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Conference News

SEMINAR ON FMS '86

Flexible Manufacturing Systems '86 held in Chicago, Illinois, March 3–6, 1986, was a seminar co-sponsored by the Computer and Automated Systems Association of the Society of Manufacturing Engineers and Manufacturing Engineering Magazine (CASE SME, One SME Drive, P.O. Box 930, Dearborn, Michigan, 48121, USA).

This event was to present and discuss recent developments in flexible manufacturing. At the 1986 FMS Seminar four tutorials and some seventeen technical presentations were delivered. The seminar ended with a plant tour of Ingersoll Milling Machine Company.

A. Tutorials

1. Defining Flexible Manufacturing by Edward A. Herring, Digital Equipment Corporation

In this tutorial a number of case studies were presented. It provided a look into the history of flexible manufacturing and a comparison with other previous methodologies, including flexible manufacturing cells, just-in-time, and manufacturing resource planning. The tutorial provided a better understanding of where FMS fits within the overall manufacturing plan.

2. FMS Around the World: A Status Report by Venkitaswamy Raju, Rochester Institute of Technology

Currently there are about 370 Flexible Manufacturing Systems operating around the world. This tutorial reported the state of the art of these systems. It included the results of a detailed study involving the FMS in Japan, West Germany, the United Kingdom, and the United States of America.

3. FMS Software Basics by Bud May, Ingersoll Milling Machine Company

A methodology for the design and implementation of a software system for FMS control was presented. The aspects of software quality and simplicity as applied to centralized versus distributed processing, database management, communications and future expansion were discussed.

4. Foundations of Artificial Intelligence by Henry Firdman, Henry Firdman & Associates

In this tutorial features of AI such as conceptual representation, symbolic processing, search and incremental design were discussed. Opportunities and long-term implications of expert systems were presented.

B. Technical presentations

1. Project Management is Vital to FMS by Joseph R. Valenta, Northern Telecom, Incorporated

The presentation examined the project management process developed at Northern Telecom for implementing FMS, including such areas as setting objectives, structuring the project team, managing new product and FMS planning.

2. Productivity by Design – FMS Applications That Work by A.J. Roch, Jr., LTV Aerospace and Defense Company

Integrated systems offer the greatest potential for productivity improvement. This benefit must be designed into FMS applications to assure success. New methods must be assessed in terms of production needs. Technology is then designed into the system in response to potential cost/benefits of implementation. Integrating and implementing technologies in new flexible systems to meet program needs is proving effective throughout the aerospace industry. This presentation described an approach to the successful application of an FMS.

3. Design of Flexible Manufacturing Systems by Dr. Andrew Kusiak, University of Manitoba

Product design and system design, two basic elements of FMS design, were presented. Features of parts and process planning for flexible manufacturing environment were discussed. Design of an FMS was described in two phases: equipment selection and layout design. To facilitate the FMS design, models for equipment selection and layout design were presented.

4. Computer Integrated Manufacturing Architecture of FMS by Hassan Gomaa, General Electric Company

This presentation described a computer-integrated manufacturing (CIM) system architecture. The architecture is influenced by two important factors: the information flow in the factory and the trends in computer technology. The high level information flows in the factory were described. The main technological trends were reviewed. A distributed system architecture was outlined which provides a foundation for developing future FMSs.

5. Next Level of Control by F.E. Harkrider & S.D. Cook, LTV Aerospace and Defense Company

LTV Aerospace and Defense Company, Vought Aero Products Division's (VAPD's) Integrated Machining Systems (IMS) integrates prismatic machining cells through a hierarchical computer control system. System-level control performs high-level scheduling and manages resources such as raw materials, blanking machines, inter-cell material handling, and a cutter assembly cell. Objectives of system control include load balancing among cells and enhances communication with cells and the business host.

6. Fault Tolerance in FMS Control by Albert Hopkins, Jr., ITP Boston, Incorporated

FMSs are becoming critically dependent on computer control, and the tolerance of computer faults is therefore becoming a critical design issue. Too much emphasis on computer fault tolerance can bring diminished returns. Finding the proper balance of the use of fault tolerance in FMS control is important, and is often left to emotional, rather than analytic, selection. This presentation reviewed existing and emerging FMS case histories which have had different choices made in this respect. Some have opted for fault-tolerant computers, some for clustered computers, and some for standby backup arrangements. Reasons for these choices, and methods for evaluating the need for fault tolerance, were discussed.

