Why CIM?*

By Dr. J. Tim Coppinger and Dr. Carl Steidley
Texas A&M University-Corpus Christi

Abstract
Why computer integrated manufacturing (CIM)? CIM brings together components that are typically studied individually over a wide range of disciplines into an integrated system. Texas A&M University-Corpus Christi is developing a CIM cell that will meet the needs of two Computer Science courses and nine Engineering Technology courses. The courses include Manufacturing Processes, Design of Machine Elements, Principles of Measurements, Programmable Logic Controllers, Control Systems, Capstone Projects, Systems Programming, and System Analysis and Design.

The Mechanical Engineering Technology students benefit from the study of mechanical components, the design of tooling and fixtures, the selection of material handling equipment, pneumatic actuators and clamps, and the relationship of material selection to the manufacturing process.

The Control Systems Engineering Technology students study the use of sensors, data acquisition, actuators, networking of equipment, robot controllers, programmable logic controllers, and the communication of the cell with overall factory operations.

The Computer Science students will focus on the development of controlling algorithms, cell control, user interfaces, networking, and the manipulation and analysis of the data collected.

The manufacture of a product will necessitate the use of interdisciplinary teams of Computer Science, Engineering Technology and other students in their capstone projects classes.

The conclusion is that computer integrated manufacturing can be the focal point of study for many disciplines at many different levels.

Philosophy

The traditional way of teaching a technical subject is to strip away all superfluous distractions and concentrate on a single issue. This is seen in the design of laboratory equipment that can perform one or a small number of very focused exercises. While this is very beneficial in introducing a concept, it leaves the student with islands of knowledge and limited understanding of how the concept is used in the real world. By introducing the student to an integrated system it is hoped that they will gain an understanding of the context of the educational principles involved as well as an appreciation of the integration issues.

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Background

CIM or computer integrated manufacturing means many things to many people. Computer integrated manufacturing involves the entire manufacturing enterprise. The Computer and Automated Systems Association of the Society of Manufacturing Engineers defines CIM as "The integration of the total manufacturing enterprise through the use of integrated systems and data communications coupled with the new managerial philosophies that improve organizational and personnel efficiency".[1] Included within the CIM umbrella is the flexible manufacturing systems (FMS).

FMS often include computer-controlled lathes and mills, material handling equipment like conveyors and robots, assembly robots and storage and retrieval systems, and controllers.

A recent survey of the Engineering Technology Division list serve resulted in 15 responses that indicated a wide variety of CIM/FMS systems in use by the academic community. It would appear that no two systems are alike. The systems are generally used in upper level electromechanical or automated systems courses. The majority of the systems are put together from various sources and vendors rather than a turnkey operation. In some cases the systems have been put together from industrial grade equipment that is capable of CIM operations. The majority, however, use tabletop computer controlled machines with limited capabilities. The products that are manufactured on these systems tend to be small give-a-way items such as key chains, penholders, and chess pieces.

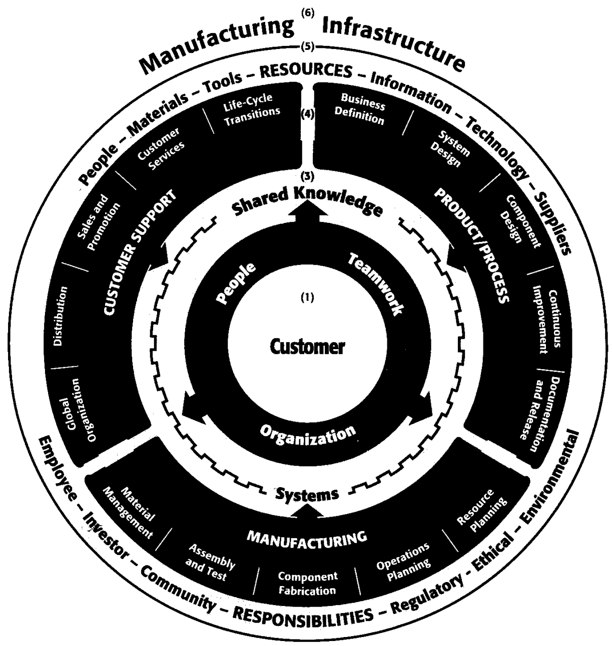
The Society of Manufacturing Engineers has conducted a survey to establish the competency gaps for their 2001 Manufacturing Education Plan.[2] The following areas were found to be lacking in today's graduates: business knowledge/skills, project management, written communications, supply chain management, specific manufacturing processes, oral communications and listening skills, international perspectives, manufacturing process control, manufacturing systems, quality, problem solving, teamwork, materials, and product design. The vast majority of these gaps can be addressed in the context of a CIM system.

