

APPLICATION OF RAMP-UP MANAGEMENT METHODS FOR JOB PRODUCTION

Dipl.-Wirtsch.-Ing. Henning Strubelt, Prof. Dr.-Ing. Hartmut Zadek

Institute of Logistics and Material Handling Systems, Otto-von-Guericke-University Magdeburg, Germany

Abstract

Ramp-up management is a management approach that is both well-known and frequently applied in series production. Its application to job production appears promising, but has not been researched so far. This research paper discusses the possibilities of ramp-up management methods for job production and presents the current state of application, combining a theoretical approach with the practitioners' view. Special focus is placed on supplier management as logistics-related management method. An overview of the most important and most effective methods as well as their specific application fields is provided. Furthermore, a ranking in which order the researched methods should be implemented and general advice on the implementation of ramp-up management methods is given.

Ramp-up Management

For all series producers, the necessity for innovation has marked the past two decades, as well as an orientation on customer demands and the shortening of product life cycles. This has led to increasing numbers of production ramp-ups for series producers. (cf. Voigt and Thiell, 2005, p. 11) The automotive industry was especially affected by this development with a dramatic increase in the number of ramp-ups over the past years, cf. Figure 1.

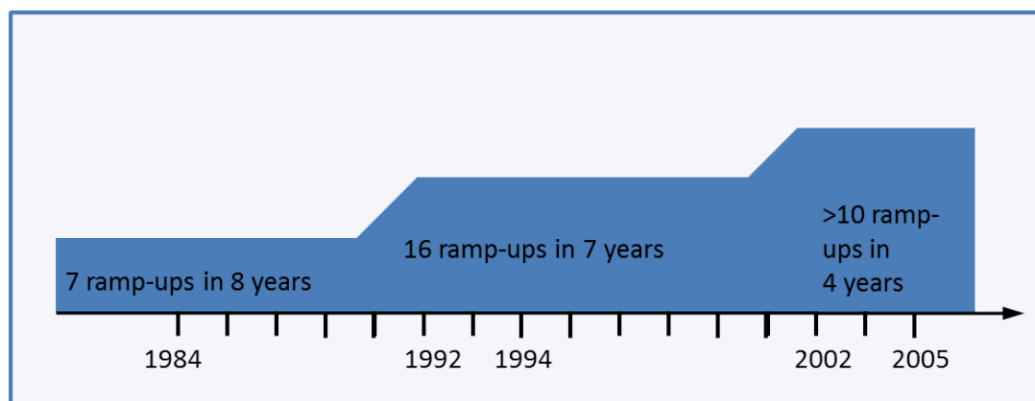


Figure 1: Increasing no. of ramp-ups at Daimler (cf. Romberg and Haas, 2005, p. 11)

The accompanying shortening of the product life cycle becomes especially apparent in the automotive industry as well, where in the 1980s the product life cycle averaged around 11 years and already in the 2000s had nearly halved to six years (Romberg and Haas, 2005, p. 10). This development can also be observed in various other industry sectors, despite the dependencies between the typical product lifespan, the applied technology and the respective branch of trade. In the electro-technical industry 60 percent of all products and in the medical technology sector even 75 percent of all products are younger than five years (Burghard, 2000, p. 12). These shorter life cycles directly influence the time for the amortization of design and investment costs, making time a strategic competition factor, essential for the existence of companies at the market. The development of the three main business objectives – costs, quality, and time – is displayed in the magical triangle in Figure 2. The development pictured is best described by the following statement: “Once time was money. Now it is more valuable than money.” (House and Price, 1995, p. 243)