7. Simulation and FMS: Partners in Productivity by David Wortman, Pritsker & Associates, Incorporated

American manufacturers are turning in increasing numbers to FMSs to solve productivity problems. While the promise of FMS is great, delivering on that promise is not an easy task. The flexibility that FMS provides comes at the price of increased operating complexity. Simulation helps to minimize the risk associated with an FMS, and ensure that it delivers the required results. This presentation explored the benefits to be

gained, and the steps involved in using simulation as an aid to designing an FMS. An example demonstrating the use of simulation in an actual design effort was presented.

8. Guidelines for the Estimation of Costs in the Economic Justification of Flexible Manufacturing Technology by Michael C. Burstein, Industrial Technology Institute

Economic justification of FMSs has been hampered by an inability of firms to generate good estimates of costs. The impact of flexibility on inventories at various points in the manufacturing system, on equipment utilization, and on labor requirements has been too complex to be captured by ordinary static methods of cost estimation. Also, the critical factor of improved quality through enhanced ability to detect bad products early and through greater manufacturing consistency has been difficult to assess in economic terms. However, quality-related stochastic effects on scrap, value-added, and rework can be evaluated by discrete-time simulation along with capacity-significant elements (e.g. workstation or work cell reliability) and the flexibility-impacted characteristics mentioned above. Beyond considerations of direct operating costs, implementers of flexible automation have become increasingly aware of significant additional indirect costs and the need for an equally careful approach to the estimation of these. Off-line materials handling, training, maintenance, and software are major sources of such indirect costs for which innovative estimation techniques are becoming available. This presentation provided a description of evolving procedures for estimating the costs of flexible automation and suggests guidelines for the application of this new knowledge.

9. FMS Simulation for Software Development by M.P. Deisenroth, Virginia Polytechnic Institute and State University, Blacksburg, Virginia; and C.B. Galgocy, Virginia Polytechnic Institute and State University, Blacksburg, Virginia

In this presentation a computer simulation program to aid in testing and debugging of control system software was discussed. The initial work was directed at systems control of a model flexible manufacturing system consisting of three machining centers and related material handling equipment. System control was implemented through ladder logic entered into a T1 530 programmable controller. The off-line computer simulation program allowed dynamic simulation of the physical system to be driven by the actual ladder logic.

10. Artificial Intelligence and Distributed Processing: Key Technologies for the Next Generation FMS by George M. Parker, General Dynamics

Artificial intelligence and distributed processing are two key technologies which are being integrated into a FMS at General Dynamics as part of the USAF Advanced Machining Systems (AMS) Program. Older control and scheduling technologies for existing FMSs were briefly reviewed. Then the technologies making-up the next generation FMS were discussed. The integral relationship between distributed processing and artificial intelligence was illustrated on an FMS at General Dynamics. Experiences and problems with implementing such technologies were also discussed.

11. Expert Systems for FMS Design by John E. Lenz, CMS Research, Incorporated

The design and operation of an FMS involves problems in three separate areas. These are aggregate or capacity planning, effects upon performance due to integration, and operational strategies. Capacity planning is needed to establish feasible target levels of utilization. These are then used as a basis for measurement of the integration effects. Operational strategies which include the study of batch-sizing, scheduling algorithms and other optimal control algorithms were also discussed.

12. FMS Tool Management Systems by Dr. J. Scott Rhodes, Jr., ITP Boston, Incorporated

In an FMS the number of cutting tools may be very large and tool management may be a significant problem. Traditional manual tool set up may decrease utilization of expensive equipment. This presentation discussed tool management alternatives which can help assure that the required tools are available at the machines when needed. Several current FMS projects were used as reference points for tool management requirements.

13. FMS at Martin Marietta Energy Systems by T.R. Webber, Martin Marietta Energy Systems, Inc.

The approach used by the Martin Marietta Energy Systems Y-12 Plant to evaluate, select and employ FMS in the machining of uranium parts was presented. A special study team, selected by plant management, recommended two FMS cells for production use. One cell semifinishes a family of hemispherical parts, the other cell produces a family of cylindrical billets. Special features of the cells dictated by the unique machining characteristics of uranium metal and the part geometries were discussed. The equipment configuration and parts being produced in each cell were described.

