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# Web-based component data for the commissioning of machine tools

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**Abstract**

This article presents an approach of simplifying machine tool commissioning processes with web based component data. As commissioning and error compensation processes of machines often require extensive manual labor and repetitive tasks, they present great potential for further digitalization. Therefore, a systematic approach for generating and implementing a digitalization concept is applied. As a result, a commissioning device accessing web based component data is implemented. The device uses geometric errors of individual components in a machine tool and generates compensation values for the control of the machine's axes.


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*Keywords:* Machine tool; Reconfiguration; Identification; Error; Lifecycle

## 1. Introduction

Between the years 1992 and 2012, the cost of computing power has declined from over 200 USD to just 0.06 USD per Million transistors. In an even shorter period of time, between 1999 and 2012, the cost of internet bandwidth has fallen from 1245 USD to just 23 USD per 1,000 Mbps [1]. These are just two of many indices that reason why a fundamental shift in the use of information technology has taken place in business just as well as in daily life. Cornerstones of this shift are the use of the internet technologies and, in the recent years, the use of mobile devices such as smartphones. However, many companies from the field of heavy and industrial machinery as well as discrete manufacturers still feel unprepared for the changes of a further digitalization [2].

As a matter of fact, not every new technology has a suitable application every field of manufacturing technology. Therefore, a key question for companies in the manufacturing industry is how to create a substantial benefit from the multitude of technologies that have become available in recent years. To answer this question, a systematic approach can support designing and testing novel technologies in the field of manufacturing technology.

Looking at the manufacturing of complex machinery, commissioning processes can often be seen as particularly time-consuming with many possible sources of error. The commissioning is often hindered by the usage of different data media and inefficient manual processes, especially when components of different manufacturers are being used. This potential motivates the systematic approach for the generation and implementation of a use case in the field of machine tool commissioning presented in this paper.

### *1.1. Machine tool components for error compensation in commissioning processes*

Geometric errors at the tool center point of a machine tool result from a sum of geometric errors within its kinematic chain. In the kinematic chain, the different components of the machine tool contribute to the error at the tool center point. Potential errors result from manufacturing tolerances of the components or their assembly. However, as avoiding errors leads to quickly rising costs with more precisely manufactured components, a compensation of errors becomes necessary [3].

Therefore, when commissioning a machine tool, geometric errors of components need to be taken into account. However, in the commissioning of machine tools paper-bound data sheets


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are still widely used to provide individual component data [4]. This leads to expensive manual labor and high error rates. It also indicates a high potential of improvements in the commissioning process and the lifecycle of machine tool components in general.

In [5], Bauer presented a highly integrated hydraulic feed axis for modular machine tools which, compared to conventional feed axes, can provide additional functionalities for error compensation. The hydrostatic guiding system integrated in the axis is able to individually control the orientation and position of the axis carriage with small compensational movements in five degrees of freedom. Therefore, geometric errors of the axis and other components within the kinematic chain of the machine tool can be compensated [5]. In [6], an algorithm to calculate the parameters for error compensation with this axis system was presented. When geometric errors of the individual components are available and additional errors resulting from assembly can be neglected[1], this calculation can be carried out prior to the commissioning of the assembled machine tool. Therefore, the calculation can supersede complex measurement and compensation of the assembled machine.

However, a modular architecture of machine tools implies further challenges for the commissioning and error compensation process. As different machine tools can be configured with modular machine tools, different kinematic chains with different modular components have to be commissioned. When components are supplied by different vendors, gathering individual component data also becomes increasingly complex.

The case of modular machine tools, as presented in [8], therefore provides a suitable base for a further digitalization of the commissioning process. Fig. 1 shows a configuration of a modular machine tool with the respective components and highly integrated feed axis [5].

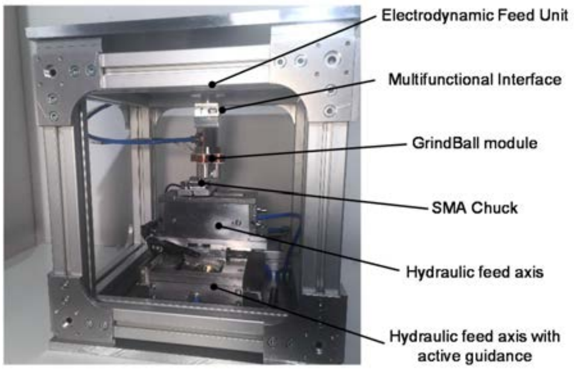


Fig. 1. Modular machine tool with hydraulic feed axes for grinding operations cf. [5]

In the context of digitalized commissioning processes, Dosch et al. [4] showed the benefits of RFID transponders for ball screw drives in machine tools. In this work, RFID transponders containing individual component data were physically attached to the ball screws. The availability of machine readable data was then used to automatize previously manual processes [4].

RFID transponders therefore present an inexpensive way to digitalize the exchange of component data and automatize the commissioning process of machine tools. Furthermore, it restricts the access to the component data to the physical possessors of the component.

Compared to storage devices that are physically attached to a component, a web based data storage can offer a number of potential advantages and disadvantages. Examples for advantages are the simplicity of scaling data storage and accessing information without physical access to the component, whereas data security issues and questions regarding permanence of information show potential disadvantages.

Therefore, the subject of this paper is the evaluation and application of web based data storage for the process of machine tool commissioning.

### *1.2. Development of use cases for the digitalization of manufacturing processes*

In the field of digitalization in manufacturing, Anderl et. al [9] present a concept of selecting suitable fields of application and generating beneficial use cases. A core aspect of this approach is the use of a toolbox for the creation of use cases in the context of a digitalization in the manufacturing industry.

The toolbox can be used for the generation of business models and technological concepts in a wide spectrum of applications. It consists of two sections focusing on new products and improvements in production processes. Each section consists of six application levels with five development stages. The application levels represent different technologies and potential fields of application for a further digitalization. The development stages of each application level represent different stages towards a higher degree of digitalization. As these stages potentially stand for a different benefit and cost, a creative process for creating valuable concepts is necessary.

In a creative process, the application levels are related to products and production processes. Suitable application levels are chosen and analyzed regarding their development stages [9].

## 2. Approach

### *2.1. Systematic generation of a technological concept for the commissioning of modular machine tools*

The subject of this work is to systematically develop a beneficial application of state-of-the-art technologies for the commissioning of a modular machine tool. Therefore, the first step is to generate and evaluate a concept for an application.

[1] As shown by Grimske [7], mechanical interfaces for modular machine tools can reach sufficient geometric accuracy. It is therefore assumed that the assembly of the machine tool does not result in geometric errors relevant for the compensation process.