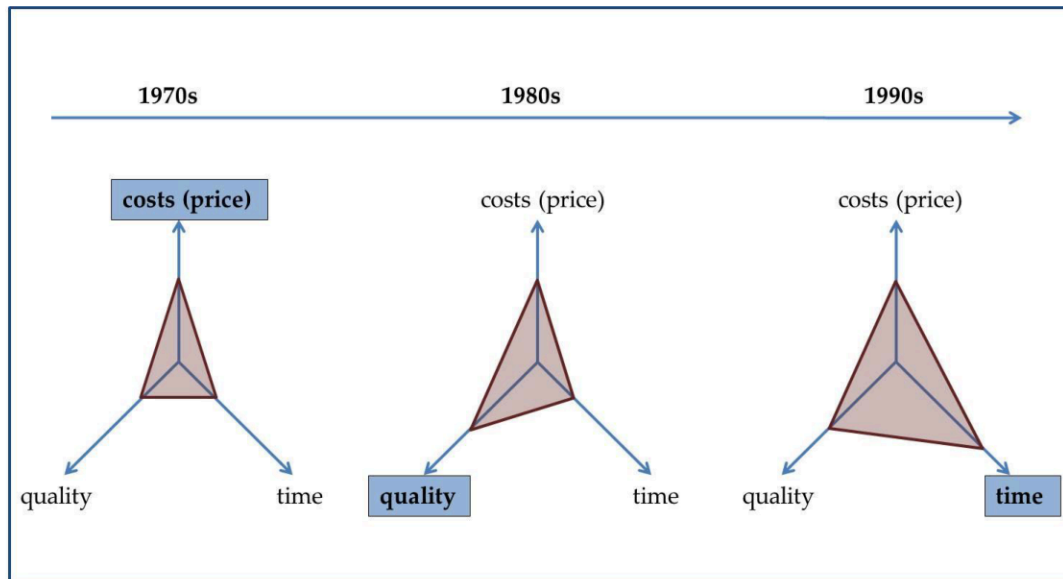


Figure 2: Magical triangle over time (cf. Kaluza, 1995, p. 1064)

The development and application of ramp-up management is based upon the need to react to the increasing importance of the factor time and the increasing number of ramp-ups. Reducing coordination efforts during the development phase, efficient control of the transfer phase between development and production, on-time market introduction and reaching and maintaining set quality levels are key challenges during new product introduction. Ramp-up management, with the objective of reducing the two stages time-to-market and time-to-volume, is seen as an adequate means to achieve these tasks and cope with the accompanying challenges.

Ramp-up management has moved into the spotlight of the scientific discussion in the recent years. First approaches to the topic date back to Schieferer (cf. Schieferer, 1957) in the 1950s followed by only few discussions in the following years and then a growing interest in the 1990s (cf. e.g. Fritsche, 1998; von Wangenheim, 1998). Since the beginning of the 2000s, the number of scientific research papers on this topic has increased rapidly. However, the recent discussion leads to a variety of different definitions and understandings of the relevant terminology. In particular the time-span of ramp-up management and the ramp-up phase are not clearly defined. Almost as many different views concerning the time span exists as there are authors – no terminology has yet been settled upon. In this research the time span covered by ramp-up management is defined as beginning with the product development phase and ending when the planned production output level is reached. The time-to-market covers the development phase and ends when the product enters the market, while the time-to-volume depicts the time span from the start of production (SOP) until the planned production volume is reached (cf. Terwiesch et al., 1999, p. 3). The focus of most researchers is clearly on the automotive industry and with almost no exceptions series production is the considered production type of ramp-up management research so far.

Research Field

The starting point for this research is the hypothesis that the application of ramp-up management adds a benefit to job production, which so far has not been recognized. A detailed literature analysis on the topic of ramp-up management showed that it has neither been widely discussed nor applied for job production (cf. Strubelt et al., 2013).

Job production, sometimes also single production or customer order production, in general produces goods according to customer specifications. The starting point for job production is usually a customer enquiry, answered with an offer which in turn hopefully leads to an order. Only one article unit is produced per planning horizon. This leads to individually planned and carried out production processes and demands a high degree of flexibility of the workforce as well as of the manufacturing tools, machines and plants. (cf. Zahn and Schmid, 1996, pp. 131-133) Due to the specifics of each customer order and the necessary planning steps for production, every customer order can be thought to start a new ramp-up process. This actually implies that job producers are experiencing exceedingly more ramp-ups than series producers. Furthermore, job producers possibly run into situations with

simultaneous ramp-ups, up to the point where all operational facilities are utilized with ramp-up products. Considering the resulting high number of ramp-ups for job producers, the possibilities of ramp-up management for job producers become obvious. This research paper therefore analyses which ramp-up management methods can contribute to the success of ramp-ups in job production. The objective is to determine the current state of application, identify best practices and recommend an implementation order for ramp-up management methods for job producers.

