

A Panel Discussion  
on the  
NSF Workshop on Manufacturing Systems Integration

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## 1. Introduction

Systems integration is an activity which until now has been largely handled on an ad hoc basis, often with disastrous effects and almost always with more work than was originally anticipated. The difficulties appear to compound rapidly with increasing complexity of the interconnections among subcomponents, and appear at several different levels, e.g. algorithmic, mechanical interconnections, electrical interconnections, communication protocols, software and data. Moreover, a broad spectrum of people is involved, and communication of common problems and solutions is often lacking. To investigate the causes underlying systems integration problems a workshop involving a broad range of experts was sponsored by the National Science Foundation. The workshop was organized by the Robotics Laboratory of The University of Michigan, and held at St. Clair, Michigan in November, 1983.

The underlying premises were

- Further and wider integration of manufacturing automation will be broadly beneficial.
- In spite of its benefits integration of manufacturing automation is taking place at an unacceptably slow pace.
- A basic research program in systems integration methodologies is needed to support and foster acceleration of integration of manufacturing.

The goals of the workshop were twofold. First, the extent to which the above three premises are true was to be determined. In particular, workshop participants were asked to answer the following questions

- What does systems integration mean in your area?
- How much systems integration is desirable? Will it be a major aid to manufacturing, or has it been overvalued?
- Is systems integration taking place at an unacceptably slow pace?
- What research areas would it be appropriate for NSF to fund under the heading of systems integration?
- Is the necessary work in systems integration primarily standards work, or is it research?

The views of industry were to be particularly important in making these determinations.

Second, the workshop would bring together and establish communication among researchers from industry and the academic world who are working on various aspects of the

integration of manufacturing automation. This was considered particularly important given the broad range of people concerned with the various aspects of integration.

The results of the workshop will be disseminated in several ways. This panel discussion is one of them. In addition, a written report is being prepared (completion is expected in May, 1986). An audio recording was made of the entire workshop, and a complete transcription of it has been prepared. A videotape of the final reporting session is being prepared.

## 2. The Technological Area

The integration of manufacturing automation at the cell and factory floor levels was the technological area of interest. The workshop started with the following tentative characterizations.

The cell level is characterized by a modest number of machines and devices in close proximity, having a great deal of interaction. Significant time intervals are short: microseconds up to minutes. Geometric coordinates, shape, high level sensor based motion control and contact constraints are important. Variables are often real valued. The cell level involves such activities as adaptive control of machines, closely coordinated control of multiple robots and machines, task level planning of robot and machine operations, trajectory planning and the building of tools to support these activities.

The factory floor level is a collection of cells, each with its own cell level description. Here, concerns are with the flow of materials, tools, parts, and information throughout the manufacturing facility. Elements are somewhat more loosely coupled, than at the cell level. Significant times are typically measured in seconds and minutes (e.g., the time required to load a machine with a part, to create a part program, to move a part from one machine to another, to bring together two pieces for assembly). It is sufficient to identify a location by name, not coordinates; to characterize a cell by its capabilities or simply "execute" programs for, say, NC machines and robots. Typical constraints are of the form "At most one pallet can be at machine #4." Variables are usually logical integers or names.

It is not only systems' integration at the cell and factory floor levels individually that is of interest, but integration of activities across these levels as well. The interconnections between the cell and factory floor levels are often in the form of commands to the cell level and status reports to the factory

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Proceedings of NSF Design and Manufacturing Systems Conference // Design and Manufacturing Systems Engineering Division.\*National Science Foundation\* ; 1992 ,1992      *Proceedings of the 1992 NSF Design and Manufacturing Systems Conference ,1992*

