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ABSTRACT

In 1987, Midlands Technical College (MTC), in Columbia, South Carolina, initiated a Computer Integrated Manufacturing (CIM) project, the Midlands Teaching Factory, LTD, which integrated various college departments with the goal of manufacturing a high quality, saleable product. The faculty developed a teaching factory model which was designed to produce products made of metal and plastic utilizing industrial grade production equipment, and computer hardware, software, and networks. The business department was placed in charge of the management of the facility, transmitting orders received throughout the network to other departments, which then ensured that all of the necessary elements came together on the shop floor. All related problems had to be solved by the faculty, staff, and students, which meant that students had to be very familiar with most parts of production. As of January 1992, the plant had begun to integrate all areas of manufacturing; the central database and the islands of manufacturing had been established, and the facility's first product, an insulated plastic drinking cup for hot or cold beverages with a machined coaster had been selected. The CIM environment emphasizes connectivity and working across platforms, utilizing IBM PC's, DEC 3100's, VAX 3100's, IBM clones, Macintosh computers, and Sun computers. The University of South Carolina, Clemson University, and MTC cooperate in computer-aided modeling, and other cooperative applications involving the CIM facility are being planned. The shop floor layout, network configuration, and software layout are attached. (MAB)

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The Vision

In 1987 Midlands Technical College (MTC) embarked on a mission to launch a Computer Integrated Manufacturing (CIM) project. The purpose of the project was to be multi-faceted. The "Midlands Teaching Factory, LTD" would integrate various departments in the College to work together toward the common goal of producing a high quality, saleable product. Students involved in the CIM project would need to understand not only their own area of special expertise but also would need to be able to communicate with students in other areas of learning and function in a team environment. Faculty from various departments would also function as a team in order to maximize the educational experience of the students.

Making the Vision a Reality

In order to create an educational experience which simulates a manufacturing environment, the faculty developed a model for a teaching factory--a real, working, product-producing plant. They envisioned a teaching factory in which all production equipment and computer hardware, software, and networks would consist of industrial grade equipment. Products would be a combination of metal and plastic that would be manufactured, labeled, and packaged in accordance with manufacturing standards. They would be marketed through computer networks; orders would be received and processed electronically. The Business Department would be responsible for the management of the factory. They would received orders over the network, transmit this information through an MRPII package, convey the necessary information to other departments over the network so that shop release orders, materials, and workers would come together on the shop floor simultaneously. Students, faculty, and staff from various areas of College would be involved in the shop activities to make, package, ship, and electronically invoice the purchaser of the products.

The factory would utilize manufacturing system controls and hardware components which are commercially available. Problems of connectivity, interfacing, and communication would be solved by the students, faculty, and staff. The factory would be designed, built, and implemented using internal personnel in order to ensure that the people who operated and maintained the systems truly understood the development and implementation of the computer integrated manufacturing concept.

The Present

This teaching factory envisioned by the faculty and staff has evolved into reality in much the same way a new plant startup would take place. New equipment has been installed, and production has started as stand alone stations using operators until the cells can be integrated into the system. Networks and software have been put on line in several stages. The plant has been producing parts in limited quantities.

As of January, 1992, the plant has begun to integrate all areas of manufacturing. The central data base has been established, and the islands of manufacturing are starting to work together.

Students research possible new products and recommend a product for production based on its manufacturability within the parameters of existing personnel, tools, and equipment. They produce a written technical report, which details their product. Then they make oral presentations on their findings to peers, faculty, and staff.

The first merchandise to be produced will be an insulated plastic drinking cup for hot and cold beverages with a machined coaster. This product applies technologies for manufacturing both plastic and metal parts. The objective of the students is to produce a set that will be affordable and useful for every day office service.

Beginning next year, Engineering Graphics Technology and Machine Tool Technology students will create the detailed design for a new product as one of their class assignments. Then, the Machine Tool Technology students will build the production tooling as one of their required projects.

