

LOGISTIC- AND COST-ORIENTED CROSS-COMPANY RAMP-UP PLANNING

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Shorter product life cycles and quicker innovation cycles entail frequent product replacements or substitutions. Due to additional aspects like a simultaneous engineering beyond company borders, the production ramp-up process becomes significantly important and more and more complex. Existing planning approaches to support the ramp-up process predominantly assume individual cases and are limited to one company or component. Regarding the supply chain as one unit, this approach may lead to logistical as well as economical inefficiencies. Hence, a method is required that enables companies to arrange and to accomplish a logistic- and cost-oriented cross-company ramp-up process in a stable and reproducible manner. A suitable approach for an efficient scheduling is the use of a ramp-up reference model which is described in the following paper.

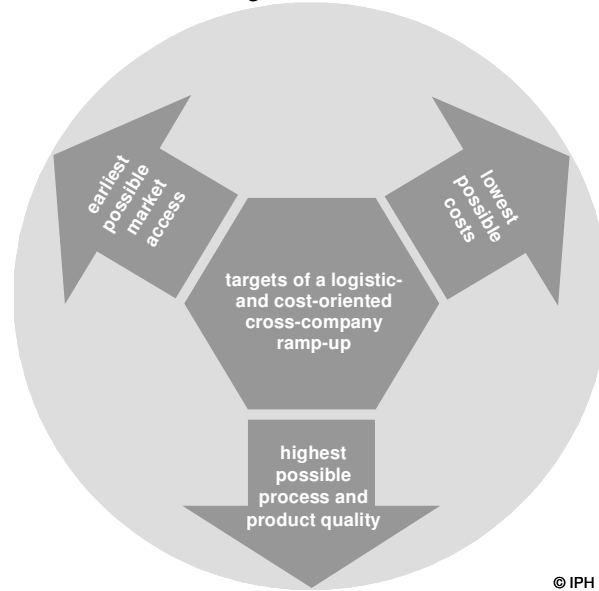
1. INTRODUCTION

Manufacturing enterprises are supposed to face continuously shorter product life cycles, which are evoked by quicker innovation cycles. Consequently product replacements as well as the substitution of components or single parts occur more frequently. To survive in this cut-throat competition, companies have to enforce their innovation activities and are expected to adapt quickly and cost-effectively to those changes. Due to ongoing outsourcing initiatives, associated with the reduction of the vertical range of manufacturing, simultaneous engineering processes beyond company borders and continuous product changes, the ramp-up phase of a new product becomes highly complex. This needs to be considered as a new challenge along the supply chain.

2. STATE OF THE ART

In order to realise and to keep competitive advantages on a highly competitive market, manufacturing enterprises have to accelerate their innovation activities [1], [2]. In addition to technical and technological innovation, mainly the logistic and organisational processes still have high potentials for improvement and cost-savings. Hence a pervasive comprehension and an ongoing search for continuous

improvement and evaluation of these processes are indispensable [3]. In order to reduce the time to market the flexibility and speed of the production ramp-up is becoming the main task which is expected to be focused on [4], [5], [6], [7]. In this context a conflict of aims occurs as Figure 1 shows.



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Figure 1: Conflict of aims of the cross-company ramp-up process

The production ramp-up process can be considered as an interconnection between product design and mass production. The effects of a rapid and economic cross-company ramp-up process resulting in an early market access are still neglected [8]. In general manufacturing enterprises do not use an adequate methodical support and or apply appropriate standards. Consequently, the design of the ramp-up processes on one hand and the logistic and economic controlling of the ramp-up on the other hand have to be researched intensely.

The scientific importance of the ramp-up process is consistently emphasised, particularly in the recent few years ([8], [9], [10], [11], [12], [13]). Most of the present research work in this field is focused respectively on organisational, economic, qualitative or technical aspects. On contrary, management approaches which consider likewise organisational, logistic and economic aspects as well exist rarely. Thus it is necessary to develop standards, strategy models, tools and methods for an efficient managing of production ramp-ups [8]. The main aim must be to manage and control complicated cross-company ramp-ups associated with a simultaneous reduction of the ramp-up time and the related costs.