14. Waterjets on the Cutting Edge of Machining by David F. Wightman, Ingersoll-Rand Waterjet Cutting Systems

Waterjet cutting and hydroabrasive machining is the emerging state of the art in FMS technology. Hydroabrasive machining (waterjet cutting with abrasives) can increase production and improve quality at lower costs. Specific applications were discussed showing the internal rate of return as a cost-savings consideration for justification. CAD/CAM down-loading to CNC shop equipment for just-in-time manufacturing case history was explored.

15. Robotic Assembly of Printed Circuit Boards by Dr. Adrian Ioannou, SCICON, Ltd.

The development of a robotic workcell for loading odd-shaped components in circuit boards was presented. The assembly cell features one IBM 7547 robot, an Automatix AV4 Vision System Scicon's Electropneumatic programmable Controller, and the necessary feeders were described. The robot's gripper is of a multifunction type, incorporating sensors, with parallel jaws.

16. Flexible Manufacturing in Fabrication – A Job Shop Environment by Jerald L. Johnson, Onan Corporation

Developing an FMS for fabrication processes offers a significant challenge. This is especially true in a large job shop environment. It is very unlikely that a standard system exists to fulfill the individual requirements of any one organization. Imagination, creativity and technical knowledge must be put together in a partnership between manufacturers and machine tool builders to adequately capture the opportunities that exist. This presentation discussed one company's attempt to bring flexibility to the sheet metal fabrication process and other opportunities that still lie ahead.

17. FMS in Light Fabrication and Forming – A Feasible Strategy for Developing Nations by V.G. Pethe, Larsen & Toubro Ltd.

Developing nations have low demand for manufactured goods. Even though labor is relatively cheap, production costs are high because of low total productivity. The atmosphere of low technology contributes to developing nations' inability to compete in international markets in terms of quality and cost. The FMS approach can help developing nations to break this vicious cycle. Progressive managements in such nations have to view FMS as a technical decision – not seek financial justification. They can modify the FMS approach to suit their own needs. Speeding core sector development through equipment manufactured on FMS brings prosperity to developing nations.

Proceedings from this seminar are available from Publication Sales Department of the Society of Manufacturing Engineers at the above given address at $64 a copy.

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1986 IEEE INTERNATIONAL CONFERENCE ON ROBOTICS AND AUTOMATION

(San Francisco, California; April 7–10, 1986).

More than 300 papers were presented at this annual IEEE event. All papers were divided into seven tracks, each containing twelve papers presented over a period of three days. The areas covered in each track are briefly described below:

TRACK 1

Manipulator Simulations & Solution; Adaptive Manipulator Control; Flexible Manipulators Modeling & Control; Robot Manipulators Hands; Robot Kinematics; Manipulators and Kinematics Algorithms; Robot Parameters; Robot Hands; New Results in Robot Mechanisms Design and Control; Robot Analysis Simulation.

TRACK 2

Robot Dynamics and Control; Manipulator Dynamics; Robot Task Controls; Robust and Variable Controls; Sensing and Control; Computational Architecture for Robot Control; Modeling and Control of Flexible Robots; Dynamics and Control; Compliant Motion Control; Robot Control; Computation Systems for Robotics and Automation; Automation Controller Architectures and Programming.

TRACK 3

Control Mechanization; Advanced Control Techniques; Multivariable Control Planning and Optimization; Robot Control Methods; Robot Grippers and Grasps; Robot Motion and Planning; Multi-Robot Motion Coordination; Robot Planning and Programming; Planning in the Presence of Uncertainty; Path Planning; Constraints and Optimization in Planning.

TRACK 4

Multi-Arm Control and Planning; Robot Control Organization; Advanced Robots Control Concepts and Mechanization; Robots in Assembly; Advanced Concepts and Education in Robotics; Planning, Simulation, Programming; Intelligence for Robot Control; Color Vision and Tactile Sensing; 3-D Vision in Robotics; Vision for Mobile Robots; Robot Software; Robotics Applications.

TRACK 5

3-D Computer Vision; Advanced Sensing Techniques and Theories; Machine Vision Techniques; Multiple Views and Motion in Computer Vision; Detection and Recognition in Machine Vision; Computer Vision; Tactile Sensing; Sensor Data Fusion; Robot Sensing.

