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ABSTRACT

A project conducted by Northampton Community College established an automated manufacturing training center for use by industry in eastern Pennsylvania. The center assists small and medium-size manufacturing firms in evaluating and integrating off-the-shelf technology to make them more competitive in the global marketplace. Comprehensive services include demonstration, training, access to consultant services, and use of technical facilities. Project activities were as follows: (1) setting up a laboratory for training and demonstration; (2) developing and piloting a training assessment model in three firms; (3) developing and piloting a comprehensive matrix of training modules for management, engineers and technicians, supervisors, maintenance personnel, and production operators involving 25 companies; (4) offering a technological literacy training program to 100 school personnel; (5) developing industry-specific training videotapes; and (6) marketing the program to area manufacturers. The program was strongly supported by local industry and was considered a success by those involved in it. (Appendixes, which make up two-thirds of the project report, include an evaluator's report, descriptions of grant courses and enrollment, course outlines, and lists of committee members and industry donors.) (KC)

AUTOMATED MANUFACTURING TRAINING CENTER

FINAL PERFORMANCE REPORT
PROJECT # V100A00063-90

DECEMBER, 1991

NORTHAMPTON COMMUNITY COLLEGE
3835 GREEN POND ROAD
BETHLEHEM, PA 18017

NORTHAMPTON COMMUNITY COLLEGE
AUTOMATED MANUFACTURING TRAINING CENTER
PROJECT # V100A00063-90

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NORTHAMPTON COMMUNITY COLLEGE
AUTOMATED MANUFACTURING TRAINING CENTER
PROJECT #V100A00063-90

NARRATIVE REPORT -- DECEMBER, 1991

PROJECT SUMMARY
The purpose of the project was to establish an automated manufacturing training center for use by industry in eastern Pennsylvania. The Manufacturing Services Extension Center, an industrial resource center funded through the state of Pennsylvania, worked with the College to develop the concept for the Center's creation.

Today Northampton Community College (NCC) has in place a fully-operational automated manufacturing training center (AMTC). The Center assists small and medium-size manufacturing firms to evaluate and integrate off-the-shelf technology to make them more competitive in the global marketplace. Comprehensive services include demonstration, training, access to consultant expertise, and use of technical facilities. The Center's mission is to facilitate companies' strategic implementation of manufacturing solutions to maximize productivity and human resource effectiveness.

Federal and state grant funds have provided support for the Center's development. This report describes results of the U.S. Department of Education Cooperative Demonstration Project in High Technology (January, 1990 - September, 1991). State support from Pennsylvania's Northeast Tier Ben Franklin Advanced Technology Center (September, 1990 - present) complemented federal support, providing funds for (1) expansion of laboratory facilities and staffing and (2) direct assistance to management-level personnel evaluating and implementing new technologies. VEA federa. funds provided further support for the purchase of equipment used in both the credit and noncredit (industry) manufacturing programs.

PROJECT GOALS
Project goals included (1) make accessible to area industry an automated manufacturing demonstration training center; (2) work with area manufacturing companies at early stages of automation to a) increase management knowledge base about automation and its application to their specific industry and company, b) determine training needs, and c) improve technical and troubleshooting skills of workers; (3) work with area manufacturing companies already involved in programmable automation to a) determine training needs and b) improve and refine the technical and troubleshooting skills of workers; and (4) increase the understanding and knowledge base of public school and community college administrators, teachers, and guidance counselors in technology, automated manufacturing, and related career choices.

PROJECT RESULTS
The primary objectives of the project were achieved as described in the text that follows.

(1) Set up a laboratory for training and demonstration.

The Automated Manufacturing Training Center is based on the successful model for delivery of technology training. consulting, and technology transfer assistance established by Northampton's National Training Center for Microelectronics (NTCu). Like NTCu, AMTC facilities and demonstrations are designed by technical staff to address industry needs, industry advisors play a key role in facility design, and the AMTC relies upon in-kind equipment donations and loans to establish and maintain facilities. Equipment is representative of current available technology.

During the first eight months of the project period, staff studied regional need for training in automation, defined program scope, and solicited support from equipment vendors.

In September, 1990, the College renovated laboratories to create space for two automated manufacturing labs adjacent to the NTCu lab, allowing for joint development of facilities to maximize technical capability and resources. (A floor plan for the manufacturing facilities is included at the end of the final grant report.) During the remaining months of the project, specific laboratory demonstrations were developed as described below.