Particularly during the ramp-up of production lines, the late phases of the ramp-up process are characterised by numerous perturbations and related high planning incertitude [14], [15], [16]. Wiendahl et al. as well as Nyhuis et al. discuss the problems and objectives, define the decisive phases and describe possible fields of action for realising a robust and failure resistant ramp-up of production systems. To resist disturbances technological, organisational and personal aspect need to be

considered and optimised. Furthermore the need for reacting strategies to clear the disturbances, which cannot be avoided is shown. It is pointed out that an independent observation of the separate processes within a comprehensive ramp-up management is essential regarding the complexity, operations network and resulting dependencies.

Fleischer et al. outline a solution concept which focuses on controlling the product quality during the ramp-up phase by means of quality simulation and allows a controlled transfer of a production system to a new series-production operating condition [6]. Via a process oriented workflow simulation the production system is modelled, simulated and optimised in an early planning stage.

In addition to quality based and disturbance oriented approaches Schuh et al. [16] present some basic conditions and requirements for the future production ramp-up management. Flexibility and target-oriented project management are presented as the core of the observation. The explanation of the basic conditions and the formulation of the central challenges of the future ramp-up management focus thereby on the automotive industry. Mainly three central requirements exist:

- For an increasing complexity of planning and control tasks in supplier networks the development of an effective decentralised, cross-company planning and control scenario becomes indispensable. Thereby the cross-company change management is expected to be one of the most important tasks.
- Multi ramp-up scenarios within the affected enterprises and supplier networks have to be supported effectively with tools, methods and supply of services. In addition to the optimised planning and control, it has to be focussed mainly on the guided coordination of the subsequent ramp-ups.
- The third requirement targets the controllability of the increasing number of software and mechatronic systems in the automobile industry. According to Schuh et al. the main objectives are expected to be the development of product appropriate structures for construction design and production scheduling as well as the design of an effective release management.

Amongst other lately released papers, the above mentioned literature shows that numerous approaches already exist to improve some aspects of the production ramp-up. The emphasised ramp-up aspects are product quality, time of the ramp-up process (time-to-market) or costs for example. It needs to be lined out, that the already developed methods are basically aiming at large-scale enterprises like automotive manufacturers, which are able to invest considerable efforts and high costs in accelerating their production ramp-ups [2], [8], [18], [19].

A suitable methodical support which especially helps small and medium-sized enterprises (SME) to execute their production ramp-ups logistically, economically, rapidly and reliably needs to be developed. Due to the fact that SME had to concentrate in the past on their core competencies, the production ramp-ups and their related planning activities occur nowadays predominantly in a cross-company manner along the supply chain. Hence, it is indispensable for manufacturers to integrate the component-, and equipment suppliers as well as the customers in an early stage. Moreover it is a great challenge to manage simultaneously both the ramp-up process of the forthcoming product and the phase-out of the current product. It is required to develop suitable ramp-up standards, strategy models, tools and methods.

3. DEVELOPMENT OF A RAMP-UP REFERENCE MODEL

The development of a cross-company, ramp-up specific reference model (RRM) for SME presents an effective solution approach. This reference model is supposed to take into account organisational, logistic and economic aspects. Furthermore, it has to consider facilities and manufacturing specific issues. Some of these issues could be for instance:

- How could the start of production of a new product be integrated effectively and without high efforts in an already existing production?
- How could the success of such a ramp-up process be evaluated regarding time, quality and costs?
- How could the gained knowledge be prepared to be used for the following ramp-up process?

In order to answer these questions an appropriate method is required as well as a software tool needs to be developed. The software is expected to be used easily by small and medium-sized enterprises. Within the research project “LogiKoPro” such a method is developed. The approach and the expected results are described below.

3.1 Initial State

The initial state of the current cooperation in a cross-company production ramp-up involves various different enterprises. This comprises the component supplier, the equipment supplier, the manufacturer of the ramp-up product itself and their customers, e.g. the OEM. The network characteristic becomes apparent, particularly due to the fact that usually numerous suppliers are involved in the ramp-up process.