The Midlands Teaching Factory, LTD will create new products each year so new students will have an opportunity to change production tooling and manufacture a new product by the time their class graduates. Students will have the satisfaction of seeing their merchandise. This approach to teaching will help students integrate the knowledge they learn in all their classes into a project with tangible results.

System Components and Networks

Connectivity and working across platforms are emphasized in the CIM environment. Many different makes, models, and sizes of computers are used in the CIM Center. Sizes range from personal computers to mini mainframes. Types of computers include IBM PC's, DEC 3100's, VAX 3100's, IBM clones, Machintosh computers, and SUN computers, to name a few.

The components of the industrial equipment and computer hardware and software are connected through two network systems, Ethernet and Token Ring. The Ethernet network connects a VAX cluster (VAX 8600/6320) and an industrial MICROVAX 3800 (which houses the CAD/CAM systems) to the CAM Lab via fiber optics and on to the shop floor through twisted pairs. Various data collection devices, communicating with a DEC 3100, collect data and

control the shop floor. This data is then transferred to a VAX 3800 for data processing and storage. Fiber optics connect the process control and instrumentation lab to the Ethernet backbone through an optical star.

The CIM briefing room and several CAD and business computer labs are housed in the Lindau Engineering Technology building. The briefing room accommodates an IBM AS400, work stations, and various personal computers (PC's). (The AS400 has various business software programs such as MAPICS). All computers in the briefing room are linked to the Barco projection equipment so that computer screens can be projected onto a large screen in order to enhance oral presentations. This room also has multimedia capabilities for use during presentations.

Through the Token Ring network, the briefing room and the engineering lab next door are connected via fiber optics with the process control and instrumentation lab. The CAM lab, business labs, and shop floor are all located in separate buildings. The CAM lab will be the point at which the two networks join. It will be a test site for Digital Equipment Corporation's router (scheduled to be released in 1992). This will allow work to flow across networks. Users will merely search for applications; the actual networking functions will be invisible to users.

Students are using personal computers or VAX stations with Schlumberg's Bravo 3 system to design in-house products. The College can also receive designs from outside the College across the statewide DECnet system through the VAX 3800 gateway. The College routinely receives designs

from the University of South Carolina via the network. Students and faculty convert these designs into a graphical CAM package, translate them into machine language code, and download them directly to CNC (Computer Numerical Control) machines, which manufacture the parts. (The College currently uses several CAM packages--Mastercam, Smartcam, and Bravo 3.)

Computer Aided Modeling

Three institutions--Midlands Technical College, The University of South Carolina, and Clemson University--cooperate to do computer aided modeling. MTC places designs on the statewide computer network in the form of two-dimensional drawings (IGES or DXF). USC stores these files on a VAX 6000. Then USC converts these files into solids models using PRO Engineer and places the files back on the VAX 6000. USC then sends an electronic mail message to notify Clemson of the name and location of the files. The Center for Advanced Manufacturing (CAM Center) retrieves the files from the VAX and converts the solids files into a format a Stereo-lithography machine can use. The Stereo-lithography machine then forms the designed part which is cured by a laser beam in a vat of liquid photo-polymer. The new prototype then emerges as a solid three-dimensional real part - without any tooling. This entire process of making a prototype part--a part that can be held in hand and fitted to other parts--takes a matter of hours rather than weeks or months required by previous conventional prototyping techniques.

Business Management System

The College has begun the process of managing the business aspects of the Midlands Teaching Factory, LDT. The business school is involved in the accounting and management information systems programs. In a classroom environment, faculty and students plan to use Fourth Shift MRPII software on a PC based Novel network. In addition the college will use other management information system software packages, mainframe and PC based platforms, for demonstration to industries that have system requirements for either platform. Students in selected business, industrial, and engineering technology classes will be able to capture and use data that is created on the shop floor.

