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Potentials for the optimization of sawing processes using the example of bandsawing machines

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Abstract

Sawing processes are the focus of process optimization in order to reduce material costs and save energy resources. Bandsawing machines allow fast processes but produce a low surface quality and great cutting losses of raw material up to now. The wear of saw blades is significant due to the cutting conditions as well as the thin and unstable tool design. Electromechanical drives can substitute inefficient hydraulic systems for workpiece clamping and for the prestressing of saw blades, and provide the precondition for autonomous process control. In order to adjust the sawing parameters during the process, the simultaneous identification of process stability is necessary. In this work, influences on the process stability were investigated by experiment and simulation in order to develop a stability criterion as a function of different process parameters. The focus here was on the behaviour of the saw blade in the kerf. A great influence of saw blade tension could be observed.

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Keywords: sawing; process optimization; resource efficiency;

1. Introduction

Due to the increasing demands of improved efficiency, reduced material consumption and avoidance of energy losses, production processes are increasingly subject to a holistic view. Thus, pre-machining processes are more and more the focus of process optimization in order to reduce costs and save resources. The pre-machining of semi-finished parts out of bar stock with sawing processes is common in the metalworking industry. For example, sawing with bandsawing machines is a fast process, but the produced surface quality of workpieces is poor and the cutting losses of raw material are severe. In addition, the wear of saw blades is significant because of the specific special cutting

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conditions during the sawing process due to the thin and unstable design of the tool, only prestressed in cutting direction. Furthermore, the energy for clamping a workpiece and prestressing the saw blade is supplied by hydraulic systems with high process-independent energy requirement and a serious noise pollution. This leads to an unstable and inefficient sawing process without the possibility for influencing the process parameters in order to control the process behaviour. Regarding sawing machines, the trend is towards electromechanical drive systems to remove the inefficient hydraulic systems. The first objective of the here described development is the possibility to implement a stand-alone process control system to automatically adjust the sawing parameters. In order to enable the control system of the sawing machine to adjust process parameters online during machining, it is necessary to simultaneously identify the process stability. For this optimization of the sawing process, the influences on the stability of the process were investigated by experiment and simulation with the aim to develop a stability criterion as a function of different process parameters. The focus here was on the behaviour of the saw blade in the kerf to characterize the sawing process during cutting. The results obtained showed a great influence of the saw blade tension on the behaviour of the saw blade. This constitutes the basis for developing a stand-alone stability control system to automatically adjust the sawing parameters. With these findings, the first step towards an optimization of sawing processes was achieved and the potentials for increasing the efficiency in sawing technology could be demonstrated.

2. Fundamentals of sawing technology

The cutting process with bandsawing machines is performed by a saw blade consisting of a continuous belt with a large number of teeth. The bandsawing process consists of a vertical and a horizontal motion of the moving saw blade. Fig. 1 shows the principle of horizontal sawing processes, normally used for automated manufacturing. The workpiece is clamped in the machine and the saw blade moves horizontally through the workpiece via the two wheels at a cutting speed v_c. One of the wheels is powered here and the other one applies the required prestressing of the saw blade. The vertical feed motion is performed by the whole saw frame at a feed rate v_f. [1].

The standard value of saw blade tension is 300 MPa. In addition to the prestressing, the saw blade must be twisted towards the cutting plane due to the deflection over the wheels. This causes a stress condition in the cross-section of the saw blade, intensively influencing the performance during cutting.

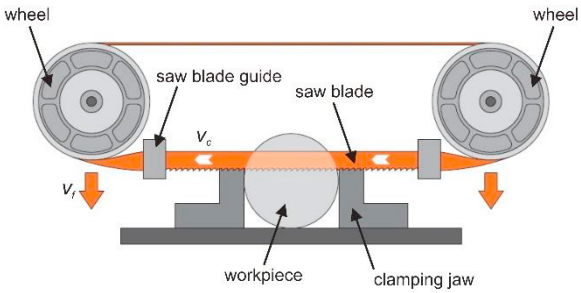

Fig. 1. Principle of horizontal bandsawing [1].

The geometry of a saw blade is defined by the tooth pitch and the setting of the teeth. The tooth pitch is subject to the tooth distance and is given as teeth per inch (TPI). A variable tooth pitch, which means a changing number of teeth in a certain section of the saw blade, helps to avoid a high vibration response due to the tooth impact on the workpiece [2]. The setting of the saw teeth refers to a bending of a single tooth to the left or to the right out of the saw blade axis at particular intervals. This prevents a jamming of the saw blade in the kerf but has the disadvantage of an increasing cutting width [3].