**Integrated Product, Process and Enterprise Design** Ben Wang,2012-12-06 The need exists in the private sector and government manufacturing sites to reduce product development time production lead times inventory and non value added activities At the same time there is increased pressure to improve manufacturing process yields production efficiency and resource utilization Much of the technology required to meet these needs already exists but an integrated structure that can demonstrate the potential for the technology in a concurrent engineering context does not This book provides a road map for building the integrated technology environment to evaluate existing products manufacturing processes and system design tools This book details innovative approaches that will significantly improve design manufacturing technology development and deployment capabilities for civilian and defense applications These approaches are integrated product process and system design IPPSD initiatives which will greatly enhance the manufacturing competitiveness of the economy These approaches involve the use of simulation modeling tools and computerized virtual workstations in conjunction with a design environment which allows a diverse group of researchers manufacturers and suppliers to work within a comprehensive network of shared knowledge The IPPSD infrastructure consists of virtual workstations servers and a suite of simulation quantitative computational analytical experimental and qualitative tools Such an IPPSD infrastructure will permit effective and efficient predictions of complete product design manufacturing process design and customer satisfaction      Concurrent Engineering Hamid R. Parsaei,W.G. Sullivan,2012-12-06 In the area of computer integrated manufacturing concurrent engineering is recognized as the manufacturing philosophy for the next decade      **1993 Japan IEMT Symposium** IEEE Components, Hybrids, and Manufacturing Technology Society,1993

**The Electrical Engineering Handbook,Second Edition** Richard C. Dorf,1997-09-26 In 1993 the first edition of The Electrical Engineering Handbook set a new standard for breadth and depth of coverage in an engineering reference work Now this classic has been substantially revised and updated to include the latest information on all the important topics in electrical engineering today Every electrical engineer should have an opportunity to expand his expertise with this definitive guide In a single volume this handbook provides a complete reference to answer the questions encountered by practicing engineers in industry government or academia This well organized book is divided into 12 major sections that encompass the entire field of electrical engineering including circuits signal processing electronics electromagnetics electrical effects and devices and energy and the emerging trends in the fields of communications digital devices computer engineering systems and biomedical engineering A compendium of physical chemical material and mathematical data completes this comprehensive resource Every major topic is thoroughly covered and every important concept is defined described and

illustrated Conceptually challenging but carefully explained articles are equally valuable to the practicing engineer researchers and students A distinguished advisory board and contributors including many of the leading authors professors and researchers in the field today assist noted author and professor Richard Dorf in offering complete coverage of this rapidly expanding field No other single volume available today offers this combination of broad coverage and depth of exploration of the topics The Electrical Engineering Handbook will be an invaluable resource for electrical engineers for years to come *IEEE/CHMT International Electronic Manufacturing Technology Symposium* ,1993 *Deadlock Resolution in Computer-Integrated Systems* MengChu Zhou,Maria Pia Fanti,2018-10-08 Complex computer integrated systems offer enormous benefits across a wide array of applications including automated production transportation concurrent software and computer operating systems computer networks distributed database systems and many other automated systems Yet as these systems become more complex automated distributed and computing intensive the opportunity for deadlock issues rises exponentially Deadlock modeling detection avoidance and recovery are critical to improving system performance Deadlock Resolution in Computer Integrated Systems is the first text to summarize and comprehensively treat this issue in a systematic manner Consisting of contributions from prominent researchers in the field this book addresses deadlock free models and scheduling detection and recovery methods the formulation of dynamic control policies and comparison and industrial benchmark studies that evaluate various approaches The editors lay the foundation for exploring deadlock issues with a typical example of an automated manufacturing process illustrating three primary modeling methods digraphs Petri nets and automata and comparing their respective advantages and disadvantages Providing all of the important models and resolution approaches this book is the complete guide for electrical and control engineers and manufacturing intelligent and network systems designers to prevent and manage deadlock issues in their systems

Artificial Intelligence in Design '96 John S. Gero,Fay Sudweeks,2012-12-06 Change is one of the most significant parameters in our society Designers are amongst the primary change agents for any society As a consequence design is an important research topic in engineering and architecture and related disciplines since design is not only a means of change but is also one of the keystones to economic competitiveness and the fundamental precursor to manufacturing The development of computational models founded on the artificial intelligence paradigm has provided an impetus for much of current design research both computational and cognitive These forms of design research have only been carried out in the last decade or so and in the temporal sense they are still immature Notwithstanding this immaturity noticeable advances have been made both in extending our understanding of design and in developing tools based on that understanding Whilst many researchers in the field of artificial intelligence in design utilise ideas about how humans design as one source of concepts there is normally no attempt to model human designers Rather the results of the research presented in this volume demonstrate approaches to increasing our understanding of design as a process **Computer Graphics And Applications**

