

Modelling, Simulation and Optimisation of a Machine Tool

Johan Fredin

Abstract

To be competitive in today's global market, it is of great importance that product development is done in an effective and efficient way. To enhance functionality, modern products are often so-called mechatronic systems. This puts even higher demands on the product development work due to the complexity of such products. Simulation and optimisation have been proven to be efficient tools to support the product development process. The aim of this thesis is to study how the properties of mechatronic products can be efficiently and systematically predicted, described, assessed and improved in product development.

An industrial case study of a water jet cutting machine investigates how simulation models and optimisation strategies can be efficiently developed and used to enhance functionality, flexibility and performance of mechatronic products. The knowledge gained from the case study is shown to be useful for companies developing machine tools. Most likely it is also useful for developers of other mechatronic products.

The thesis shows that with the presented optimisation strategies, comprising a mix of different computerised optimisation algorithms and more classical engineering work, design problems with a large amount of design variables can be solved efficiently.

A specific result is a validated simulation model for simulation and optimisation of a water jet cutting machine. As all mechatronic disciplines of the machine tool are considered simultaneously, synergetic effects can be utilised. Optimisation studies show a significant potential for improving manufacturing accuracy, for manufacturing speed and for a more light-weight design. Carrying out simulation and optimisation has also provided a great amount of information about the studied system, potentially useful in coming product development work.

By reducing the number of physical prototypes through simulation and optimisation, the resource consumption during product development is reduced. Also, with more optimised products, the resource consumption can be significantly reduced throughout the whole use phase. These benefits support the competitiveness of the product developing company as well as a sustainable development of society as a whole.