Texas A&M University-Corpus Christi, a rapidly growing regional university, has technical degree programs in Computer Science, Mechanical Engineering Technology and Control Systems Engineering. All of these programs are very applications oriented and look to produce students that can make the transition from an educational to an industrial environment with minimum effort.

Mechanical Engineering Technology

Although the major thrust of the Mechanical Engineering Technology program at A&M-Corpus Christi is in the facilities maintenance area a large number of students will be employed in manufacturing and product design. A basic understanding of all mechanical equipment and machinery lies in an understanding of the materials, manufacturing processes, and the design of the product. Of particular importance is the understanding of the integration of individual components into a system and the effects of component failure upon the system operation.

The first time the Mechanical Engineering Technology students will be introduced to the concepts of CIM is in the later portions of their Manufacturing Processing courses. They gain an understanding of the Manufacturing Enterprise Wheel published by the Computer and Automated Systems Association (CASA)[3] of the Society of Manufacturing Engineers. They learn about the interdependencies of customer support, product/process, and manufacturing and the importance of communications and teamwork.



The Manufacturing Enterprise Wheel
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Society of Manufacturing Engineers

In their Design of Machine Elements courses the Mechanical Engineering Technology students will revisit the hardware used in a CIM cell. They will study the applications of chains, belts, bearings, and material handling equipment. The cell will also serve as a source of problems dealing with fixture, end effector design, and product design for automation.

Control Systems Engineering Technology
The Control Systems Engineering Technology students will use the CIM cell in 4 courses. In the Principles of Measurements course they will focus on the use of different types of sensors and the acquisition of data and learn how this information will be used in the overall concept of CIM.

The second time the students become involved with the cell will be in their Programmable Logic Controller course. The students will program the PLC used in the overall control of the cell and any other PLC's used in the control of individual pieces of equipment or process. This will allow the students to work in a hierarchical control environment.

In the two course Control Systems sequence the students will be able to apply various control schemes to real devices and processes used in the cell. They will also be involved with the networking and data highways that are required by CIM.

Computer Science
The life of many Computer Science students is limited to sitting in front of a monitor. They have very little exposure to the needs of the industrial users of the software they create or how their software is used in the workplace. The CIM cell offers the opportunity for the Computer Science student to get involved with the interfacing of equipment, data communication and networking, and the development of control and simulations programs. The courses that will use some of the

features of the CIM cell will include Data Structures, Network Design and Management, Human Computer Interfaces, Systems Programming, Systems Analysis and Design, and Introduction to Artificial Intelligence.

The CIM Cell

In order to produce graduates that can solve today's manufacturing problems education must go beyond introductory courses. Therefore, the educational CIM cell should have the following characteristics. Each piece of equipment must be capable of being operated individually for introductory purposes and as an integrated part of the system. Since the world market place requires that manufacturers produce numerous products in small lot sizes, the equipment must be able to handle a family of multiple products and be capable of rapid change over. For example the CNC machine tools must have automatic tool changers and the robots must have changeable end effectors. Fixtures should be capable of being easily and quickly changed. Ideally the robots within the cell itself would perform the change. If this is not possible a list of instructions for the change should be computer generated. The system should contain enough equipment to allow for alternate routings and processes. The system should be capable of producing enough products that quality issues may be identified and solved.

Conclusion

CIM by its nature requires an interdisciplinary approach to problem solutions. It is an ideal source of problems that require an interdisciplinary team of students to solve. It allows the students to experience the complexity of the real world in a manageable format. The members of these teams of students should go beyond the Engineering Technology and Computer Science programs to include students from other colleges. All students would benefit from the inclusion of operation technical writing, management, business, and with the association with students from other disciplines.

The future is bright and increasingly complex. Education must keep pace.

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J. Tim Coppinger

Dr. Coppinger is a Professor and Coordinator of the Engineering Technology at Texas A&M University-Corpus Christi. Dr. Coppinger is a Registered Professional Engineer and a Certified Manufacturing Engineer in the area of robotics. He currently serves on the International Board of Directors of the Society of Manufacturing Engineers. He holds BS and MS in Mechanical Engineering and Doctor of Environmental Design degrees.

Carl W. Steidley
Dr. Carl W. Steidley is currently a Professor and Chair of the Computing and Mathematical Sciences Department at Texas A&M University-Corpus Christi. He has developed advanced computing laboratories at several institutions. His industrial experience includes a Senior Engineering position with Liton Industries Data Systems Division. Dr. Steidley holds AAS in EET., BA and MS in Mathematics, and Ph.D. in