TRACK 6

Planning & Scheduling for Automated Electronics Manufacturing; Performance Modeling of Manufacturing Systems; Automation and CIM in Europe; Human Factors Aspects of Robotics and Automation; Managerial Considerations of Automation; Production Control and Scheduling; Production Planning and Control; Manufacturing Systems Specifications and Analysis; A.I. in Automated Systems.

TRACK 7

Machining Simulation Programming and Planning; Automated Material Handling; Autonomous Space Robotics Systems; Telepresence and Telerobots in Space; Teleoperation and Telerobotics; Navigation for Robot Vehicles; Vehicle Automation; Legged Robots; Autonomous Vehicles; The DARPA ALV Project.

The three volume conference proceedings are available from the IEEE Computer Society, 1730 Mass. Ave. N.W., Washington, D.C. 20036-1903, USA.

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THE 1986 SCS MULTICONFERENCE

The 1986 Multiconference, held by the Society for Computer Simulation at the Bahia Hotel in San Diego, California featured a keynote address by Brigadier General Alonzo E. Short on the Army Supercomputer Program. A special plenary lecture was delivered by Dr. John L. Hay of the University of Salford. He addressed current and future trends in simulation software for the full spectrum of computer hardware. Trends in Continuous Systems Simulation Languages were examined as well as the advanced simulation support environment of the future. Papers from the four individual conferences within the Multiconference have been published in the following books, all available from the SCS office; *Aerospace Simulation*, 1986, hardbound $36. *Intelligent Simulation Environments*, hardbound $36. *Languages for Continuous System Simulation*, softbound $24. *Modeling and Simulation on Microcomputers*, softbound $24.

Noteworthy from the conference and book *Modeling and Simulation on Microcomputers* were the following papers: "Simulation of Parts Machining to Optimize Daily Machine Scheduling". This article describes a *FORTRAN* simulation program on an IBM PC that determines an optimum part schedule for a machine group. The paper is by Paula L. Hahn of General Dynamics Corporation, Fort Worth, Texas, USA.

Automated machining has changed the way GD machines metal aircraft parts. An operator was formerly assigned to each lathe or milling machine. With the introduction of automation, a single operator now tends a group of machines manufacturing different parts.

This program was written to aid the operator in choosing an optimum part combination that optimizes the amount of time the machines stand idle.

In this same volume Ricki G. Ingalls and Dr. Robert E. Shannon present a paper on "Simulation of Flexible Manufacturing Systems on Microcomputers". The abstract reads as follows: "Because of the highly complex interactions of an automated manufacturing system, managing the flow of parts through the system is extremely difficult. Dispatching rules have been chosen in this study as a means of scheduling an existing flexible manufacturing facility using the personal computer version of SIMAN to model the facility. Several assumptions, including deterministic set-up and run times and no order splitting have been dropped from the study. The dispatching rules which were tested were first come first served, earliest due date, shortest processing time, dynamic slack, and dynamic slack divided by the number of remaining operations. The performance of the system was greatly effected by order splitting and tight due dates. However, the earliest due date and slack performed best."

Another paper of interest in this book is "A Model for Comparison of the Traditional Push Type and the Just in Time Production Configurations" by Wanda Austin of the Aerospace Corporation and Behrokh Khoshvevis of the University of Southern California.

"A generalized multistage production system is analyzed using both the conventional Just-In-Case (or Push) system and the Just-In-Time with Kanban (or Pull) system configurations. The effectiveness of the two approaches is measured by comparing work in process inventory levels, production cycle times, production output rates, effects of variable demand and volume of rework resulting from random quality problems. The model provides a tool and methodology for comparing the Just-In-Time or Pull system with the traditional production method which uses a Just-In-Case or Push system configuration. The system is modeled using the event and network orientation of the SLAM simulation language. The model may be run on an IBM PC using SLAM II.

A paper of interest from *Intelligent Simulation Environments* is "Expert Systems and Simulation in Industrial Applications" by Brian R. Gaines of the University of Calgary. In his paper, "The role of expert systems and simulation, and their combination," is considered in the context of integrated

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manufacturing systems (IMSs). The information processing system for an IMS is considered and the relations discussed between the: organizational structure; human-computer interface; communication protocols; remote communications; computation; databases; control systems; instrumentation systems; knowledge bases; expert systems; and simulation."

