Editorial

Spencer Onuh

Regional Centre for Manufacturing Industry (RCMI),
Department of Mechanical and Design Engineering,
University of Portsmouth,
Anglesea Road, Anglesea Building,
Portsmouth PO1 3DJ, UK
Fax: +44 2392842351
E-mail: spencer.onuh@port.ac.uk

Agility, as a desirable strategic feature of industrial enterprises, was introduced by the Iacocca Institute at Lehigh University in the 1990s. The main topic at that time was Agile Manufacturing (AM). This involved techniques such as Virtual Enterprises (VE), Lean Manufacturing (LM), Flexible Manufacturing and Rapid Prototyping (RP). Because agility is defined as the ability of a system to adapt itself to rapid and unexpected changes, the concept soon was applied to fields beyond manufacturing. The entire production process starting from the customer order, through product development, procurement, manufacturing, supply chain management, delivery and servicing should be agile in order to be competitive. Also, for the software development industries, process industries and services industries, agility is either or will be essential. Agility covers both technical and managerial aspects.

The competitiveness of industry is based on its flexibility in adapting to new technologies and market trends. The support for enterprises to improve their capacity and competitiveness can be achieved with the help of rapid prototyping, tooling and manufacture technologies. Therefore, this special issue aims to consolidate the experimental and theoretical works in new and advanced RP technology potential and solutions as well as user's recommendation for efficient implementation of agility in product development processes.

The papers that appear in this special issue deal with strategic frameworks, analytical models, case studies and experimental investigations focussing on new architectures, changes in the organisation, technology and people required for the design and implementation of AM in Rapid Manufacturing (RM) technologies in order to enable companies to compete on flexibility, quality and responsiveness. The papers deal with, but are not limited to, the following:

- an overview of RM/Rapid Tooling (RT) and AM integration
- strategic and organisational implementation of AM in RP/RM
- design methodologies for RM/AM systems including architectures and evaluation of adaptability for LM, AM and value chain integration

- enterprise integration and quality issues in RP/RT
- high speed machining strategies and investigations as enablers of RM, AM and services.

The paper 'Trends in agility for rapid product development and manufacturing – a review', by Onuh, Popov, and Bennett presents a review of some of the important research works done on the RP, RM and AM to show how RP/RM has been used successfully for implementing agility in a number of research fields. Case studies are cited to show how RP/RM has been used as an enabler of agility in a RP Service Bureau. The authors conclude with some recommendations for the implementation of agility in RP/RT/RM.

Millward et al. in their paper titled 'A case study of flexible tooling solutions for a small healthcare company' used a case-study methodology to examine how flexible tooling solutions can drive rapid product development in a small company context. Customisation of the company's product has been matched by agility within the overall development and manufacturing process. The case study shows that: flexible tooling solutions provide a balanced development strategy; risk management is a key element during the initial tooling development; cost reduction and time compression can be achieved through the use of reconfigurable tooling, high-speed machining techniques and advanced cutter technology.

Advances in process technology have opened new possibilities for rapid manufacturing. High speed machining is one of these innovative areas. High-speed cutting (HSC) offers the most appropriate opportunity for reduction of run times. However, it is difficult to predict the tool wear of HSC because section parameters of chip geometry contain key parameters that affect the calculation of tool wear. Yan Luo in his paper on chip form strategy for tool wear prediction solution presents an algorithm to analyse chip forms and calculate chip geometry for HSC. This enables the results of chip geometry to be used in the calculations of tool wear and analyse tool safety. This development will lead to reduction in production cost, improvement of product quality and shortening of development time. Closely related to the work of Yan Luo is the work on white layer formation and tool wear in high speed milling of 57HRc tool steel using coated and uncoated tools by Mativenga and Mubashar entitled 'White layer formation and tool wear in high speed milling of 57HRc tool steel using coated and uncoated tools'. Mativenga and Mubashar's paper focuses on formation of white layers during high speed milling of hardened tool steels. Their investigation is both theoretical and experimental whereby they used uncoated and TiAlCrN coated micro-grain carbide end mills in the machining experiments. Their paper explores the correlation of white layer formation to tool wear progression and how this is affected by the Physical Vapour Deposition coating. Surface hardening, subsurface tempering, surface finish and compositional change are also presented. Their results show that in milling, tool wear is a significant driver for white layer thickness progression.