The main objective of the presented approach is the rapid and economic planning and lead-through of the over-all production ramp-up process. Particularly the cross-company ramp-up process needs to be shortened and simultaneously controlled tightly in respect to logistic quality, effort and costs. With this in mind the purpose of the planned ramp-up reference model is designing, configuring and controlling of different types of a production ramp-up along the value chain or supply chain.

3.2 Structure and Appliance of the Reference Model

Figure 2 shows the four steps in the appliance of the RRM. The basic principle is an element-based approach which initially analyses different elements of the production ramp-up process from the three fields: organisation, production system and product. These fields cover organisational, logistic and economic aspects. The analysed coherences between the identified ramp-up elements are used to define different production ramp-up types. For this purpose so-called ramp-up enablers are determined. Then classification criteria for the determination of the production ramp-up types are identified. After that, ramp-up reference process schemes are built for the essential ramp-up types. Each reference process scheme corresponds to one pre-assigned ramp-up type. The process schemes serve for both configuring the over-all ramp-up process and designing the individual ramp-up processes of the respective party in the ramp-up network. In addition to the reference process schemes the RRM considers the support of their configuration, a cross-company cost-benefit-risk-assessment and action guidelines for the cooperation in the ramp-

up network. Thus, the planning and execution of production ramp-ups become significantly shortened and due to the reference characteristic reproducible.

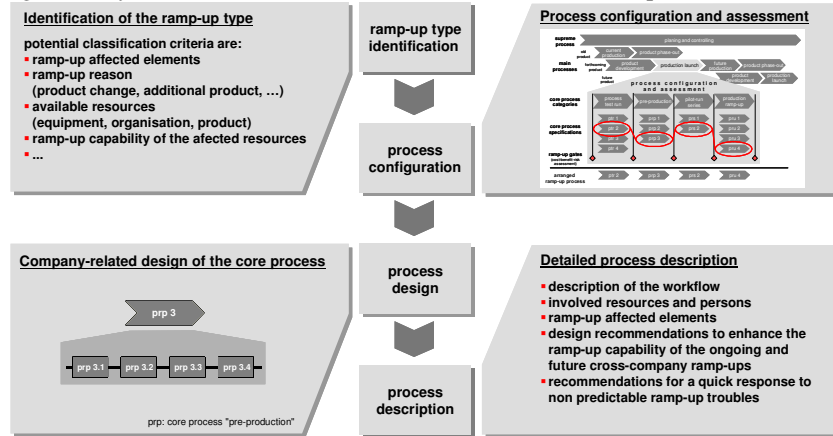


Figure 2: The four steps in the appliance of the ramp-up reference model (RRM)

The four steps of the application of the RRM are described below:

The first step is the **identification of the ramp-up type**. The classification criteria which are needed to differentiate are the above described ramp-up elements and its values and specifications. While ramp-up-aiding characteristics of the elements can be considered as ramp-up enablers, the repressive characteristics of the elements can be classified as ramp-up disablers. Other classification criteria like the ramp-up reason (product change, additional or new product) or the available time for the ramp-up need to be identified.

The **ramp-up process configuration** defines the second step. After identifying the ramp-up type, the production launch is configured and assessed (cp. Figure 3). Within this step the supreme process refers to an ongoing planning and controlling, which is indispensable during the whole production launch. The main processes apply to the different phases of the product life cycles, in which the focus is on the production launch of the forthcoming product.