In a previous research project an extensive literature analysis was conducted, analyzing over 100 literature sources, to identify the management methods associated with ramp-up management. (cf. Strubelt et al., 2013). It needs to be said that ramp-up management itself is not a straight forward method. Methods are defined as planned, systematic, and rule-based procedures, with a prescriptive character, according to which certain activities are performed in order to accomplish a specific goal (cf. Kosiol, 1976, p. 34; Lindemann, 2009, p. 58) The literature analysis showed that ramp-up management in contrary comprises several different methods, concepts, tools and measures. Additionally, some scientific literature may discuss a specific approach, terming it method, while in another source the same approach may be described as a tool, and yet another source defining it as a concept.

After collecting and clustering all methods associated with ramp-up management, the literature analysis revealed that a total of 82 methods can be associated with ramp-up management. These 82 methods were then subject to an expense-utility analysis to evaluate the most suitable and most promising methods for the application in job production companies. The resulting ten most relevant methods for job production are displayed in Table 1.

Methods
Employee Qualification, Measures for
Auditing
FMEA
Process Planning & Analysis
Supplier Evaluation & Selection
Project Definition & Organization
Project Controlling
Standardization, Modularization
Engineering Change Management
Knowledge Management

Table 1: Ramp-up management methods for job production

Questionnaire Study

An empirical study in form of a questionnaire study was developed to identify the current status of application and to evaluate the benefits of these ten ramp-up management methods for job production. Furthermore, a ranking for the implementation order of these methods is determined. The questionnaire study encompasses up to 3,000 German job production companies. After sending out the survey to all 3000 potential participants, a total number of 133 participants opened the questionnaire, out of which 82 completed the entire questionnaire. This corresponds to a response rate of 4.4% and 2.7% respectively. Even though these numbers seem quite small, they are well in the range to be expected for this type of survey.

In a first step the questionnaire gathers general data about the participants. The production type and industry sector of the participants are checked to ensure the desired group of participants. Further such data as company size and location are collected to evaluate the specific data on these criteria and to secure an adequate cross sectional representation. The classification of the participants into small, medium and large size enterprises is done according to their number of employees and their turnover in 2012. Following the recommendation of the European Union for SME small enterprises have less than 50 employees and not more than 10 million Euros turnover per year. Medium size enterprises have less than 250 employees and not more than 50 million Euros turnover per year and

large size enterprises are defined as having 250 or more employees or a turnover of more than 50 million Euros per year. (cf. European Commission, 2003)

The questionnaire begins by determining the participants' awareness of the researched methods. The majority of participants know the methods of Employee Qualification and Auditing, while only about a third of the participants are aware of Engineering Change Management and Knowledge Management, cf. Table 2.

Ranking awareness of methods (n=82)	
Method	Percentage
Employee Qualification, Measures for	90%
Auditing	85%
Project Controlling	63%
Process Planning & Analysis	63%
FMEA	62%
Supplier Evaluation & Selection	61%
Standardization, Modularization	60%
Project Definition & Organization	59%
Engineering Change Management	36%
Knowledge Management	29%

Table 2: Awareness of methods

The awareness of the methods varies with the company size. Larger companies are more aware of the researched methods than smaller companies. This finding is particularly pronounced with Engineering Change Management, which is known to 65 percent of participants from large companies but only to 18 percent of participants from small companies, and with Supplier Evaluation & Selection, known to 82 percent of large companies and 46 percent of small companies. It can be assumed that larger companies in general are more aware of management methods due to their larger and more complicated structures and to a higher number of employed managers.