The 1987 SCS Multiconference will be held January 14–16, 1987, once again in San Diego, California. A Call for Papers has been issued. The following meetings will be organised: Modeling & Simulation on Microcomputers, Emergency Planning; C.I.M. Systems & Robotics; Multiprocessor & Array Processor; Intelligent Simulation Environments.

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ROBOTIC PING PONG – FACT OR FICTION?

The IMechE awarded a £100 prize at the first UK Robotic Ping Pong Event which took place in a hotel close to Wimbledon (U.K.) in parallel with the tennis championships in July 1985. The finals were included in the Thames Television programme 'Database'.

Of note was an entry from Ilford County High School which was rapidly christened 'Guillotine' because of its rapid vertical action. With a square vertical dexion frame, the cross bar carrying the bat moved at a very rapid speed. The ball location system was based on a set of sonar transducers but further work was needed to be done to close the position control loop.

The runners-up who was awarded the IMechE prize were Mr John Knight and Mr David Lowery of Fareham, Hants. Their robot was controlled by a Dragon and Acorn Atom Computer. The vision tracking system used three rings of cylindrical lenses which whirled to scan the scene in stereo and track the ball. The bat position was controlled by electro-magnetic brakes which halted the bat in a spring driven lunge. The bat was then returned starting position in time for the next stroke. The IMechE prize will enable Mr Knight and Mr Lowery to compete at the Brussels European Robotic Table Tennis Finals in September 1985.

The winner, Dr John Marr's 'Zillian' was a more dainty device altogether. Slender rods resembling an angle poise lamp held a transparent bat. Behind the bat, a 45° mirror reflected the field of view to a lens system mounted on and parallel with the forearm. Motors were mounted in a sleek box at table level, one foot square and only six inches high and a control box completed the system. Dr Marr now travels to San Francisco for the second International Personal Robotics Congress and the International Final of the Robotic Ping Pong Competition. He is assisted by a £500 travel grant from the American organisers.

The judges for the competition included Mr John Collins, Chairman of the British Robotic Association, Mr Michael Shortland, Chairman of the Computing and Control Division of the Institution of Electrical Engineers and Peter Pugh, Executive Officer of the Engineering Manufacturing Industries Division of the IMechE.

Although the standard of play was rather short of Wimbledon level, the robots have got great potential. Vision systems and actuators are coming together, and great strides will be made before the September contests in Europe and the USA. Micro-mouse Maze Competition got off to an equally faultering start in 1980 and Robotic Ping Pong was proposed because the maze solving task of the micro-mouse was beginning to seem too easy. Robotic Ping Pong hasn't quite reached that stage yet, though!

Arrangements for the 1986 competition will shortly be announced and those interested in participating are asked to contact the organiser Dr John Billingsly, Department of Electrical and Electronic Engineering, Anglesea Building, Anglesea Road, Portsmouth PO1 3DJ (U.K.) Tel: (0705) 827681.

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AUTOFACT '85 CONFERENCE & EXPOSITION

Described as a "major, new impetus for computer-integrated manufacturing and factory automation," AUTOFACT '85 attracted a record 33,107 manufacturing engineers, industrialists and automation experts to Detroit's Cobo Hall November 4–7, 1985.

The new attendance mark for the AUTOFACT conference and exposition eclipsed the former record of 22,776 set in Detroit in 1983, said officials of the sponsoring Computer and Automated Systems Association of the Society of Manufacturing Engineers (CASA/SME). The original attendance goal for AUTOFACT '85 had been 25,000 registrants.

Attendees came from more than 25 countries including the U.S.A. and Canada.

With the theme "Manufacturing Integration Comes of Age," AUTOFACT '85 emphasized the concerted efforts now underway to computer-integrate manufacturing and other industrial processes.

1. *Map/Top sets pace*

Reflecting this movement, the MAP/TOP exhibit sponsored by General Motors and Boeing and involving the equipment and systems of 21 other companies was one of the highlights at AUTOFACT '85. This exhibit demonstrated the Manufacturing Automation Protocol (MAP) – a computer-integrated communications specification pioneered by GM for the factory floor – and Technical and Office Protocol (TOP) – a communications protocol for technical and office environments that Boeing has adopted.