**- Proceedings Of The First Pacific Conference On Computer Graphics And Applications, Pacific Graphics '93** S Y Shin, Toshiyasu L Kunii, 1993-08-06 This volume of proceedings contains papers by computer graphics researchers developers and practitioners The papers report on the latest advances and new ideas in computer graphics They also discuss future directions in the field The volume reflects the aim of the conference to promote computer graphics research activities in the Pacific region

*Artificial Intelligence and Digital Systems Engineering* Adedeji B. Badiru, 2021-08-12 The resurgence of artificial intelligence has been fueled by the availability of the present generation of high performance computational tools and techniques This book is designed to provide introductory guidance to artificial intelligence particularly from the perspective of digital systems engineering Artificial Intelligence and Digital Systems Engineering provides a general introduction to the origin of AI and covers the wide application areas and software and hardware interfaces It will prove to be instrumental in helping new users expand their knowledge horizon to the growing market of AI tools as well as showing how AI is applicable to the development of games simulation and consumer products particularly using artificial neural networks This book is for the general reader university students and instructors of industrial production civil mechanical and manufacturing engineering It will also be of interest to managers of technology projects business plants and operations

**Artificial Intelligence in Structural Engineering** Ian Smith, 1998-07-15 This book presents the state of the art of artificial intelligence techniques applied to structural engineering The 28 revised full papers by leading scientists were solicited for presentation at a meeting held in Ascona Switzerland in July 1998 The recent advances in information technology in particular decreasing hardware cost Internet communication faster computation increased bandwidth etc allow for the application of new AI techniques to structural engineering The papers presented deal with new aspects of information technology support for the design analysis monitoring control and diagnosis of various structural engineering systems

Project Management for Research A.B. Badiru, 2012-12-06 Graduate research is a complicated process which many engineering and science students aspire to undertake The complexity of the process can lead to failures for even the most brilliant students Success with graduate level research requires not only a high level of intellectual ability but also a high level of program management skills After many years of supervising several graduate students I have found that most of them have the same basic problems of planning and implementing their research programs Even the advanced graduate students need the same mentoring and management guidance that has little to do with actual classroom performance It is my conjecture that graduate students could make a better job of their research programs if a self paced guide were available to them The guide provided in this book covers topics ranging from how to select an appropriate research problem to how to schedule and execute research tasks The book takes a project management approach to planning and implementing graduate research in engineering science and manufacturing disciplines It is a self paced guide that will help graduate students and advisors answer most of the basic questions about how to do this and how to do that There is a need for such a guide book

The book will alleviate frustration on the part of the student and the research advisor

**Group Technology And Cellular Manufacturing** Ali K. Kamrani, Rasaratnam Logendran, 2020-09-29 This book provides the latest up to date documentation on the scope of research in Group Technology GT and Cellular Manufacturing CM It is a comprehensive listing of the methodologies techniques algorithms and tools used for practical implementation of the concepts of GT and CM

**Operations Research** Jay E. Aronson, Stanley Zionts, 2009-04-01 Drawn from a conference honoring Gerald L Thompson the pioneer of operations research this volume brings together some of the latest writings of major figures in the field The volume is divided into four parts the first part reviews the career and significance of Thompson the second concentrates on linear and nonlinear optimization the third looks at network and integer programming and the fourth provides examples of applications oriented research in manufacturing This volume will be an invaluable resource for all scholars and researchers involved in theory and methodology in operations research and management science