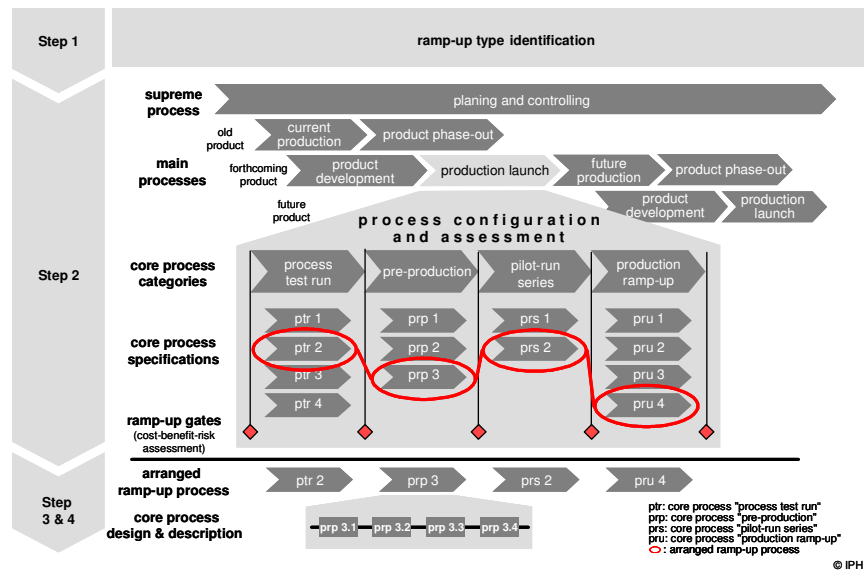


Figure 3: Ramp-up process configuration by means of the ramp-up reference model

The process configuration of the production launch is supported by action guidelines and the use of the above mentioned reference process schemes for the different ramp-up types. Based upon four different core process categories (process test run, pre-production, pilot-run series and production ramp-up) diverse specifications of the core processes can be combined. Complementary to Figure 3 the return processes, for example of deficient pre-production parts, are incorporated. The assessment is provided by the ramp-up gates, which are described below (chapter 3.3). Thus, the RRM considers organisational and economic aspects as well as logistic and technical conditions. The result is a process configuration that corresponds to the ramp-up type.

The third step contains the **company related design of the core processes**. The core processes of the configured main processes are expected to be designed in respect of the specific requirements of the enterprises. Each partial stage of the core processes design is supported by well-defined action instructions and checklists, enabling a depiction of the designed core processes including input, output, function and resources.

The fourth step comprises the **detailed process description** and contains the following aspects:

- description of the workflow,
- involved resources and persons within the framework of the accordant core processes,
- ramp-up affected elements,
- design recommendations to enhance the ramp-up capability of the ongoing and future cross-company ramp-ups,
- advices for designing a rapid ramp-up production system technology and

- recommendations for a quick response to non predictable or unscheduled ramp-up troubles.

3.3 Ramp-Up Supervision - Controlling as a Comprehensive Task

During the whole cross-company production ramp-up process the supervision of time, quality and cost aspects can be seen as a comprehensive task. Hence, a ramp-up controlling method is required that records data along the value-added chain (supply-chain) on an intra- and interplant wide range. Therefore ramp-up gates will be defined and implemented in the RRM according to the established quality gates in the automotive industry [20]. Yet in addition to quality operating figures, these ramp-up gates analyse cost and time key data and thus allow a cost-benefit-risk-assessment at certain stages of the ramp-up configuration process. By means of this gate based supervision ramp-up participants are given a basis for decisions throughout the whole production ramp-up. Moreover, a platform is provided which enables the possibility to document the gained knowledge and to save it for the forthcoming ramp-ups.

4. SUMMARY

To realise and to keep competitive advantages, manufacturing enterprises have to accelerate their innovation activities. This results in shorter product life cycles and, consequently, the product replacements as well as the substitution of components or single parts occur more frequently. Due to additional aspects like an ongoing outsourcing, the reduction of the vertical range of manufacturing, simultaneous engineering beyond company borders and continuous product changes, the ramp-up process becomes more and more essential and complex. Existing planning approaches to support the production ramp-up generally do not consider the cross-company characteristic and may lead to logistical as well as economical inefficiencies.

By means of the presented integrative ramp-up reference model (RRM) the time-to-market is expected to be shortened substantially due to a rapid logistic- and costs-oriented planning and lead-through of the over-all production ramp-up process. Based on pre-assigned relevant ramp-up elements, previously identified ramp-up enablers and different types of standard ramp-up processes for distinct partners along the supply chain, this reference model supports the process configuration and the process design along the manufacturer's supply chain. In addition to practice-oriented check lists and operation recommendations, the reference model includes an integrated instrument for a cost-benefit-risk-assessment of the proposed ramp-up process configuration. Thus, the reference model is expected to serve as a process management and knowledge system for cross-company ramp-ups and is supposed to provide an efficient tool, particularly for small and medium sized enterprises (SME).

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