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High Quality Machining

Innovation results in precision manufacturing of highly complex components from high-quality materials as well as optimized surface properties

Manufacturers must constantly improve their manufacturing processes and technologies to keep up with marketplace demands to improve product quality, speed up production and reduce costs. In some industries, such as aerospace, quality and safety aspects are of particular importance. In order to meet the need for adaptability and cost-effectiveness in this context, flexible manufacturing cells require autonomous processes.

Objective

The Institute for Production Engineering and Photonic Technologies (IFT) at TU Wien strives for significant quality improvements as well as energy and cost savings through innovation. Our work is concentrated on industrial high-performance production from mass to individual production (batch size 1).

A particular challenge is posed by manufacturing uncertainties such as varying component geometry, tool wear and scattered material properties (e.g. changing material, composites or inhomogeneity.) Another challenge is an increase in the use of high-grade materials for thermal, hemical or corrosion resistance. Their higher cost makes manufacturing processes necessary that save on material and minimize production errors and rejects. These new processes must automatically detect and independently correct instabilities.

Our Solutions

The approaches that have proven particularly successful at the IFT include a majority of the following elements:

- carrying out feasibility studies
- selection and further development of appropriate production processes
- development of suitable measurement and test procedures as well as sensor and actuator systems
- sensor integration to record process data (for monitoring, quality assurance) as well as for data communication and the adaptive control of production processes (in-process control)
- targeted modification of the surface properties of complex components

Results

Sensorized machining tool holder

At the IFT, a machining tool holder with an active control system was developed which records process parameters parallel to cutting, grinding or drilling. If necessary, parameters are adapted to changed production conditions via the process control system. This allows process instabilities to be detected and compensated for at an early stage. Production failures and downtimes can thereby be avoided. The machining data transmitted by the tool holder are analyzed in real time within the process control. An adjustment of the current machining parameters, such as feed rate and speed, is made whenever needed. This enables:

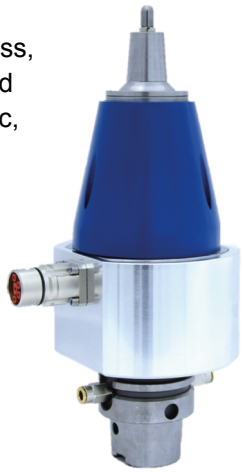
- autonomous optimization of process parameters, increase in productivity
- avoidance of instabilities such as rattling and premature tool failures
- monitoring to provide data for post-processing and quality management

Machine Hammer Peening

The functional performance of a component is to a great extent determined by the properties of its surface and the near-surface boundary layer. In order to manipulate these properties, mechanical surface hammering or machine hammer peening, MHP, is used. A tool, typically with a spherical carbide metal tip, is set into an oscillating motion of up to 500 Hz by an actuator system. Surface treatment is performed by strokes of the tool tip arranged consecutively along a path.

The new actuator system developed at the IFT is the first one to allow for individual and precisely defined strokes as well as control and monitoring of the entire mechanical surface treatment process.

Due to the highly dynamic short-stroke linear reluctance motor, each single movement of the hammer can be accurately set and controlled. This fine level of control enables:

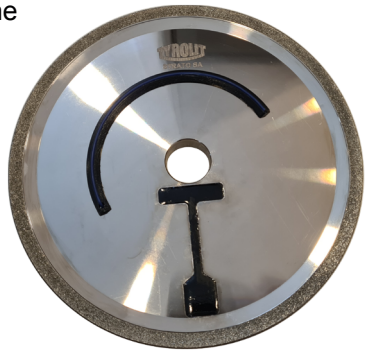


- specific manipulation of roughness, smoothness, micro-geometry and hardness as well as the magnetic, thermal, electrical, and chemical properties of surfaces
- reduction of flow resistances
- substitution of thermal hardening processes
- replacement of manual polishing processes
- invisible 3-dimensional coding option for components

Sensorised grinding wheel

Grinding is often used as the last process in the manufacture of a workpiece and is therefore of particular importance for its quality. Dimensional tolerances must be maintained and surface quality requirements must be attained.

In order to improve this important machining step, the IFT has developed a technique which measures the deformation and dynamic behavior of a grinding wheel and correlates those measurements with process parameters. This makes it possible to:

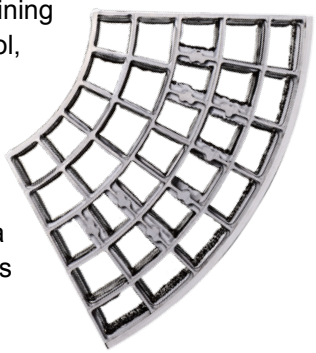


- objectively compare the performance of new product variants
- help our industry partners rapidly achieve product innovation goals
- significantly increase the stock removal rate of grinding wheels

Additive manufacturing of high-quality metal parts

Additive manufacturing can be used to produce near-net-shape parts, which is particularly important in the case of high-strength and difficult-to-machine materials. The materials required are often nickel-based (e.g. Inconel) or contain expensive elements (e.g. titanium). Through the targeted combination of additive and subtractive manufacturing processes, it is possible to significantly reduce both the amount of material machined and machining time.

The IFT can draw on a great deal of experience and specialized knowledge in this area, which enables us to:



- select and optimize machining processes, process control, monitoring and regulation based on the component quality targeted
- develop measurement systems and analyze data with regard to autonomous defect detection and self-optimized manufacturing

Your Benefits

The IFT at the TU Wien has more than 40 years of experience innovating in the field of machining and machine tools. The findings from a large number of scientific projects and industrial co-operations enable highly effective co-operation, competent consulting, and the efficient implementation of innovation. TU Wien brings you:

- comprehensive improvement of individual manufacturing processes with multidimensional objectives
- product innovation
- optimization of the entire production chain – including machining, logistics, energy consumption, and operational efficiency
- access to a diverse network of experienced tool and machine manufacturers
- rapid implementation of innovation ideas for your products

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