



Variety Management in Manufacturing. Proceedings of the 47th CIRP Conference on Manufacturing Systems

## Managing Variety in Manufacturing

Hoda ElMaraghy

*Intelligent Manufacturing Systems (IMS) Centre, University of Windsor, 401 Sunset Avenue, Windsor N9B 3P4, ON, Canada*

Tel.: +1-519-253-3000 (Ex. 5034) .E-mail address: [hae@uwindsor.ca](mailto:hae@uwindsor.ca).

### Forward

Manufacturing is a corner stone of the world economy; its share of global GDP is 16%. The health of the manufacturing sector matters as one of the main drivers of the economy which generates well-paid jobs and wealth throughout the whole value chain in manufacturing and services. Sustainable manufacturing is becoming a must. Over the past several years, this vital economic sector has faced significant challenges due to globalization, shortage of professional and skilled labor, concern about the environment and need for maximizing customer value through high quality customized products at a competitive cost.

Change, in products and systems, has become a constant in manufacturing. This sector continues to witness major market shifts, introduction of new materials and production technologies as well as great changes in consumer preferences and products variety. These present significant challenges to industrialists and researchers alike in developed and developing economies. Competition based on low wages alone is not sufficient; innovation in products and manufacturing processes and systems is a must to stay ahead.

Modern manufacturing is experiencing a paradigm shift towards more flexibility to respond quickly and efficiently to changing products design, production requirements and market demands. There is a clear need for innovative product design and manufacturing processes and technologies to ensure competitiveness, responsiveness, and economic sustainability. Change enablers and adaptation mechanisms to mitigate the effects of, and capitalize on, changes in manufacturing are needed.

As the pace of change continues to accelerate due to the development of transformational new technologies, manufacturers have to continuously upgrade their products, processes and technologies. Innovative product design and manufacturing processes and technologies are needed to remain competitive, flexible and responsive.

Global competition in advanced manufacturing is growing more intense as the life of products and technologies decreases and windows of opportunity shrink. It is important to design and manufacture products and systems smartly to regain competitiveness. It is no longer sufficient to make things better, we must make better things.

In addition to achieving economies of scale through mass production, today's dynamic markets require achieving economies of scope by rapidly and economically producing alternative variants of products to satisfy diverse global customers and segmented markets and managing frequent changes due to increased product variety, mass customization and personalization. The market volatility and demand fluctuations as well as increased products variety and complexity require agility, adaptability, responsiveness and effective use of innovative enablers of change.

The proliferation of product variety is present in a wide range of products from simple light bulbs to more complex appliances, cars, airplanes and ships. Product customization and personalization is also on the rise to increase consumers' value. However, satisfying the increased demand for product variety should not be achieved at any cost. Product variety can offer the potential to expand markets and increase sales volume and revenues. This positive outcome is not always guaranteed unless variety is well-managed in all stages of design, planning, manufacturing, supply and distribution, usage, dismantling and recycling. Many manufacturing challenges emerged due to the proliferation of product variety caused by product evolution and

customization and the effect on their manufacturing systems. As products continue to evolve, the challenge is to realize economies of scope while achieving the efficiencies and cost advantages of economies of scale, through grouping and classification, modularization and standardization of interfaces, and delayed product differentiation manufacturing techniques, and variant-oriented product design and PLM tools, process planning, production planning and manufacturing systems.

Several mega-initiatives are on-going to develop the new tools and technologies required to face these new challenges. The United States of America, for example, is embarking on a major “Intelligent Manufacturing” program and investing in new collaborative research centers and R&D programs aimed at bringing this objective to reality. Similarly, the European Union has initiated many research and development programs under the overall objective of developing future cyber-physical production systems or what is called the “fourth industrial revolutions - Industry 4.0”.

These topics and others such as de-manufacturing technologies to promote sustainability and better manufacturing systems control methods are discussed in four keynote papers. Issues pertaining to productivity, education are also discussed with particular emphasis on various types of learning factories.

The proceedings of the 47th CIRP Conference on Manufacturing Systems (CMS 2014) held at the University of Windsor in Canada from 28-30 April 2014 contains 146 papers which address a wide range of issues related to the design, planning and control of modern manufacturing systems and their products. The conference theme of “Managing Variety in Manufacturing” is well covered from product innovation and design to retirement and re-cycling throughout the whole product and manufacturing systems’ life cycle. The papers are grouped in 23 sections: 1) Keynote papers, 2) Design of Manufacturing Systems, 3) Changeability, Flexibility and Reconfiguration of Manufacturing Systems, 4) Learning Factories and Manufacturing Education, 5) Complexity Management, 6) Quality of Products and Processes, 7) Co-Development and Product Platform, 8) Managing Product Variety, 9) Life-Cycle and Risk Analysis of Products, 10) Design of Products, 11) Dynamic Analysis of Manufacturing Systems, 12) Production Planning and Control, 13) Performance Analysis and Evaluation of Manufacturing Systems, 14) Energy-Efficient Processes and Systems, 15) Sustainability and Green Manufacturing, 16) Beyond Lean Manufacturing, 17) Logistics, 18) Supply Chain, 19) Production Networks, 20) Manufacturing Technology, 21) Materials and Joining, 22) Digital and Rapid Manufacturing, and 23) Automation and Control.

I would like to thank the conference co-chair, Professor Waguih ElMaraghy, Director of the Intelligent Manufacturing Systems Centre at the University of Windsor, for his valuable contributions throughout the effort of organizing the conference and papers submission and evaluation. Members of International Scientific committee of the 47th CIRP Conference on Manufacturing Systems played a very active role in reviewing the manuscripts and providing feedback to the authors to ensure a high level of quality in both papers content and format. Special thanks are also due to the many members of the Intelligent Manufacturing Systems Centre, the Faculty of Engineering and various support units at the University of Windsor who gave generously of their expertise, talent and time to make the conference organization successful and the publication of this conference proceeding possible.

*Hoda ElMaraghy*

Guest Managing Editor, Elsevier SI of Procedia CIRP CMS 2014

Hoda A. ElMaraghy, PhD, PEng, FCIRP, FCSME, FSME  
Canada Research Chair in Manufacturing Systems,  
Director, Intelligent Manufacturing Systems Centre,  
Professor, Industrial and Manufacturing Systems Engineering,  
Centre for Engineering Innovation (CEI), Faculty of Engineering,  
University of Windsor,  
Windsor, Ontario, Canada

© 2014 Elsevier B.V. This is an open access article under the CC BY-NC-ND license  
(<http://creativecommons.org/licenses/by-nc-nd/3.0/>).

Selection and peer-review under responsibility of the International Scientific Committee of “The 47th CIRP Conference on Manufacturing Systems” in the person of the Conference Chair Professor Hoda ElMaraghy”