The Future

As the project moves forward, the CIM Center will become a test site for new hardware and software. Vendors and suppliers will have an opportunity to access the Center in order to test their products and use feedback from the Center to develop new and better products. There are numerous examples of the cooperative relationships that are developing between the College and industrial application research groups, including becoming a test site for the Digital router, Expert Systems' new CAD selection software, and Sclumberger's CAD/CAM software.

Shared Educational Opportunities

A proposal is being made to the University of South Carolina to use the College's Technologies Applications Center (TAC) and the Midlands Technical College for elective course work. USC engineering students would be able to take courses on practical CIM applications. USC faculty, working in conjunction with MTC faculty, would teach hands-on classes at the Center on such topics as programmable logic controllers (PLC's), robotics, materials handling, etc. USC students would then be able to get practical experience in a real manufacturing environment; USC would not have to duplicate the center or depend solely on co-op courses to give students practical experience. Graduate students would also be able to use TAC and the Teaching Factory, LTD for PhD-level research in order to develop new technology applications.

Through cooperation with other teaching institutions and manufacturers, MTC will strive to ensure that the Midlands Teaching Factory, LTD stays on the cutting edge and continues to contribute to the economic development of the Midlands region by serving as a demonstration site, sharing technology advances with local industries, and providing a qualified work force.

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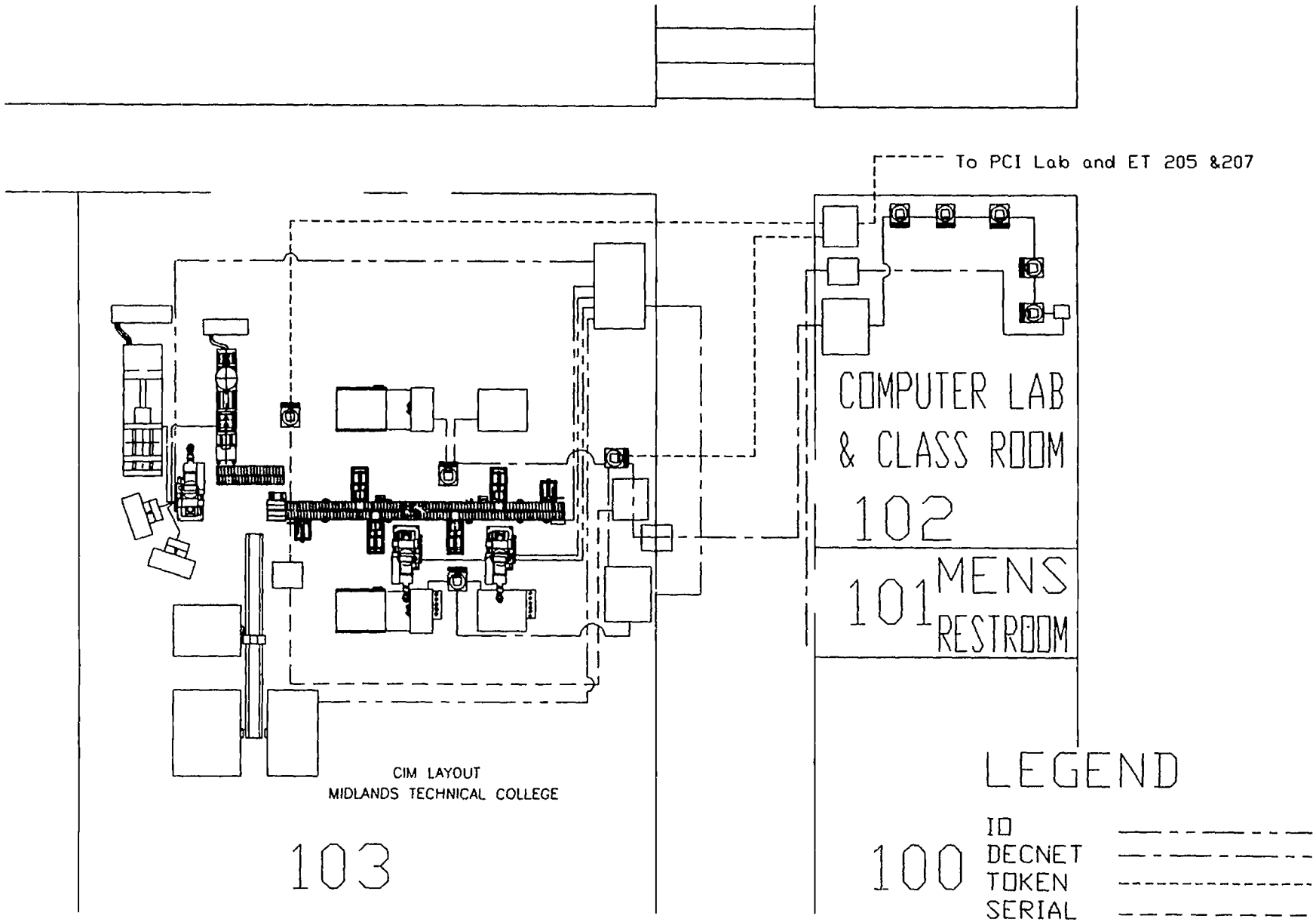
SHOP FLOOR LAYOUT