In the next step the application of the methods is researched. The participants were asked to rate their use of the methods in five degrees from never to very often. The number of evaluable replies to each method is lower than the total number of participants, due to the fact that they were only asked to rate the application of methods for which they had previously indicated awareness and due to participation declining during the course of the questionnaire. The two methods that are applied most frequently (those that received a rating of often or very often) are Engineering Change Management and Project Definition & Organization. The two methods that are applied least frequently are FMEA and Knowledge Management, cf. Figure 3. While Knowledge Management, the method showing the least awareness, is also only rarely applied, FMEA is known to more than 60 percent of the participants but is nevertheless not applied very frequently. This could be a first indication that FMEA is not seen as a useful method for job production. Interestingly Engineering Change Management, of which only about 36 percent of all participants are aware, receives the highest marks of application by those participants who know the method. Therefore, it can be assumed that a potential for the application of Engineering Change Management in job production exists.

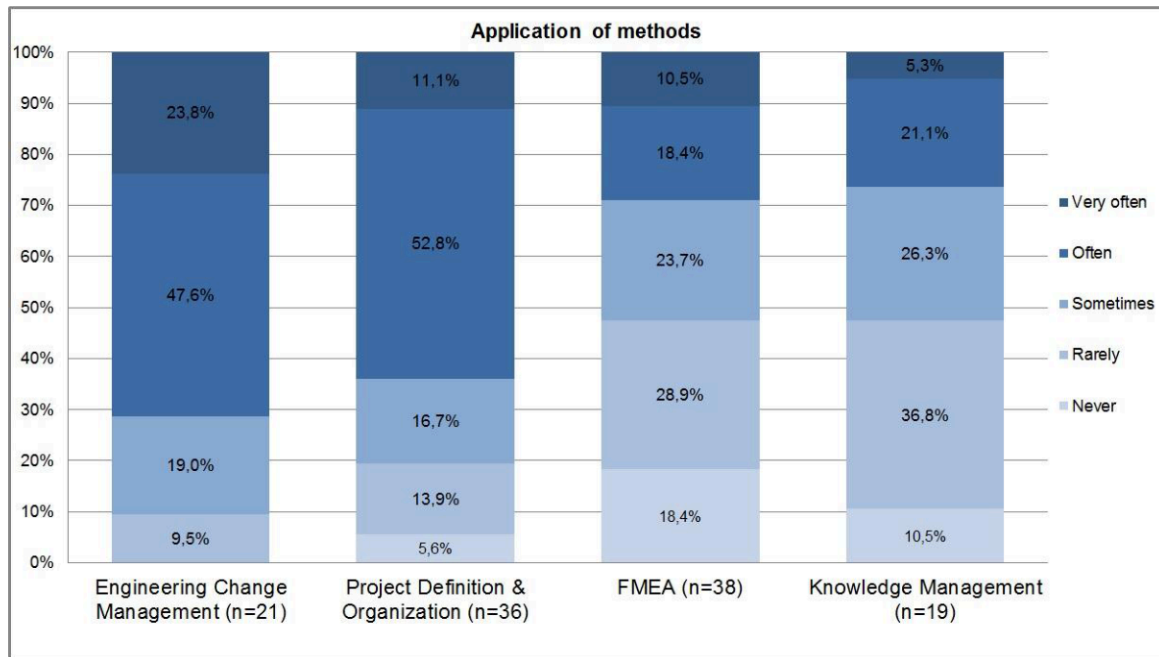


Figure 3: Application of methods

To analyze the potentials of the researched methods for job production the participants were asked to rate the methods on cost-benefits. To increase the validity of the questionnaire study this was done in two different ways, the results of which were later compared to another. The participants were given five questions per method which all indirectly questioned the benefit of the method. All of these questions were tailored specifically to each method. To show an example, for the method Supplier Evaluation & Selection one of the questions was, whether the participants could agree with the statement that Supplier Evaluation & Selection facilitates long-term fulfillment of material requirements. Similar questions were used to identify the costs of the methods. The results to these individual questions are used to calculate a cost-benefit factor, which then allows a ranking of the methods. The other approach to rate the cost-benefits of the method was quite bluntly a direct rating conducted by the participants. The result of the calculation, comparison and evaluation of both approaches is displayed in Table 3.

