ABSTRACT
A modern product creation process has been applied to a commercial vehicle development project at DaimlerChrysler do Brasil S.A. Key elements are a structured development process in defined stages divided by gateways, which are surpassed only upon successful completion of exit criteria. The process is based on the product development process GPO of DaimlerChrysler’s European truck business unit.

DEFICIENCIES OF CURRENT PRODUCT DEVELOPMENT PROCESSES

Product development processes are often signified by certain deficiencies, which do have an impact on the factors of time to market, development costs and product quality. The following examples can be encountered:

♦ Application of unrealistically short development master schedules
♦ Late creation of a product documentation (bill of material) only towards the completion of product development
♦ Testing of prototypes with non-representative parts
♦ Missing control on development parts maturity
♦ Procurement of product parts without released documentation (insufficient maturity level of parts)
♦ Budget and product cost overruns due to insufficient control of occurring expenses in product development

MEASURES FOR IMPROVEMENT

Modern project management tools have been applied to the product development process at DaimlerChrysler do Brasil S.A. to assure initial project goals regarding product cost, time-to-market and product- as well as process-quality. Tools are:

♦ A structured product creation process in 6 phases
♦ Verification of development parts maturity and creation of an early bill of material through ‘Checklists’
♦ Alignment of matrix project organization through a common project mission and defined rules & responsibilities
♦ Introduction of detailed Masterplanning
♦ Verification of potential parts collision through Digital Mock-Up (DMU)
♦ Continuous monitoring of product and process maturity
♦ Verification and frequent update of product target costs
♦ Planning and monitoring of development capacity through the definition of work packages
♦ Installation of System Groups, which consists of interdisciplinary teams of representatives from functional areas. Each system group covers certain parts of the vehicle, e.g. interior assembly parts, cabin in white or drive-train.

INTRODUCTION OF A MODERN PRODUCT CREATION PROCESS AT DAIMLERCHRYSLER DO BRASIL

In order to more effectively design and produce commercial vehicles in different development locations around the world, DaimlerChrysler decided to standardize for a common product creation process (GPO), which is divided into 6 main phases:

1. Initial Phase (product ideas and market analysis)
2. Product Definition Phase (project description, economic feasibility analysis, project approval)
3. Product Configuration Phase (technical product description and selection of system suppliers)
4. Product Execution Phase (firm definition of product details, prototype geometries, remaining suppliers, cost target)
5. **Series Development Phase** (prototype tooling creation and testing of prototypes, detailed product engineering)

6. **Series Preparation Phase** (Series Tooling, Pre-Series-Production, Try-Out Concept).

Each Phase is completed with a “Gateway”, which can be surpassed only upon successful resolution of specified Exit Criteria.

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**Picture 2:** 6-Phase-Product Creation Process (GPO)

The successful application of the GPO requires a firm control on the overall maturity of the project. The concept of **Maturity Monitoring** uses several instruments to control the three success-factors of a project: **Time, Quality and Costs.** Maturity Monitoring is a modern project management tool, which allows a fast and simple overview on the current project status at any given reporting date. By using different levels of aggregation, the project status can be displayed at various degrees of detail.

**Picture 3:** Maturity Monitoring

An often used way of communicating a project status is using the “lights” signal: the green light represents successful completion of exit criteria, yellow alerts of minor current problems, which do have pending solutions, while red signals major problems, which most likely will affect time and cost of the project.

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**Picture 4:** Maturity Monitoring using “Lights”

The project maturity is divided into 3 factors: Process Maturity (Time), Product Maturity (Quality) and Maturity of Costs.

The **Process Maturity** is verified along general project milestones, such as the completion of a product specification book, update of the master schedule, etc.

The **Product Maturity** is divided into 3 segments: vehicle maturity (static, dynamic evaluation of prototypes and the ease of parts assembly), maturity of parts (evaluation of parts along a sequence of 20 statuses) and maturity of meeting the formerly defined customer requirements (Fulfillment of quality goals, reliability, economy, technical specifications).

The **Costs-Maturity** covers the attendance of vehicle target costs, project budget (development costs and investments) and economical feasibility (NPV).

For a product development project at DaimlerChrysler do Brasil S.A. a total of 99 exit criterias have been defined. They represent selected milestones or activities of the underlying project Master Schedule.

**Picture 5:** 99 exit criteria at Maturity Monitoring
The project Master Schedule is the backbone of all maturity monitoring. Besides the 99 exit criteria, it contains an additional approx. 300 items, which describe the detailed proceeding of all phases of the product creation process. On a daily working level and for the ease of presentations, the masterschedule is condensed to a total of 40 items.

The ending points of selected masterschedule items represent planning dates, which are the basis for the maturity monitoring. Evaluation forms do provide an orientation on which exit criteria regarding process maturity should be accomplished from gateway to gateway.

THE PROCESS MATURITY

The degree of process maturity reports on processes, which do not have a direct relation to product parts or modules. The covered processes are lined out in their logical sequence together with their planned ending dates. Their completion is verified through the project management team, the development, prototyping and purchasing departments.

Picture 7 provides an overview on all 54 exit criteria concerning process maturity. In picture 8 an example of a typical verification listing is displayed, where the project leader can perform an assessment of process maturity in between gateways, e.g. between Gate II and III, and comment on responsibilities and countermeasures.
THE PRODUCT MATURITY

The product maturity describes the development status of the underlying product. It is divided into maturity of individual parts, maturity of the overall vehicle performance and the degree of fulfillment of previously stated markets requirements.

