E-Manufacturing : Business Paradigms and Supporting Technologies

Edited by **João José Pinto Ferreira**

E-MANUFACTURING: BUSINESS PARADIGMS AND SUPPORTING TECHNOLOGIES

18th International Conference on CAD/CAM Robotics and Factories of the Future (CARs&FOF) July 2002, Porto, Portugal

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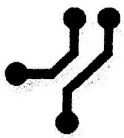

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FOREWORD

The International Conference on CAD/CAM Robotics & Factories of the Future (CARs&FOF) has been organised in several locations around the world for almost two decades. Under the topic "E-Manufacturing, Advances in business paradigms and supporting technologies", this event took place in July 2002 in Porto, Portugal, a joint organisation of:

INESC Porto
Faculty of Engineering of the University of Porto
International Society for Production Enhancement

and with the support of the Portuguese Foundation for Science and Technology.

This book includes a selection of the papers presented in CARs&FOF'2002 as well as invited papers reflecting the vitality of the discussions held in the conference plenary sessions. This is the consequence of extensive teamwork, combining the generous collaboration of the invited editorial board members that jointly selected the papers herein published. These acknowledgements should be further extended to the Conference Organising Committee, Conference Co-chairman, Conference Secretariat and finally to the support given by Mrs. Sónia Pinto and Mrs. Marta Oliveira in the final editing of this book.

The Editor

João José Pinto Ferreira
July 2003

EDITORIAL BOARD FOREWORD

E-Manufacturing implementation and related business practices demands an ever increasing knowledge about enabling technologies. Moreover, the digital and wireless world will surely trigger new business practices. This conference aims therefore at bringing together the business and technology research worlds into a catalyst forum for new business models and technology opportunities. In this context we have the objective of bridging the gap between technical and business discussions, usually developing in widespread forums.

E-Business is a very significant economic and social paradigm and is now building on the convergence of several technologies. Under this topic, and concentrating our efforts in the E-Manufacturing area, we aim at highlighting strategies, methods, the demand for deployment of new business models and for intra- and extended-enterprise business processes.

This book opens with a set of interesting selections from invited authors, covering perspectives such as concurrent engineering in product and process design, the tools needed to deal with people, relationships and networks, enterprise networking in Europe. This section closes with business and innovation topics, handling issues such as knowledge, innovation and investment, and joint ventures for innovation and competitiveness. The remaining parts of the book tackle the following e-manufacturing issues: advanced logistics, mechatronics, manufacturing systems integration and supporting technologies.

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PART ONE
INVITED PAPERS

PERSPECTIVE ON CONCURRENT ENGINEERING IN PRODUCT AND PROCESS DESIGN

Dr. Robert J. Graves
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Abstract: *There have been many advances in the processes of product design and development over the last 25 years. Some of the advances have been in technology support tools and some have been in the product realization processes themselves as recognition of the technology capabilities develops and matures and incorporates the business practices that guide the development practices. These advances are briefly described in this paper as we observe the maturation of CAD/CAM technologies, the development and improvement of Design for Manufacturing technologies, the change in business practices from vertically integrated firms to distributed supply chain-oriented enterprises, and the increasing use of network-based approaches in E-engineering.*

Keywords: CAD/CAM, Product Development Processes , E-engineering

INTRODUCTION:

The engineering of products is often a complicated and technical process that occurs under pressures of time constraints, cost constraints, and quality issues. One way in which to view design is as a series of activities by which the information about an object is created and recorded. It is a creative process and one which changes the state of knowledge about an object. As engineering design progresses, the amount of information available about the designed object increases and becomes more detailed in its nature. It is no wonder then, that engineering design relies so heavily on good quality information and the associated technologies that support its access and use in design of the object.

Engineering design is an integral part of a product realization process. It is joined by the determination of customers' needs and the relationship of these needs to company strategies and products, development of marketing concepts, development of engineering specifications, then the design of both the product and the tools and the processes by which it will be made and assembled, followed by

determining the approaches to distribution, sales, repair and disposal. The focus of this paper is on the engineering design process and its integration with fabrication and manufacturing, hence leaving out the market concept development and specifications development as well as the later aspects of product realization dealing with distribution, etc.