The paper by Coole et al. titled 'Development of a tool life prediction model for plaster machining' reviews the developments of the ongoing research into the application of Computer Numerical Control (CNC) machining techniques to produce plaster moulds and prototypes. The experimental work was carried out on plaster using conventional cutting tools (slot-mills), using a six-axis anthropomorphic robot. Based on the tool wear measurements (Flank wear – VB), an analysis of the cutting tool failure was undertaken. The work comprises of three phases. Initially, an experimental screening was carried out in order to identify the major important criteria regarding the cutting tool wear problem. The second phase corresponded to the development of a tool life prediction model for the machining of the plaster material. The calculations were carried out using the response surface methodology and the 2^3 factorial design. The experimental results showed that the cutting speed is the most significant factor to the tool wear process. Finally, results developed from a theoretical analysis with the tool life prediction model were compared with the experimental results. This test demonstrates the validity of the theoretical analysis and showed how the optimisation process can be performed using this methodology in the drive to integrate CNC machining with AM.

Another interesting paper on process optimisation is by Xue-liang et al. on ‘Six Sigma approach for build-time estimation for the Selective Laser Sintering (SLS)’ process. Build-time estimation function of RP plays an important role in optimisation of process parameters, job scheduling, and job pricing and quoting. The common estimation function as used by most RP systems is not sufficient to give the accuracy build time for Selective Laser Sintering (SLS) process. Hence, finding an appropriate method to estimate the build time is very important. In their investigation, the Six Sigma methodology and its ‘Define Measure Analyse Improve Control’ (DMAIC) model was used to find the main factors in build-time estimation for the SLS process. They used their results to develop a new estimation model which significantly reduces the estimation errors availably.

The paper by Popov and Onuh, ‘Critical notes and considerations on the use of ISO 286-1 for Computer-Aided-Design (CAD) modelling and rapid product development’, discusses International Standard Organisation (ISO) system of limits and fits used in linear tolerancing. The authors highlight the ambiguity in these standards. They show that in some cases, the data and the technical terms given in the standard may be misinterpreted especially when used in automated CAD modelling systems. The objective of their research work is to clarify the procedure of determination of the fundamental deviation of a tolerance. This is necessary in order to radically improve the product development cycle by reducing the modelling time. They propose a new universal formula for the calculation of the correction (Δ), which supersedes some numerical data from the standard that could be potentially misused. Some amendments related to key technical terms have been offered to bring agility to linear tolerancing. The methodology developed in their paper is robust for preserving feature integrity for use in Geometric Dimensioning and Tolerancing (GD & T), CAD and Computer Aided Engineering (CAE) applications.

The paper by Quayle and Rennie entitled ‘Integrating CFD and prototyping technologies in the investigation of multi-element profiles for a high-lift variable pitch vertical-axis tidal power generator’ is both theoretical and experimental. The authors present preliminary Computational Fluid Dynamic (CFD) results which are used to validate and optimise the design of a multi-element profile for a vertical axis tidal stream energy device, where the relative velocities, fluid type and Reynolds number differ significantly from those found in the aerospace sector. The resulting designs and optimisation have allowed for the manufacture of stereolithography prototypes for *in situ* testing in the ‘wet’ facilities at the UK University. The UK is in a prime position to exploit energy capture from tidal stream with the advantage over other renewable sources in that it is completely predictable. Such exploitation requires the quick turnaround offered through design, analysis and product development technologies – in other words, manufacturing agility.

Acknowledgments

The Guest Editor of this Special Issue has been overwhelmed by the response to the call for papers for 'Rapid product development, tooling and agile manufacturing'. Each paper was reviewed by at least two referees. The Guest Editor gratefully acknowledges the assistance provided by the Editor of the *Int. J. Agile Systems and Management* (Professor Yahaya Yusuf) and more than 20 anonymous referees who reviewed manuscripts for this Special Issue.