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On the application of agility principles in ramp-up management: Approaching the challenges in the high-end powder metallurgy industry

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Abstract

In recent years, the field of ramp-up management has received wide attention in both science and industrial practice. However, current research mainly focuses on discrete manufacturing and assembly industries, whereas companies in process-oriented industries are still lacking a practicable approach to manage their highly interdependent ramp-up operations.
This paper presents findings of a detailed requirements analysis at a world leading metal producing and processing company. It outlines the specific characteristics of such hybrid industries and emphasizes the need for agility considerations in ramp-up management in order to outperform competitors in increasingly volatile and uncertain business environments. Main criteria for agile ramp-ups are derived from theoretical as well as industry-specific considerations and first steps towards a practice-oriented management approach are taken. This paper shows that early and reliable information on product and process maturity is a major imperative for process-oriented industries and reveals how standardized ramp-up readiness levels shall contribute substantially to the success of future ramp-up projects.

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Keywords: Ramp-up management; Agility; Agile ramp-up; Ramp-up readiness levels; High-end powder metallurgy

1. Introduction

Several cross-industry trends concerning products and markets steadily increase the importance of ramp-up management, especially for manufacturing companies. Highly fragmented customer segments and the growing request for specialized products lead to more product lines and variants. Beyond that, ever shorter product life cycles and accelerated innovation times can be observed across different branches. This inevitably results in an increase of the total number and frequency of highly complex production ramp-ups [1,2]. In addition, today's business environment is characterized by unprecedented degrees of volatility and uncertainty. This applies for both the financial as well as the real economy and poses further demanding challenges to many industrial companies [3]. Therefore, successful companies not only have to master tighter timelines in development and growing complexity in production but also strive for an accelerated time-to-market, whereas actual selling behavior is often difficult to predict.

In the past, several concepts on how to deal with volatility and uncertainty on a business level have been scientifically discussed. A new interpretation of the agility concept (often also called agility in manufacturing, agile manufacturing or agile production) builds on established approaches but aims to extend the viewing area as well as the scope of action [4]. Particularly when focusing on the operational agility of a company, the management of agile production ramp-ups is considered to be a main lever for achieving significant improvements. Current approaches in the field of ramp-up management mainly focus on certain industries, mostly addressing discrete manufacturing industries such as the automotive industry. In fact, so-called hybrid industries are hardly considered in relevant literature. Hybrid industries, in this context, can be characterized by an often highly integrated production route, which requires companies to master both

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demanding process as well as manufacturing techniques. This leads to specific challenges in the field of ramp-up management which have not yet been investigated in detail. Moreover, research has not devoted sufficient attention to the crucial link between ramp-up management and agility so far.

Starting with theoretical basics and a brief overview of the current state of research, this paper presents practical insights from a metal processing company which covers both high-end process and discrete manufacturing. It is shown that, within the investigated branch, requirements and future challenges in the field of ramp-up management differ fundamentally from those in industries already investigated. Therefore, industry-specific challenges are explained and the necessity of making agility considerations in order to achieve competitive advantage in today's demanding environment is pointed out. Based on this, the key agility principles are discussed regarding their applicability in ramp-up management and four criteria for agile ramp-ups are derived from both theoretical considerations and practical needs. Additionally, an approach using ramp-up readiness levels to indicate the overall feasibility early as well as the maturity of ramp-up processes is introduced.

Findings from this paper form the basis for the development and sustainable operationalization of a practice-oriented ramp-up management approach in the high-end powder metallurgy industry, which aims to be adaptable to comparable process and hybrid industries as well.

2. Current state of research and practical need

In order to ensure a common understanding of ramp-up management and agility terms, the following section summarizes state of the art research from a scientific point of view. Furthermore, the practical need for a new ramp-up approach is pointed out and a clear research gap is derived.

2.1. Ramp-up management

The ramp-up phase (often also described as the start-up or launch of production) covers the time span between completed development of a new product and its production at a predefined performance level. Thereby, the production output is gradually increased over time, and given quality, time and cost objectives are considered highest priority [1,5,6]. The interdisciplinary field of ramp-up management thus covers all main activities related to the planning, controlling and execution of a production ramp-up, with the overall goals being high product quality, cost compliance and a steady reduction of the required ramp-up time [1,7,8]. Fig. 1 shows the typical progress of a ramp-up curve and major milestones, starting with the release for development and ending at the production of a predefined volume.

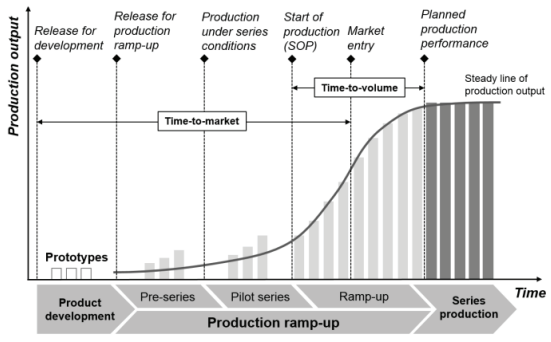

Fig. 1. Typical shape of a ramp-up curve and different phases during production ramp-up (cf. [5,13]).

While earlier research mainly focused on shortening development times and streamlining production processes, the great potential for optimization in field of ramp-up management has remained untapped for a long time. Above all, this applies to ramp-up specific measures in management and organizational structures as well as the utilization of practical knowledge [9]. In recent years, ramp-up management has become a major competitive factor, but there is still an urgent need for improvement in many sectors. For automotive and related industries in particular, this has been confirmed by extensive research studies [1,10].

The current state of research in ramp-up management consists of numerous scientific approaches, whereby most works are rather theoretical, focus on specific industries or only cover single subfields of ramp-up management. Relevant studies exist, for instance, concerning the mathematical description of learning curves, the targeted utilization of learning effects during ramp-up or analytical modeling of the ramp-up curve [11,12,13]. Further research addresses individual aspects such as risk, time-to-market, performance or production management in the context of production ramp-ups [6,14,15,16]. In order to counter the increasing complexity in the ramp-up of mechatronic products, in [17] a procedure model is developed based on the agile software development framework Scrum. Finally, in [18] Schuh, Stölzle and Straube present an integrated ramp-up management model which aims to take a holistic and practice-oriented view on the topic of ramp-up management, but this, like most other works, specifically targets the automotive and automotive supplier industries. Further industry-specific research concentrates on aircraft and electronics industries [19,20]. Process-oriented industries such as powder metallurgy have gained substantially less attention in ramp-up research so far.

2.2. Agility

High degrees of market volatility as well as increasing uncertainty concerning business development present companies with the difficult challenge of constantly having to adapt to changing surroundings. This fact not only applies to the financial sector, but has also become a major challenge for producing companies as well [3]. Serious events such as the last financial crisis or the environmental disasters in Asia, just to name two, showed impressively how today's high degree of global cross-linking enhances scale and scope of externally triggered business impacts [21]. Moreover, the actual time until an external impact effects business in a noticeable way continues to decrease. This means companies are forced not only to reduce the time needed to react with targeted countermeasures but also to ensure early and reliable warning [22].