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Highly Iterative Product Development Within The Tool And Die Making Industry

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Abstract

The tool and die making industry, characterized by single and small series production, sees itself faced with new challenges due to decreasing product life cycles and increasing product derivatization. Therefore tool and die making companies need to shorten their development times and raise their efficiency. Currently tool makers are often still little integrated into customers' processes, which complicates the decrease of development times significantly. To improve the integration, high value-added processes and services need to be offered to their customers to participate in the whole customers' product development processes. Due to the fact that customers still demand constantly high tool's quality, new procedures and technologies are needed in order to achieve an early product maturity. The solution presented in this paper concerns the potentials that can be addressed by using highly iterative product development processes within the tool and die making industry. It includes high frequency optimization, paired with generative manufacturing technologies to ensure a resource-efficient and fast product development process. The usage of modern information and communications technologies (ICT) like tablet-based 3D-visualization will be shown to describe how these products and services in the Internet of Things (IoT) era support decreasing developing times.

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1. Introduction

The tool and die making industry is one of the key industries in the manufacturing sector due to its role in the value chain between product development and series production of manufacturing goods [1, 2]. As the enabler of product development, it is the foundation for every kind of manufacturing sector, especially the high-performance manufacturing sector in Western Europe [2]. On the basis of these characteristics the tool and die making industry majorly influences the product's quality and costs and thereby its success [1, 3, 4].

This position within the value chain leads to a strong impact of customer's requirements on the tool development. For some time past a significant trend towards increasing product individualization but shortening life cycles can be recognized. Due to that the number of product derivatives increases

continuously while the amount of sales per derivate decreases simultaneously [5]. As a consequence companies of the tool making industry are demanded to provide their products to their customers much faster than today. Furthermore the competition increases constantly as a result of the internationalization of tool procurement. Because of that especially companies from high-wage countries need to expand their range of services and thereby attract new customers and revenue opportunities [6]. Therefore it is advantageous to expand the product range horizontally to the customers' value creation process and thus achieve a deeper integration into the customer's processes [7, 8]. This integration can be achieved by agile processes in connection with innovative production processes as well as information and communication technologies (ICT). Thereby tool making companies can support their customers to reduce their time to market significantly.

This article considers the potentials and challenges, which are given by accompanying highly iterative product development processes, like decreased development times and higher amount of turnover on the one side and necessary new abilities on the other side. Firstly the structure of highly iterative product development processes will be explained. After that this paper will especially explain the work at the Laboratory for Machine Tools and Production Engineering (WZL) at RWTH Aachen University of creating an approach how the tool and die industry can accompany highly iterative product development processes.

The paper consists of 3 chapters which will illustrate the present situation in the tool and die industry and compare this with the potential of highly iterative product development processes. Afterwards it will be shown how modern ICTs can support companies in realizing shorter development times. Some short concluding remarks will finalize the paper.

In the following, the word “tool” is used to describe tools as well as dies. Therefore companies of the industry are described by the expression “tool making company” and the industry itself by the expression “tool making industry”.

2. The Tool Making Industry

2.1. Overview

The international tool making sector is characterized by a high inhomogeneity in quality of service provision. Tool making companies from countries like Germany or Japan offer high-quality tools and services. Tool making companies from emerging markets such as Mexico or South Africa have the potential to undergo the current development of the Chinese market and offer high-quality tools in addition to not that complex ones, in future too. Consequently they would become a serious competitor in the international tool procurement market [9].

What they all have in common is the characterization through small and medium sized enterprises [10]. In Germany for example about 80% of approx. 54,000 employees are employed in companies with less than 20 workers [11]. The current economic development of the tool making market is deemed positive in principle. For example in Germany the tool production increased from about € 3,567 M in 2010 to € 4,319 M in 2013 [10]. The product range includes die-casting-, sheet- and massive forming- as well as injection molding tools and varies depending on the country. In Portugal, for example, 91.5% of the production is attributed to injection molding tools, whereas Germany shows a balanced output of sheet- and massive forming tools (45.3%) and injection molding tools (49.6%) [10]. Especially in high-wage countries the importance of additional up- and downstream services, so called Product-Service-Systems, which they provide in addition to their core product, increases constantly due to new competitors from low-wage countries [12].

2.2. Present product development process

Currently tool making companies go through a rigid and chronological process during their product development as visualized in Figure 1.



Figure 1 Present position of the tool maker's order fulfilment process within the customer's value chain [13]

The actual tool maker's order fulfilment process normally starts only after the customer's product development has been finished. At this time the product is completely developed and all product specifications are determined so that tool makers cannot bring in their competences. The tool maker's order fulfilment process includes the five steps of design, work preparation, mechanical manufacturing, assembly as well as try-out, which are located between the customer's product development and parts production. Because of those conditions, the customer often receives a first realistic impression of its product not until the tool is finished. At that time the tool cannot be adjusted without high financial expense and expenditure of time anymore. This kind of rigid order fulfilment process is heavily limited in its potential to decrease customer's product development times in the long term.

2.3. Challenges and potentials

Currently the tool making sector is subjected to numerous trends which require an adjustment of business structure. On the one hand, the characteristics of customer's tool requirements change continuously. As a result, all tool making markets, regardless of their tool quality, need to find answers to the trends of increasing product individualization as well as derivatization and, as a consequence, the decreasing quantity per batch. Simultaneously the product life cycle decreases [5]. The life cycle of the VW Golf I, produced since 1974, was 10 years. 34 years later the life cycle of VW Golf VI has already been halved to 5 years [14]. This means, that the need of tools increases in total, but due to the fact that tool budgets remain stable the price pressure on tool making companies increases constantly [15]. The situation is aggravated by higher requirements on the tool's quality, new available production processes as well as new raw materials customers use for their products [16]. A factor, which is especially relevant for tool makers from high-wage countries is the steady pressure to innovate, in order to remain profitable in competition with competitors from low-wage countries [17, 18].

Currently tool makers are explicitly limited in their range of services, which makes it difficult to find answers to these challenges. Furthermore they act in slow processes, which

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