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# Quality- and Lifecycle-oriented Production Engineering in Automotive Industry

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**Abstract**

This paper presents a new quality- and lifecycle-oriented approach of integrated production engineering in automotive industry. In a first step, current production engineering projects are analyzed and present methodical, information-technical and organizational challenges regarding the project phase of concept planning are depicted. Based on this, existing industrial- and research-oriented solution approaches are illustrated and critically evaluated. Considering the weaknesses of these solutions, this paper introduces the new developed quality- and lifecycle-oriented production engineering approach. As one key issue of this new planning approach, the idea of using a model- and rule-based configuration system is presented.


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*Keywords:* production engineering; quality management; lifecycle management; data integration

## 1. Introduction

In order to gain important market shares, car manufacturers (OEMs) are currently engaged in an innovation race characterized by the following market-driven key demands:

- Soaring number of product variants with many product derivates
- Increasing product complexity due to increasing quality demands and increasing mechatronic components (e.g. powerful and reliable driver assistance systems)
- Increasing time pressure due to decreasing innovation and model cycles
- Reduction of internal costs (e.g. development costs)

These global trends inevitably have an effect on all phases within the overall product creation process – especially on the project phase of production engineering. On the one hand, the processes within production engineering become increasingly more complex and, in consequence, more error-prone. On the other hand, the time for production engineering has to be cut to the bone. In addition, these trends cause extensive changes of the production systems: Production facilities become more and more flexible (as base for producing several product types into one production line), their lifecycles extend and the number of worldwide production ramp-ups will be continually rising – especially after integration processes during running production.

As portrayed in Fig. 1, this paper focuses on the project phase of concept planning in the field of automated assembly systems (e.g. car marriage). Dependent on the special car project, the concept planning phase starts about 1.5 years before SOP (start of production) and has a duration of about half a year. The tasks within concept planning are very different and can be divided into technical, economic and organizational tasks. Examples of these tasks are the development of the concept of the production line (e.g. the degree of flexibility), the process sequences, the layout of the production line including the line-specific bill of material as well as the accomplishment of economic calculations or the definition of the project plan for the phases of detailed planning, realization and ramp-up. All these results lead into specification documents. These specifications forms the basis for the later placing of the respective production facilities.


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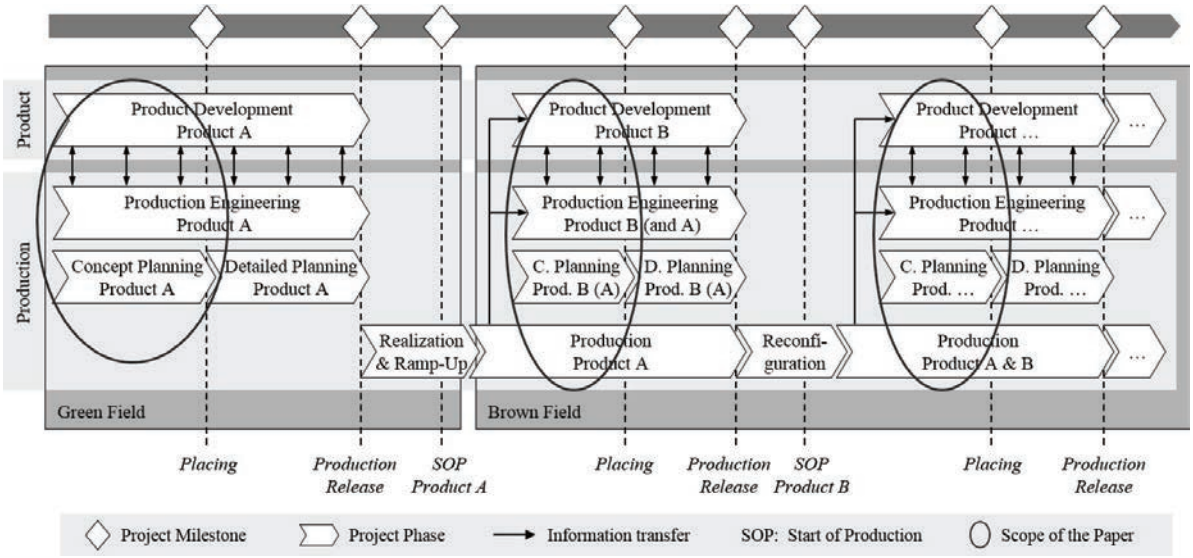


Fig. 1. Scope of the paper within product creation process

In general, production engineering takes place within two different application fields: the first planning of a new production line (green field) and the re-planning of an existing production line (brown field). Due to economic issues, the number of brown field projects will be more and more rising in the future. More information regarding these integration projects can be found in [1]. As depicted in Fig. 1, in both scenarios production engineering forms the linkage between product development and production.

Due to the described global trends and the key position of production engineering within product creation process, there are various challenges and goals regarding the project phase of concept planning such as:

- Reduction of engineering times and lifecycle costs
- Highest engineering quality as base both for shorter and more robust production ramp-ups and highest production quality
- Managing of rising product, process and resource complexities and risks
- Managing of rising heterogeneous data (goal: seamless digital CAx process chain)
- Seamless change management between product development, production engineering and production
- Unified and standardized specifications as base for short allocation phases
- Seamless and standardized communication and data exchanges between OEM and line builder

## 2. Current solution approaches

In order to cope with these various challenges in the field of concept planning, different industrial- and research-oriented solution approaches have already been developed. The following sections illustrate both the characteristics and the critical evaluation of the most essential solutions with the special focus on the planning process of automated assembly systems.

### *2.1. Methods of quality management*

Advanced quality planning is a crucial element of an operating management system. Its target lies on a logical and structured planning process ensuring best possible quality for the lowest costs. Within automotive industry, the method of Advanced Product Quality Planning (APQP) is an established standard. APQP is a framework, which includes quality-oriented procedures and tools within the product creation process. APQP postulates to establish in

- establishing interdisciplinary teams working efficient on procedures and tools
- use of different methods of quality management (e.g. QFD: Quality Function Deployment, FMEA: Failure Mode and Effects Analysis)
- documentation of results

Within the product creation process, APQP mainly covers the phases of product development, realization and product launch. As illustrated in Fig. 2, APQP includes five major activities, which can be divided into five phases: Phase 1 stands for the planning and definition of the program. Product design and development verification (second phase) uses preventive quality methods such as FMEA or FTA (Fault tree analysis). Within the third phase, process design and development verification, the main features of the production system are evaluated. Used methods in this phase are for example the process FMEA, process charts or standard operation procedures. Product and process validation as next phase assesses the production system and the containing processes by using e.g. pilot production and approvals. The last phase includes launch of production, assessment and corrective action [2].