THE MATURITY OF PARTS

The maturity-assessment of parts or vehicle modules occurs along 17 development-related statuses (MP) and 3 supplier-related status (FP), such as parts engineering completed, requests for proposal submitted, assembly of prototype parts and quality assurance process.

The chronological sequence of all 20 parts maturity statuses along all gateways covering the complete product development cycle is displayed in picture 11.

The assessment of parts maturity statuses is performed in so-called “Checklists”, which provide a easy visualization which status has been reached for any particular part of the new vehicle project. Checklists are typically divided by vehicle modules according to the responsibility of system groups. They also fulfill a secondary function as preliminary bill of material. The system group leaders are responsible for updating and regular communication feedback to the project management.

Additional functions allow the reporting of accomplished, pending and future activities.
OVERALL VEHICLE MATURITY

The overall vehicle maturity allows assessments of the technical maturity of completed vehicles, starting initially from the prototype phase. Main points of verification are the static evaluation of the vehicle regarding fit and finish, material surfaces, the dynamic evaluation regarding chassis torsion, suspension, basic technical functions and overall vehicle performance during use. Finally the fit and ease of parts assembly is evaluated.

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<th>Picture 13: Verification Listing Overall Vehicle Maturity</th>
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Problems, which might occur during dynamic and static evaluation of the vehicle, such as parts collision, do generate re-engineering activities and result in “downgrading” of the affected parts in the parts maturity listing, until the underlying problems are resolved.

MATURITY OF REQUIREMENTS-FULFILLMENT

The initially specified market (customer) requirements from the project specification book are compared to real fulfillment during systems and overall vehicle testing.

The assessment is divided into technical criteria, such as product life, applicable norms and legislation, maximum forces, materials, tolerances, measures, weight and economical criteria, such as fuel consumption, target costs, costs for warranty and spare parts.

The gradual development of these criteria can be displayed using trend-curves, which do allow a certain prognosis on future probability for accomplishment.

MATURITY OF PROJECT COSTS

The maturity of project costs provides an information on the ability to attend previously defined vehicle target costs. The contribution of cost increases or reductions compared to previous modules can be displayed as a “stairway”-chart. Showing the gradual development of target costs does also support a trend analysis.

The overall economical feasibility of the project is defined via net-present-value analysis, setting current project expenses and future vehicle sales into perspective.

Picture 14: “Stairway”-Chart of Target Cost Deviations

Economical project feasibility and definition of required project budget have to be defined with every gateway. Budget liberation for each phase usually happens upon successful gate-completion.

WORK PACKAGES

Work packages help to structure an often rather complex vehicle project. For all involved functional areas and along all project phases, potentially necessary work tasks are defined on a formal sheet containing data such as begin and ending date, detailed description of tasks, responsible party, quality requirements, and signature-section. A numbering concept allows for further detailing of packages as needed.

Using work packages not only provides more transparency and awareness, it helps to provide sufficient capacity and reduces typically “forgotten” contents, which are also needed apart from often development focussed work packages such as preparation of assembly lines and creation of a marketing concept.

Most important, defining work packages emphasizes the concept of a “customer” and “service provider” relation, not only towards outside suppliers but more over within the company. The functional areas are appointed to provide certain defined tasks and are “paid” from the project budget. By signature, the internal suppliers assure completion of task in time and budget.

| Picture 15: Structured Work Packages |
RESULTS AND EFFECTS
After the duration of a approximately a year of implementation and working with the new processes the following results and effects were observed:

♦ Application of a detailed master schedule supported the definition of more realistic product duration and start-of-production dates.
♦ Necessary capacities in all involved areas could more easily be defined.
♦ Due to the lack of an early bill of material from the company’s product documentation system, using checklists provided a great deal of transparency.
♦ Systematic sequenced maturity statuses help to assure consistent parts development and representative prototype testing.
♦ Reporting on the project status, related to individual vehicle configurations, can be now performed in a more standardized way.
♦ Finally, through standardization of project development phases and instruments, co-working regarding future product developments within the DaimlerChrysler organization will be enhanced in the future.

BIOGRAPHIES
Dr.-Ing. Henning Oeltjenbruns is Senior Manager at DaimlerChrysler do Brasil, S.A. and coordinates as project leader the development of a new heavy truck generation (HTC). Being also responsible for process management, he assures that modern development tools are implemented and standardized with the approaches used at the German development headquarters in Stuttgart.

Univ.-Prof. Dr.-Ing. Uwe Bracht is chairman of the ‘Institut für Maschinelle Anlagentechnik und Betriebsfestigkeit’ at the Technical University of Clausthal, Germany. His research involves new approaches in the Design of Production Facilities and Material Flow Logistics. Previously, Dr. Bracht has held for eleven years leadership positions within the Technical Planning Department at the DaimlerChrysler plant in Bremen.

Cand.-Ing. Gunther Neidlein, Michael Frisch and Jörg Hanking, all students from the University of Clausthal-Zellerfeld, defined at DaimlerChrysler do Brasil, S.A. a concept for structured product development and implementation of maturity monitoring as a modern project management tool.

REFERENCES