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**Combined expertise for the medical industry**

**Functionally integrated implants through novel synchronised machining processes - ZykloMed**

**With the joint project funded by the Federal Ministry of Education and Research (BMBF), the participating partners INDEX, Paul Horn GmbH, Beutter Präzisions-Komponenten GmbH and the wbk Institute for Production Engineering at the Karlsruhe Institute of Technology (KIT) are demonstrating their expertise in the medical industry. Using new and modern manufacturing processes, the partners have tackled the challenges for economical machining of implants with multifunctional as well as non-round bionic designs. The focus was on the three manufacturing processes of eccentric turning, polygon turning and turn whirl milling.**

Modern medical implants for orthopaedics, traumatology and dental technology are characterised by rigorous demands on strength, biocompatibility and bionic-optimised geometry. The geometry of an implant is adapted to the bone and tissue. In the process, the functional surfaces of the implants are given an increasingly sophisticated design in order to facilitate their attachment in the body and make them less invasive for the patient. The new designs of implants drive up manufacturing costs because the surfaces are no longer circular or square. They have more curved surfaces and functional elements with continuous transitions in a very small space. In particular, the need for several manufacturing steps on different machines causes costs to rise significantly. For example, precise handling for exact reclamping of a workpiece represents a considerable cost factor. Therefore, despite the high level of functional integration, an efficient process route is needed for economical production.

**Novel processes**

The novel manufacturing processes of eccentric turningen, polygon turning and turn whirl milling are all based on the same kinematic principle of multiple synchronised rotating axes. While this principle is well known, its application to non-circular and curved shapes is highly demanding. At the same time, the practical implementation must meet the high quality requirements of the medical industry.

The project partners researched and developed novel manufacturing procedures along the entire process and supply chain, from the machines and control technology to the tool design to prototype and pre-series production. The manufacturing processes were simulated and designed based on known methods with the same mathematical principles in order to determine the requirements for tool and machine. The tests were divided into equivalence tests under laboratory conditions as well as pre-series tests in laboratory and near-application environments. The engineers focused on both machine and tool technology for the development and design of the individual processes.

In eccentric turning, a rotating non-circular tool is guided along a rotating workpiece under positional coupling. The speeds are brought into a certain ratio to each other. The out-of-round shape is thus reproduced on the component within certain limits. The process offers highly productive production of eccentric outer contours. The rotation of the tool reduces the thermal load at the cutting edge, which ensures long tool life. The process also enables the production of tapered profiles.

Polygon turning is a process for producing non-circular external and internal contours with the shape of a hypotrochoid. Like rotary eccentric turning, the process offers the possibility of producing non-circular contours on lathes. In the process, the parallel axes of the workpiece and the tool are offset from each other by an axial distance and are brought into a specific speed ratio under positional coupling. The axial distance, the speed ratio of the workpiece to the tool and the cutting diameter of the inserts define the dimension of the contour. A tool system for polygon turning is individually adapted to the contour of the workpiece to be produced.

Turn whirl milling is a highly productive process for producing threads for bone screws. One or two circular milling cutters are set at a certain angle to the workpiece. The directions of rotation of the cutters and the workpiece can be the same or opposite. The speed ratio of the workpiece to the two cutters depends on the number of threads and the number of cutter inserts. For the first time, turn whirl milling can also be used to economically produce threads with a true variable pitch by dynamically changing the thread profile.

**Tests close to series production successful**

With successful tests in a near-series production environment, the partners of the ZykloMed project have come a big step closer to the goal of the research project, the economic production of implants of multifunctional and non-round bionic design. The engineers proved that the synchronised manufacturing processes enable the economic production of modern implants. In addition to the production of new component geometries, the processes also offer optimisation potential for the economic production of existing implants, as well as possible applications beyond the medical industry.

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Picture caption: Eccentric turning enables highly productive production of non-round external contours.

Source: HORN/Sauermann



Picture caption: Polygon turning offers the possibility of producing non-round contours on lathes.

Source: HORN/Sauermann

Ein Bild, das Text, Im Haus enthält.

Automatisch generierte Beschreibung

Picture caption: Turn whirl milling is a highly productive process for manufacturing bone screw threads.

Source: HORN/Sauermann



Picture caption: The joint project ZykloMed is funded by the Federal Ministry of Education and Research (BMBF).

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Picture caption: All procedures are in use under cutting conditions.

Source: HORN/Sauermann



Picture caption:

The project participants at the final presentation of the BMBF joint project (from right to left):

Dr.-Ing. Volker Sellmeier / INDEX-Werke GmbH & Co. KG Hahn & Tessky, Andreas Kanz / Paul Horn GmbH, Dr.-Ing. Wolf-Dieter Kiessling / BEUTTER Präzisions-Komponenten GmbH & Co.KG, Tassilo Arndt / Institute for Production Engineering at the Karlsruhe Institute of Technology (KIT).

Source: HORN/Sauermann

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