Analysis of structural oscillations on linear handling axes

Nowadays trend to lightweight structures in handling machines offers many advantages (e.g. less energy consumption, faster movements), but due to the decreased stiffness of these structures, more effort needs to be done considering the control of structural oscillations. In order to guarantee the desired position accuracy, and also to deepen the understanding of the complex couplings between motions and forces inside its own machines, Güdel decided to extend its developing processes with the flexible multi body simulation tool RecurDyn.

The Güdel Group is a manufacturer of high-precision machine components and a supplier of sophisticated automation solutions. The company's product range encompasses linear tracks, racks, pinions, transmission systems, linear modules and gantry robots. In its development process, Güdel already uses different simulation tools. Nevertheless most simulations aim to determine characteristics such as stability or resistance. However receiving a desired position accuracy, a more complex understanding of occurring oscillations enforced by the complex coupling of forces and motions is required. Thus the modeling of all the modules is indispensable.

In a first step, an existing Gantry System is modeled using as little parameters as possible. Thereby different reduction methods are applied to reduce the computational effort. One important reduction method used in RecurDyn is the generation of reduced flexible interface (RFI) bodies. After performing a modal analysis in ANSYS, which is already done for many applications in Güdel projects, RecurDyn is able to create a reduced RFI body using modal superposition.

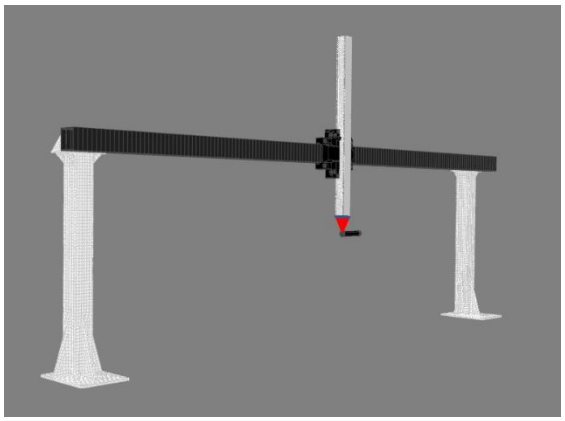

Figure 1: Simplified Model of the Gantry System. Footholder and carriage are modeled as reduced flexible interfaces (RFI), the axes are modeled as beam elements and the tool-center point is modeled as rigid body.

This RFI body then substitutes the original full flex body, which significantly lowers the computational effort.
The axes are reduced by modeling beam elements. Most axes developed by Güdel are driven by rack and pinion drive systems. In order to correctly model this contact, a tool is required which implies the complex coupling between forces and motion implied by this contact onto the beam and vice-versa. RecurDyn provides a very useful tool for this application called Machine-Tool, which is one of the key features in the whole simulation process.
It is a goal to build a construction-kit of all machine types developed by Güdel. Using this construction-kit arbitrary combinations of all Güdel components can be easily modeled and the systems behavior can be predicted. Also new ideas can be easily implemented and analyzed without building expensive prototypes. In a fast-moving industry such as the manufacturing industry, this is a must have in order to guarantee a successful innovation process and to cover the variety of all the customers' needs.
Already in the presales phase FunctionBay convinced with an extensive support. Using example-models specific to Güdel products, the benefits of using RecurDyn as a simulation tool were clearly shown. Combining the experimental data of the Gantry System with the gained knowledge of the modeling results many unknown aspects can be understood and thus improvements can be achieved.

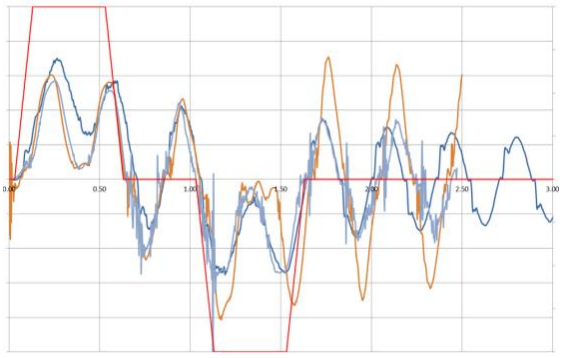

Figure 2: Characteristics of the actuation force. Using a predefined acceleration setpoint (red), different parameter settings are studied and compared to an experimental measurement (blue).