Cost-benefit ranking (n=60)	
Method	Rank
Employee Qualification, Measures for	1
Project Definition & Organization	2
Standardization, Modularization	3
Process Planning & Analysis	4
Engineering Change Management	5
Supplier Evaluation & Selection	6
Project Controlling	7
Knowledge Management	8
FMEA	9
Auditing	10

Table 3: Cost-benefit ranking

From a cost-benefit viewpoint Measures for Employee Qualification receive the highest ranking, followed by Project Definition & Organization, and Standardization. Knowledge Management, FMEA and Auditing receive the lowest ratings. For Knowledge Management and Auditing this confirms the low application results for these methods. Apparently both methods are not very important for job

producers. The high rating of Employee Qualification can possibly be attributed to the point that it is becoming increasingly difficult for German small and midsize job production companies to hire qualified personnel.

Interestingly, when asked for the implementation order of the methods, the participants did not recommend Employee Qualification as number one priority but Project Definition and Organization (Overall). They also recommended the implementation of Project Controlling (7th in cost-benefit ranking) earlier than Engineering Change Management (5) and Supplier Evaluation & Selection (6), both of which are ranked higher in the cost-benefit ranking. Knowledge Management, FMEA and Auditing are in the last three places both in the cost-benefit rating and the implementation order, cf. Table 4.

Implementation order				
	Overall (n=60)	Small ENT (n=24)	Medium ENT (n=16)	Large ENT (n=20)
Method	Rank	Rank	Rank	Rank
Project Definition and Organization	1	1	↓ 3	↓ 2
Employee Qualification, Measures for	2	2	↑ 1	↓ 3
Standardization, Modularization	3	↓ 4	3	↑ 1
Process Planning & Analysis	4	↓ 6	↑ 2	↑ 3
Project Controlling	5	↑ 3	↑ 3	5
Engineering Change Management	6	↓ 8	6	6
Supplier Evaluation & Selection	7	↑ 5	7	7
Knowledge Management	8	↑ 7	8	8
FMEA	9	9	↓ 10	9
Auditing	10	10	↑ 9	↑ 9

Table 4: Implementation Order

For the implementation order the participants were asked to name their top three priority methods and rank them in the order they should be implemented. The results of the implementation ranking need to be viewed with a bit of caution as all participants were asked to conduct this rating and as previously already discussed not all methods were known to all participants. This influences the rating and helps the better-known methods to receive higher ratings. Nevertheless, the results of the cost-benefit ranking are comparable to those of the implementation order and thereby support the meaning of this ranking.

In conclusion, a closer look is taken at the results of Supplier Evaluation & Selection. First of all, following the general definition in literature, supplier (relationship) management is divided into two separate fields, Supplier Evaluation & Selection and Supplier Development & Integration (cf. Boutellier and Wagner, 2000, pp. 27-30). In a previous research project Supplier Development & Intergration, where suppliers have a more active role and conjoined goals are defined, has been determined to be less beneficial for job production and it is therefore not researched further in this context. The questionnaire results considering Supplier Evaluation & Selection show, that the method is fairly well known (61% overall). Large size companies are especially aware of the method (83%), but as with most methods the awareness decreases with the company size (67 % medium size ENT, 46% small size ENT). The same applies for the application: while 57% of large size enterprises apply Supplier Evaluation & Selection only 23% of small size enterprises do. Interestingly, it is ranked higher by small size enterprises than by medium and large size enterprises in the implementation order. When it did get recommended to be implemented it was often ranked as second method to be implemented in combination with Project Controlling, Project Definition & Organization, and Employee Qualification. It appears that for Supplier Evaluation & Selection no general recommendation for its use in job production companies can be made.

Application Fields and Implementation

Several scientific studies have identified different application fields for ramp-up management, so far (cf. Kuhn et al., 2002, p. 17; Romberg and Haas, 2005, pp. 53-54). Based on these differing

approaches a new concept is developed extending the existing approaches by the connecting elements information flow and documentation, cf. Figure 4. The Ramp-up Strategy and the Project-Matrix-Organization, representing the most common organization form for ramp-up organization, represent the basic application fields. They are long-term in character and are supposed to remain constant over several ramp-ups. They are also to be understood as provider of management methods to improve the ramp-up, meaning they provide all management methods as included and defined in the company strategy.