There have been many advances in the processes of product design and development over the last several decades. Some of the advances have been in technology support tools. Others have been in the product realization processes themselves as recognition of the technology capabilities develops and matures and begins to incorporate the business practices that guide the development practices. Such advances are considered in this paper in the context of engineering design as a creative process involving information retrieval and use as well as information generation. These advances are briefly described in the following as we observe the maturation of CAD/CAM technologies, the development and improvement of Design for Manufacturing technologies, the change in business practices from vertically integrated firms to distributed supply chain-oriented enterprises, and the increasing use of network-based approaches in E-engineering.

PRODUCT DEVELOPMENT PROCESSES AND TOOLS:

Traditional product development tools relied on drafting boards and later, in the 1970s, the use of Computer-aided design (CAD) tools. While the original CAD tools were little more than automated drafting technologies, they have matured and become more integrated with Computer-aided Manufacturing (CAM) technologies. Advances through the 1980s and beyond were both technological and process or procedural in nature.

1980s

The common business environment of the 1980s was one of vertically integrated firms with internal fabrication and assembly shops. Product development engineers used drafting tools and CAD tools in their functions of product design. When the need arose, these engineers would consult with manufacturing engineers to gain knowledge of the issues in fabrication and assembly associated with their product designs. One might view this knowledge as readily at hand, in that the fabrication and assembly shops were either close by or easily accessed through internal corporate processes.

The common product realization process, as depicted in Figure 1, might also be characterized as the "over-the-wall" practice where product design was the initial phase and little discourse with fabrication and assembly took place. When design was completed, the design was then handed to manufacturing for review and comment and this may or may not have led to design adjustment. In a similar manner, manufacturing would indicate to purchasing what was needed from a material perspective and purchasing, in turn, would interact with suppliers to order necessary purchased parts. The limitations of the over-the-wall practice then become clear in that there is limited interaction between functions or phases of the process to

help support the support the design development in ways that aided cost efficiencies, improved manufacturing of internal parts and improved assembly ease for the product.

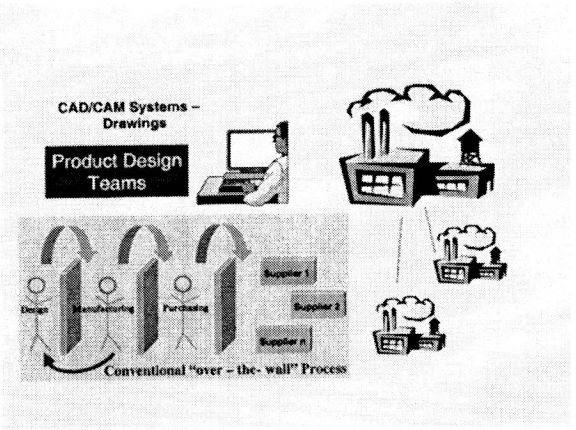

Figure 1: Product Development in 1980s

As a consequence, the 1980s began to see the development of design-aid tools which intentionally captured manufacturing and assembly knowledge into evaluative technologies for use by design engineers. The advent of Design for Assembly analysis and various Design for Manufacturing (e.g. Injection Molding, Die Casting, and Stamping) design aids heralded the era of improved design evaluation at the early phases of design by the consideration of fabrication and assembly consequences of design choices. Some of these design aids were analytical and some were qualitative in nature, but they supported what was increasing being called "concurrent engineering" as the 1980s gave way to the 1990s.

1990s

Business practices began to change in the 1990s and these changes affected the product realization processes. Firms which had been vertically integrated began increasingly to "outsource" not only purchased parts for their products but also fabrication and perhaps assembly functions. This phenomenon led to the development of enterprises composed of "original equipment manufacturers" or OEMs and their associated supply chain members.

This migration of fabrication and assembly functions out of the former umbrella of the vertically integrated company into separate corporate entities able to compete on their own, led to changes in product development. The knowledge of fabrication and assembly that had been shown to be useful in product design now was less accessible to the design engineers with the increased distance of geographical separation and organizational boundaries. Product realization processes, as seen in Figure 2, now had to rely upon exchange of information through communication devices (e.g. fax, phone) or perhaps surface mail with contracted suppliers to gain design review knowledge. This increased difficulties due to communications and