Controlling the cut: Engineers top the leader board

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A high-tech, precision, water jet milling control system which could transform the manufacture of complex aerospace, optical and biomedical structures and devices is being developed by an international team of engineers led by The University of Nottingham.

With European funding of €3.8m (£3.17m) Dragos Axinte, a professor of manufacturing engineering, and his research team in the Department of Mechanical, Materials and Manufacturing Engineering are developing a new 'self-learning' controlled-depth milling technique which can be programmed to work — with high accuracy and without human intervention — on the surface of 3D, geometric, multi-gradient surfaces.

Professor Axinte, who is co-ordinating the project, said: "If you want to generate surfaces in difficult-to-cut or heat-sensitive materials while exerting minimal specific forces abrasive water jet milling will do the job. For this technology the research team of ConforM2-Jet project, developed a precision technique to generate even the most complex multi-gradient surfaces with high accuracy.

"The accuracy of the ConforM2-Jet self-learning control system is due to a set of original mathematical models of the material removal and process monitoring techniques to allow corrections of the system as milling is taking place. These unique systems combine to ensure that complex milling of difficult-to-cut materials can be carried out with high accuracy."

Emerging technology

Abrasive water jet machining is one of the most promising non-conventional processing methods for difficult-to-cut materials — such as advanced aerospace components, orthopaedic implants, ultra-precision lenses, composites and super-abrasives including diamonds.

This fast emerging technology uses a jet of water as small as 1mm or less in diameter which is released under pressure at as much as three times the speed of sound. With the addition of abrasive particles this high velocity jet of water will cut even the hardest material into the most complex shapes. Or, conversely, precision machine polish optical moulds and lenses at very low pressure.

Professor Axinte said: "Monitoring solutions in other machining processes are either inefficient or cannot cope with the harsh working environment. The ConforM2-Jet project will lead to the development and demonstration of the first self-learning control system for abrasive waterjet milling capable of dealing with advanced applications to address the needs of niche and high value added manufacturing industries. At the end of the project we will have produced the software and a control system to completely automate the abrasive water jet milling and, hence take it out of the craftsmanship remit."

How the new technology will work

Based on the key elements of the milling process and their energy-related sensory signals the technology uses a specially developed computer aided manufacturing (CAM) system to enable the generation of the theoretical path of the jet plume. The self-adaptive module also receives real-time sensorial information indicating the status of the actual abraded abrasive jet footprint that contributes to the generation of

the freeform surface. Based on this information, the self-adaptive module makes the necessary adjustments to bring the abrasive water jet milling process to the required performance level. The resulting information is used by the system to refine and update the knowledge on the process, leading to efficient response of the ConforM2-Jet system when new working scenarios are considered.

Provided by University of Nottingham