The ultimate objective is to establish a single protocol that will enable computer, robotic and communications systems made by different manufacturers to communicate with each other.

All told, the AUTOFACT Exposition featured more than 220 company exhibits demonstrating over 130 categories of computer-based engineering, manufacturing and management technologies and equipment. These included networking systems, CAD/CAM, numerical control systems and software (CNC), factory cell controls, workstations, artificial intelligence, flexible manufacturing, voice recognition and vision systems, programmable controllers, sensors and scanning technology, and CIM software.

2. *New Conference high*

With 3,174 registrants, the AUTOFACT '85 Conference was the most successful since the AUTOFACT events were introduced in 1977. More than 120 automation experts made technical presentations. The four-day Conference spanned a variety of CIM technology in 38 sessions, tutorials and forums.

"From the standpoint of technological progress, AUTOFACT '85 must be considered a milestone event," said James M. Hardy, CASA/SME President and Director of New Business Projects for TRW, Inc., Cleveland, Ohio.

"AUTOFACT has demonstrated to industry leaders and engineers how effective computer-integrated manufacturing can be – and if pursued aggressively and creatively, how CIM will improve manufacturing productivity, product quality and a company's competitiveness in the world marketplace."

3. *AUTOFACT '86*

Planning is underway for AUTOFACT '86, also to be held at Detroit's Cobo Hall November 11–14, 1986. Approximately

85% of available exhibit space for AUTOFACT '86 already has been assigned to over 200 companies and a call for conference papers has been issued.

Inquiries concerning exhibit space should be directed to the Expositions Dept., Society of Manufacturing Engineers, One SME Drive, P.O. Box 930, Dearborn, MI 48121 (USA) Telephone 313/271-0023. To submit papers for presentation at AUTOFACT '86, contact Susan Gretchko, CASA/SME Conference Administrator, at the same address, Telephone 313/271-1080.

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AUTOMACH AUSTRALIA CONFERENCE & EXHIBITION

A total of 3,186 persons, including 250 conference registrants, attended the second AUTOMACH AUSTRALIA Conference and Exhibition held in Melbourne, Australia, July 2–5, 1985. As a result, sponsors of the event, the Society of Manufacturing Engineers (SME), two of its affiliated associations, the Computer and Automated Systems Association (CASA/SME) and Robotics International (RI/SME), and seven SME Australasian chapters have organised the third AUTOMACH event in Sydney, Australia, May 27–29, 1986.

The 1985 event featured 50 exhibitors showing a variety of "high tech" equipment and systems integral to the automated, integrated factory – NC machine tools, CAD/CAM systems, industrial robots, software, tooling and accessories, and flexible manufacturing systems.

"The conference was an overwhelming success. The quality of the technical sessions and workshops truly represented an international viewpoint – technology transfer was definitely in progress during this event," says SME President Marvin M. DeVries.

The technical papers emphasized the conference theme, "Dare to Step into Tomorrow – Through Value, Productivity, People, and Profit." More than 50 technology experts from Australia, Canada, the United States, Japan, and France described the latest advances in computer-integrated manufacturing, manufacturing management, factory automation, manufacturing design and control, robotics, quality improvement, and technological change.

Discussing paper topics for the 1986 event, Paul Borawski (CASE/SME Executive Director) refer to the CASA/SME organizational wheel. "It provides the organizational structure for the AUTOMACH conference and emphasizes the mutual dependency that exists among all segments of advanced manufacturing technology." He noted that integration will be stressed among the many technical papers that will be presented at AUTOMACH '86.

Specific paper topics include: automated systems and assembly, automatic controls for automated processes, FMS, engineering analysis systems, inspection and quality assurance, predictive maintenance systems, CAD/CAM, robotics, software in manufacturing, materials requirements planning and inventory control systems, and materials flow and handling.

For further information, contact Anna Guy (call for papers and conference) or Leslie Hossack (exposition) at SME World Headquarters, One SME Drive, P.O. Box 930, Dearborn, MI 48121, U.S.A. Telephone: (313) 271-1500, TWX 810-221-1232 SME DRBN.

In Australia, contact Adolph Greco at A. Greco & Associates Pty Ltd., Integrated Project Management Services, P.O. Box 1399, Cherrybrook 2120, NSW, Australia. Telephone: (02) 875-2377, Telex: SECCO AA25468.

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