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Concept for a self-correcting sheet metal bending operation

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Abstract

Geometrical deviations can appear in the production of plug contacts used in electrical connection technology and in fittings for the furniture industry. The reasons for this can be a variation in the properties of the semi-finished product, or wear phenomena on the forming machine itself or on the bending tools. When geometrical deviations appear, the process parameters normally have to be adjusted manually. Finding the most appropriate process parameters is currently done manually and is thus very time consuming. In order to reduce the scrap rate and the setup time for production scenarios, a concept for self-correcting bending operations is being developed using the V-model of the VDI guideline 2206. In this case, the V-model will make it possible to set up a self-correcting control strategy consisting of a closed-loop control approach, measurement devices and actuators. Having implemented these components in the forming machines, it will be possible to recognize geometrical deviations automatically and to take corrective action during production, aiming at a reduction of the scrap rate and setup-time.

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Keywords: self-correcting process; punch bending; continuous bending process; design methodology

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1. Introduction

Complex metal parts concealed in everyday devices, such as in plug contacts for electrical connection technology and pull-out rails for the furniture industry, are produced by forming processes. The challenges involved in the production of these metal parts lie in the time-intensive setup of the bending processes and compliance with the product requirements during production. Today, when undesirable geometrical deviations appear, the machine operators have to set new process parameters on the basis of their experience. These targeted interventions are only possible when the production run has been stopped, and hence this procedure is very time consuming, especially when it has to be performed more than once. Besides that, the frequent production of out-of-tolerance parts leads to high scrap rates.

New techniques for controlling manufacturing processes are necessary to ensure that the requirements on the functionality and quality of the produced parts are met and that the setup time is shortened. The approach presented here involves the development of self-correcting forming processes. The rapid and successful development of new, intelligent manufacturing processes is supported by the use of the V-model [1]. This paper presents a systematic approach for self-correcting forming processes which focuses on the process design with the help of the V-model and hence not on a detailed description of the individual steps.

2. Intelligent forming process

The aim of this work is to develop intelligent forming processes which will be able to react adaptively to process properties as well as to variations in the raw material. A self-correcting control strategy is thus implemented in the processes. The current process consists mainly of machine-drive and forming tools, which are adjusted manually. The workpieces are then produced from the semi-finished product and measured after the process. If geometrical deviations are detected in a workpiece, new process parameters will be set manually.

To avoid the complex and time-consuming setup of the process, the current process is extended by self-X components. These are actuators, measurement systems and a closed-loop control (Fig. 1). The measurement system obtains the current information from the process on-line. After the corrective action has been calculated, the actuators modify the process parameters. This leads to a so-called on-line process control system.

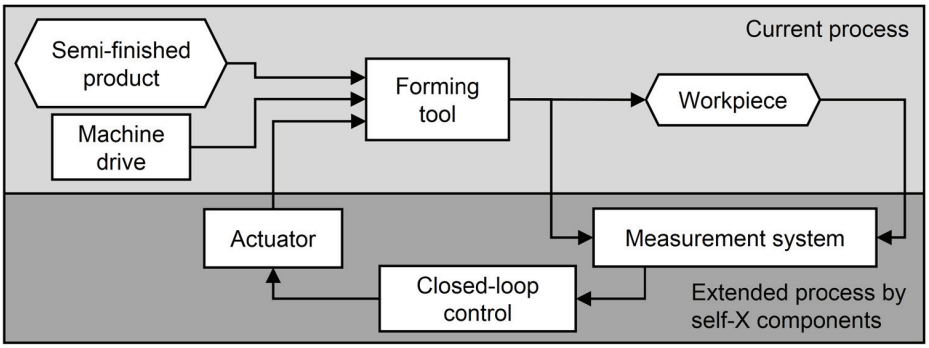

Fig. 1. Operating structure of the process.

The development of new self-X components is highly complex and is thus performed through the consistent application of a design methodology that involves primarily model-based design and analysis. The correcting strategy with self-X components is being implemented in prototype plants in order to successfully achieve an intelligent forming process.