Guest Editorial

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Biographical notes: Hsi-Yung (Steve) Feng is an Associate Professor in the Department of Mechanical and Materials Engineering at the University of Western Ontario, London, Ontario, Canada. He received his BS in Mechanical Engineering from National Taiwan University in 1986, and his MS and PhD in Mechanical Engineering from The Ohio State University in 1990 and 1993, respectively. Before joining UWO in 1997, he first worked in industry and then in Canadian government laboratories as a researcher at National Research Council. He currently serves as an Associate Editor for the *Int. J. Manufacturing Research* and an editorial advisory board member for *Recent Patents on Engineering*. His research interests in CAD/CAM/CAI (computer-aided design, manufacturing and inspection) presently focus on multi-axis sculptured surface machining, machining process planning, computational/coordinate metrology, 3D scanning and precision inspection of complex surfaces and surface reconstruction from point cloud data.

Sculptured surface machining is one of the most challenging operations facing today's machining industry. Because of the advances in the commercial computer-aided geometric modelling software systems, mechanical parts with complex 3D sculptured surfaces can now be modelled without much difficulty. The function of such sculptured or free-form surface geometry in a part design is to ensure superior working performance of the part or simply to enhance its aesthetic appeal. The formation of these geometrically complex surfaces is most often via machining on a three- or five-axis Computer Numerical Control (CNC) machine tool with input machining commands generated by a Computer-Aided Manufacturing (CAM) software system.

Modern CAM/CNC technologies are widely applied in practice to attain both precision and efficiency in the machining of sculptured surfaces. Nevertheless, at present these technologies are not fully automated and many process-related variables/parameters require user input. This is because current commercial CAM systems only focus on geometric computations without considering the effects of machining mechanics and dynamics. In other words, an ideal and completely rigid machining system is consistently being assumed. As a result, the selection of optimal or even applicable process parameters is to be based on the user's experience and/or extensive (and expensive) practical trials. In an effort to automate the manual practice of optimal process parameters selection in sculptured surface machining, active research work is being conducted in the following subject areas:

- planning of intermediate machined geometries for multi-stage machining including roughing, semi-finishing and finishing
- optimal feed rate determination based on process constraints.

In addition, current commercial CAM systems only offer limited geometric analysis capabilities, in particular for the complicated operation of five-axis sculptured surface machining. The associated geometric setting and computations become very challenging for this advanced machining operation due to the two rotational degrees of freedom between the cutting tool and the workpiece. Significant research efforts have been devoted to the development of novel computational algorithms to resolve the following important issues in five-axis sculptured surface machining:

- selection/determination of optimal cutting tool, tool orientation and tool path
- machining error evaluation due to interpolated NC tool movements.

This special issue contains seven invited papers contributed by internationally well-known researchers in the challenging field of sculptured surface machining. These papers cover a typical spectrum of active research topics that are essential to sculptured surface machining. The main feature of each paper is briefly stated below.

- The first paper 'A parametric implicit solid modeller-based morphing technology for free-form surface machining' by Bin Huang and Daniel C.H. Yang at the University of California, Los Angeles, presents a novel solid modelling concept to systematically represent the intermediate machined part geometries from the initial stock to the final object geometry using Laplace-based solutions.
- The second paper 'Process simulation and feed rate selection for three axis sculptured surface machining' by Robert B. Jerard, Barry K. Fussell, Min Xu and Cuneyt Yalcin at the University of New Hampshire and the third paper 'Machining of complex sculptured surfaces with feed rate scheduling' by Mustafa Kaymakci, Ismail Lazoglu and Yavuz Murtezaoglu at Koc University, Turkey, report similar offline strategies of determining fastest possible feed rate for each NC tool movement based on predicted cutting forces in order to improve machining efficiency.
- The fourth paper 'Accessibility comparison for optimal cutter selection in five-axis finish milling of sculptured surfaces' by L.L. Li, Y.F. Zhang, A.Y.C. Nee, J.Y.H. Fuh, Y.S. Wong, Millan Yeung and Z. Gui at National University of Singapore, documents an efficient algorithm for finding the optimal cutting tool size without causing machining interference (local-gouging, rear-gouging and global-collision).
- The fifth paper 'On the B-spline interpolated tool trajectories for five-axis sculptured surface machining' by O. Remus Tutunea-Fatan and Hsi-Yung Feng at the University of Western Ontario, illustrates the effective application of the newly implemented B-spline interpolation scheme for reduced machining errors due to approximation of ideal curved tool paths.

- The sixth paper 'Multiple-axis sculptured surface machining' by John C.J. Chiou and Yuan-Shin Lee at the North Carolina State University, applies the innovative concept of swept envelope to the determination of optimal tool orientation and machining direction, leading to optimal tool path generation for open-boundary sculptured surfaces and closed-boundary pocket surfaces.
- The seventh paper 'Tool path planning for 3½½-axis machining' by Armando Roman Flores, Sanjeev Bedi and Fathy Ismail at the University of Waterloo, introduces the advantage and application of locking the cutting tool orientation in five-axis machining to avoid decreased feed rates caused by the saturation of servo drives for the rotational axes.

The guest editor would like to take this opportunity to thank all the authors for their high-quality contributions to the special issue as well as the many anonymous referees for their time and insightful review comments. Finally, the guest editor is grateful to the trust and patience of Dr Lihui Wang, Editor-in-Chief, during the process of compiling this special issue.

Hsi-Yung Feng
Guest Editor