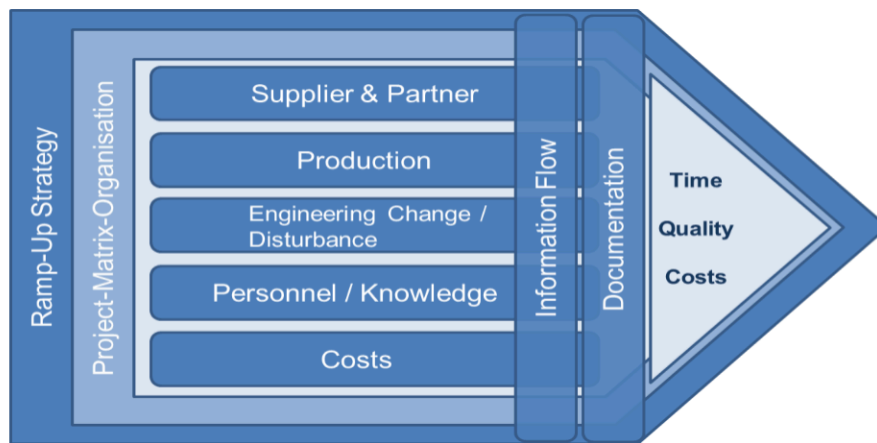


Figure 4: Ramp-up Management Application Fields (adapted from Schuh et al., 2008, p. 4)

Together with the five other application fields, this allows for a holistic view of the ramp-up process as the application fields are coupled and interacting with each other. All application fields can be influenced through the application of the discussed methods in different ways. In general all of the discussed methods are appropriate to improve the ramp-up process and they all influence at least one application field directly, while influencing others indirectly. While the qualitative influence of the methods on the application fields can simply be assigned, their quantitative impact depends on several different factors, such as company strategy, company structure, extent of method implementation, or employee structure, to account just for a few of them. The objective is to find the best methods and the best combination thereof to reach or surpass the main business objectives time, quality, and costs.

Considering the implementation of ramp-up management methods it needs to be pointed out that simply following the implementation order provided by the questionnaire study is inadequate. The implementation of methods should always be complementary to a company-specific production system, following the company's strategy. It is the task of the production system to define the company's internal and external general conditions for production and it should always be adapted to the company's needs. Production systems describe the production process and include concepts, methods and tools, which in combination account for the effectivity and efficiency of the entire production process (cf. Zwanzig, 2010, p. 61). The definition of production systems and necessary planning steps for the implementation of production systems is extensively discussed in scientific literature. To give an example, the REFA-method is suitable for the implementation of production systems (cf. Bergmann, 2010, p. 38).

Conclusion and Outlook

The results indicate that Knowledge Management and FMEA are the researched methods least important for job production and should not be primarily considered for implementation. Auditing is considered a well-known method for job producers, but apparently has a poor effectiveness and cost-benefit ratio. The best-known method Employee Qualification is at the same time the method with the best cost-benefit rating. It is also placed second in the implementation ranking, but when looking at the application level of the method compared to its rankings, it seems it could be applied more often. Project Definition & Organization is rated second on cost-benefits, first in the implementation order, and it is applied quite frequently by the participants. Together with Employee Qualification, Project Definition & Organization should be implemented and applied in most job production companies. Probably the most interesting results of the questionnaire study are provided with regard to Engineering Change Management. Following the questionnaire results, only a handful of job producers are aware of this method, but those that are aware appreciate and frequently apply the method.

Therefore, it is assumed that this method can offer further optimization potential to job producers and more attention should be called to it.

It can be concluded that the implementation and application of ramp-up management methods can open up additional opportunities and benefits to job production companies. The cost-benefit ranking and the implementation order give a first overview and orientation. However, the selection for and implementation of suitable methods should always be made while considering the specific company structure, strategy, and production system.

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