**Integrated Product and Process**

**Development** John M. Usher, Utpal Roy, Hamid Parsaei, 1998-03-13 The phenomenal success of integrated product and process development IPPD at such companies as Boeing Motorola and Hewlett Packard has led many manufacturers to place renewed emphasis on this critical aspect of concurrent engineering If you are among those charged with the daunting task of implementing upgrading or maintaining IPPD you need a single reference handbook that covers all of the tools technologies and applications that support IPPD You need Integrated Product and Process Development Emphasizing applications this extremely user friendly guide covers everything from basic principles to cutting edge research It addresses ideas and methods in product design as well as issues related to process design and manufacturing Case studies illustrate the application of various tools and techniques of IPPD in manufacturing for the defense industry making the most of product planning applications of quality function deployment QFD the effective use of design optimization and integrating design and process planning Other topics covered include Identifying customer needs using QFD Issues and constraints in time driven product development Enhancing automated design systems with functional design Rapid prototyping Case based process planning systems

**Concurrent Design of Products, Manufacturing Processes and Systems** Ben Wang, 1999-01-27

Methods presented involve the use of simulation and modeling tools and virtual workstations in conjunction with a design environment This allows a diverse group of researchers manufacturers and suppliers to work within a comprehensive network of shared knowledge The design environment consists of engineering workstations and servers and a suite of simulation quantitative computational analytical qualitative and experimental tools Such a design environment will allow the effective and efficient integration of complete product design manufacturing process design and customer satisfaction predictions This volume enables the reader to create an integrated concurrent engineering design and analysis infrastructure through the use of virtual workstations and servers provide remote instant sharing of engineering data and resources for the development of a product system mechanism part business and or process and develop applications fully compatible with

international CAD CAM CAE standards for product representation and modeling      Information Infrastructure Systems for Manufacturing Hiroyuki Yoshikawa, Jan Goossenaerts, 1993 The possible benefits the external characteristics and the broad range requirements of information infrastructure systems for intelligent manufacturing systems are widely known However it is recognized that various problems are impeding achievement in this area including the lack of understanding and agreement about techniques and methods for coordinating and systematizing the broad range information processing requirements and for synthesizing these requirements into deeply structured easily adaptable and comprehensive conceptual models This hampers the development of information infrastructures amalgamating the conceptual models and computing communication storage technologies and the development of intelligent manufacturing systems amalgamating the information infrastructures with advanced machine tools and skillful people This publication elaborates on these issues and affords a greater understanding of and agreement about methods techniques and tools for solving related problems To ensure an in depth coverage of the wide problem domain contributions sourced from reknowned experts are focused on some of the most relevant research and development issues The book will provide a useful foundation of information for further research and development on information infrastructure systems for manufacturing      Design for Profitability Salah Ahmed Mohamed Almoslehy, 2018-10-09 Since the success of products significantly depends on the quality of product performance inadequate management of the product design process can lead to improper performance of products that can result in significant long term business losses Design for Profitability Guidelines to Cost Effectively Manage the Development Process of Complex Products presents a design guideline for complex product design and development that enables you to cost effectively improve the technical performance of your products and consequently improve your competitiveness in the marketplace as well as improve profitability The book helps you improve the competitiveness of your organization in the market and eventually improve profitability It presents a mobile robots design guideline based on an empirical study of the mobile robots design process This is an unprecedented guideline based on the empirical investigation of the internal aspects of the design process of complex products for cost effectively enhancing the competitiveness in the market The book also presents a hybrid lean agile design paradigm for mobile robots In addition it points out key approaches and risks to manage the product development process efficiently In designing complex products and integrated systems industrial designers face a dilemma of cost effectively striking a balance between product development time and product performance attributes This book shows how and when value is added in product design and development through identifying statistically the most and least correlated design activities and strategies to product performance attributes Introducing a new paradigm in the field of engineering design the book gives you key approaches to efficiently manage the product development process      Product Modelling for Computer Integrated Design and Manufacture Michael Pratt, R.D. Sriram, Michael J. Wozny, 2016-01-09 This state of the art text explores developments in geometric modeling product modeling and their applications In particular it

looks at the means by which product geometry emerges from the conceptual stages of design and the use of geometric reasoning for applications downstream of design including manufacture and assembly. Much existing design research is either totally geometry based or totally non geometric and the interface between the two areas is of intense interest to industry as well as being crucial for the successful development of integrated systems for design and manufacture. This interface is currently not well understood and the book makes a significant contribution towards its understanding. This book is essential reading for technical managers and research and development engineers.



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