

Professor Hoda ElMaraghy



Dr. Hoda ElMaraghy is Canada Research Chair in Manufacturing Systems, Professor of Industrial & Manufacturing Systems Engineering and Director of Intelligent Manufacturing Systems (IMS) Centre, University of Windsor, Canada. She received an Honorary Doctorate from Chalmers University of Technology in Sweden in 2013. Hoda is an expert in Productivity, Automation, Globalization, Competitiveness and Sustainability. Her research interests include Manufacturing Systems Paradigms - Flexibility, Reconfiguration and Changeability and Managing Product Variety. She pioneered research on the Co-Evolution and Co-development of products and their manufacturing systems inspired by natural evolution of species. She is a professional engineer and Fellow of CIRP, SME and CSME.

She and Dr. Waguih ElMaraghy set up the first in North America truly Reconfigurable and Changeable Assembly System (iFactory) - a "Factory-in-a-Lab." which provides a unique experiential learning opportunities and a test bed for advanced research in manufacturing.

Professor Waguih ElMaraghy



Dr. Waguih ElMaraghy is a Professor of Industrial & Manufacturing Systems Engineering and Director of Intelligent Manufacturing Systems (IMS) Centre, University of Windsor, Canada. His research interests include Product Design, Manufacturing Systems, Design for Disassembly and Life Cycle, Rapid Prototyping, and Managing Complexity in Products and Systems. He is a professional Engineer and Fellow of CIRP, ASME, CSME and CEA.



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The Intelligent Manufacturing Systems (IMS) Centre of Research Excellence was founded in 1994. It pursues leading edge research in the multidisciplinary field of manufacturing systems from products design to production and manufacturing systems including the complete product life cycle issues. Its research is supported nationally and provincially and is engaged in many projects with industry, centers of research excellence, international collaborations and exchanges. The IMS Centre (www.uwindsor.ca/imsc) is located in the Centre for Engineering Innovation (CEI).

The Department of Industrial and Manufacturing Systems Engineering offers accredited Bachelor, Master and PhD degrees in Industrial and Manufacturing Systems Engineering. The University of Windsor is a comprehensive, student-centred university, with more than 16,500 students enrolled in undergraduate, graduate and Professional programs.

LEARNING FACTORY FOR MANUFACTURING SYSTEMS

There has been increased interest in learning factories in the last 10 years. Several have been set up in academic institutions and in industry to serve many and different objectives. Learning factories enhance opportunities for experiential learning both for students and practitioners in the field. The definitions of Learning Factories and categorizing them according to their objectives, technical focus, type, and applications will be discussed.

Learning factories, as the name indicates, aim to enhance learning with an implied focus on manufacturing technologies and systems. They involve hands-on experience with some fundamental concepts, technologies and paradigms which provide valuable knowledge and practical experience that is much needed both before graduation and while practicing in the field. The results of a recent survey of existing learning factories in Universities, research Institutes and industry demonstrates the wide scope and scale of implementation of learning factories. The selection and/or design of sample products for demonstration using learning factories depend on their particular focus and objectives. This task is particularly challenging when dealing with systems-oriented learning factories.

Although a number of research institutions worldwide have established learning and experimental manufacturing facilities in their labs, only a few of them are geared towards developing the enablers of manufacturing systems changeability. This paper will discuss existing learning factories as prototypes for changeable and reconfigurable manufacturing systems. Several of these systems were analyzed to identify the state-of-the-art and prospects for their future development. A classification scheme of learning factories will be overviewed.

The cost of implementing learning factories can vary widely from ones with reasonable cost to others that require significant investment to set up and operate. Alternate forms of experiential learning involving gaining experience at real factories through internships, Factory-in-a-Laboratory, and simulated factories will be discussed and their advantages and disadvantages will be compared from affordability and learning effectiveness points of view. Discussion and conclusions regarding the state-of-the-art learning factories implementation, use, usefulness and future trends will also be presented.

In this Keynote paper, a classification of the different types of learning factories and the experiential learning that can be achieved using them will be provided. Emphasis will be placed on learning activities related to "systems" design, planning and control, the characteristics of learning factories which support this class of learning and the design of products and learning factory needed to support these activities and curriculum. Examples of learning factories in both industry and academia, particularly from North America, are discussed. Physical, virtual and hybrid learning factories strategies and earlier models of experiential learning will be overviewed and their advantaged and disadvantages will be compared. Conclusions about the challenges and future directions will be presented.



The changeable and reconfigurable "iFactory"
in the Intelligent Manufacturing Systems (IMS) Center at the University of Windsor