the fulfillment status of different kinds of maturity indicators. Different aspects of the maturity like technical solutions or market analysis (compare dimensions of the project maturity in 5.3) may have different degrees of maturity achievement. Ex post analyses of the deviations of the actual to planned project maturity can be used for process advancements.

8 CONCLUSION

The maturity controlling system creates a common understanding of definitions and content of the innovation projects. This understanding leads to higher information quality and facilitates cross-organizational comparability. For project success, important participants (marketing, production, development…) are involved early and major challenges can be solved in early stages where product changes are relatively inexpensive.
The method leads to early uncovering of goal deviations and thus allows guiding the projects on the right track again. Therefore the project maturity controlling can be utilized as a management tool. The criteria can be used to draw special attention to development activities, e.g. more customer orientation. The system helps the alignment of different processes within a company through the criteria in each maturity stage (e.g. with a criterion like “Are all projects known in the patent department?”).
Insights into general (integration) problems from former automotive projects are transferred through the maturity criteria to upcoming projects. The importance of systematic learning from past experience is supported by several studies, e.g. [6].
This Framework enables frontloading problem solving, which is defined as a “strategy that seeks to improve development performance by shifting the identification and solving of problems to earlier phases of a product development process” [21].

The key advantages of the above described flexible project maturity management method can be summed up as follows:

1. Highly flexible and lean as only these maturity indicators are chosen that produce the greatest benefit. That means different aspects (e.g. market analyses, technological feasibility, legal assurance etc.) are promoted project specific with different intensities depending on the target and character of the project.
2. Projects with different maturity grades are easily to integrate into the maturity controlling process, because the maturity criteria are mostly constituent.
3. Different levels of detail in the maturity indicator system allow an efficient and project specific controlling intensity.
4. Further different processes within and between companies can be synchronized through the maturity milestones (patent process, vehicle developments, communication etc.).

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