NETWORK CONFIGURATION

SOFTWARE LAYOUT

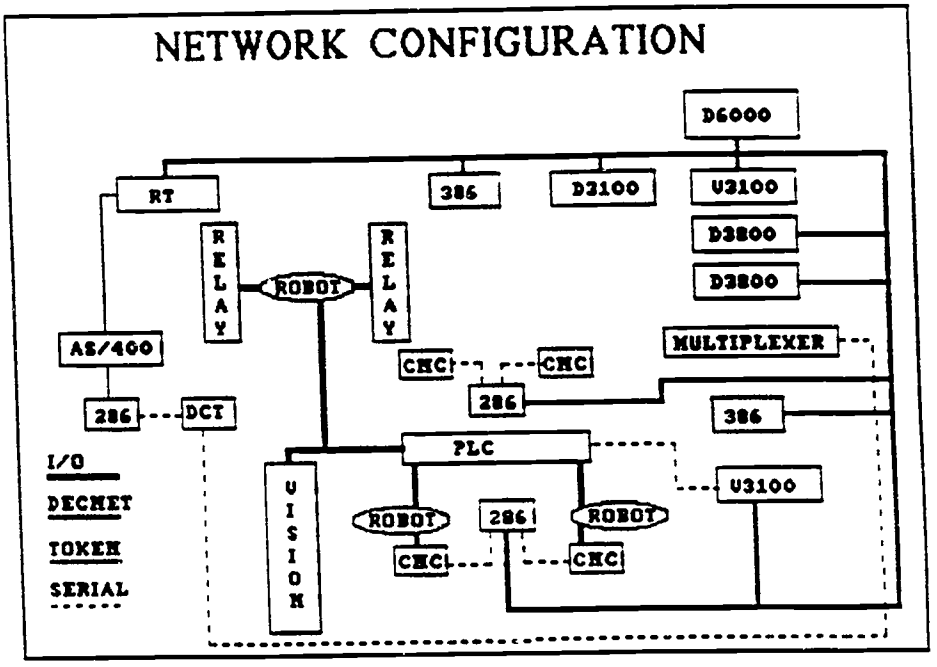
October 1992



SOUTHEAST MANUFACTURING TECHNOLOGY CENTER
COLUMBIA, SC

SHOP FLOOR NETWORK

DRAWN BY: JANET KNOTT
SCALE: FIT
DATE: 4-28-92


NETWORK CONFIGURATION
D6000
RT
386
D3100
U3100
D3800
D3800
RELAY
ROBOT
RELAY
AS/400
CNC
CNC
MULTIPLEXER
286
DCT
286
386
I/O
DECNET
TOKEN
SERIAL
PLC
U3100
VISION
ROBOT
286
ROBOT
CNC
CNC

SOFTWARE LAYOUT