Penn Hall 135: Simulated Production Facility
In the fall of 1990, technical staff completed plans to create a model of a small manufacturing company demonstrating production from product design through product ship. Plans included the design and manufacture of an actual product. By August, 1991, a manufacturing cell demonstrating CAD/CAM/CNC integration, automated assembly, and barcoding was installed and operational. During the 1991/92 academic year, technical staff will refine cell operations and prototype the first products using the manufacturing cell for machining of parts and final assembly.

Penn Hall 133A: Controls Lab
Throughout the project industry sponsors donated and loaned equipment for PLC demonstrations and hands-on training. In November, 1990, as part of a competitive grant application process, Texas Instruments donated to the College a classroom set of programmable logic controllers (PLCs) valued at $22,625. In May, 1991, Allen-Bradley donated a second classroom set of PLCs valued at $30,475. Today the Controls Lab contains 8 stations, each equipped with a 486 PC and a PLC (TI or Allen-Bradley). Staff designed Input/Output panels for each station. These will be fully assembled by January, 1992. Finally, during the early summer months of 1991, SmartCAM and AutoCAD software packages were installed on 486 PCs for use in training programs and laboratory demonstrations.

Penn Hall 136: National Training Center for Microelectronics (NTCu) Throughout the project industry sponsors loaned and donated automatic equipment for demonstrations and hands-on training in electronics manufacturing. In the fall of 1990, DuPont donated a Mech-El automatic wire bonder to be used in hybrid and advanced packaging programs. In the spring and summer of 1991, Nicolet loaned an x-ray system to the College for use by regional industry for training and real-time evaluation of product quality and reliability. Also in August, 1991, Siemens Industrial Automation loaned to the College automatic placement equipment valued at greater than $270,000. While not in place in time to develop further training for electronics manufacturers during the grant period, this equipment will be utilized in the future for hands-on training programs. The equipment loan from Siemens Industrial Automation is part of a long-term technical/business partnership with the College establishing NTCu as the exclusive surface mount trainer for Siemens' customers.

Goals developed by technical staff for the design of the automated manufacturing facility far exceeded original plans outlined in the grant proposal. The original grant proposed solicitation and installation of programmable automation (PLC and CNC) equipment as the primary thrust of laboratory development activity. This goal was accomplished during the project period. More extensive laboratory development was planned beyond the scope of the original proposal, with initial demonstrations completed during the project period (as described above) and others targeted for completion during the 1991/92 and 1992/93 academic calendar years. Future laboratory development activities will include: (1) installation of a process control system designed and donated by Fischer & Porter; (2) the downloading of circuit board design date (from P-CAD) to the placement equipment; (3) the networking of the PLC lab and manufacturing floor; and (4) the demonstration of multiple software packages for cost estimating, production scheduling, data collection, materials tracking, and production inventory and control.

Long-term plans for future development of the facility will be guided by a functional specification (Penn 133-136) written by W.M. Angell & Associates in the summer and fall of 1991. The functional specification is the Center's first step in the systems development process. The purpose of the specification is to define the function of Northampton's advanced manufacturing facilities and serve as a reference for their development. It will guide the future selection of hardware, software, and systems to meet operating goals. Additionally, the Center's use of a systems development process to integrate its operations will serve as a demonstration for regional firms automating their facilities.

(2) Develop and pilot in 7 firms a training assessment model.

The original grant proposed piloting the training assessment model in 7 firms. In the late spring of 1991, approval was granted for piloting of 3 rather than 7 assessments. Project staff felt 3 pilots would provide ample opportunity for refinement and testing of the assessment model.

Keystone Cement Company
Keystone is a local cement manufacturer employing approximately 160 personnel. In January, 1991, the company installed their first PLC-controlled automated system. At Keystone's request, AMTC staff conducted a comprehensive assessment of training needs related to the company's immediate and long-term plans for automation. The assessment included a skills survey and a series of interviews with management, technical staff, electrical maintenance supervisors, production supervisors, electrical maintenance personnel, and production personnel (Copies of the Keystone skills survey and interview questions are included with the set of AMTC curriculum materials accompanying this report.) As a result of the assessment, AMTC staff recommended and conducted a series of customized programs targeted for all personnel levels. Program content included strategic planning for management, supervisory training, technical training, and vocational skills training. Between March and November, 1991, 146 Keystone employees enrolled in 240 hours of training conducted both at the College and on-site. Following training, Keystone management enthusiastically endorsed the automated manufacturing programs, citing increased technical skills of their personnel and positive attitudes among workers about using new equipment. The program was co-sponsored by the Manufacturing Services Extension Center (MSEC).

The Keystone program demonstrates how the automated manufacturing training center effectively addresses the multifaceted issues associated with the successful integration of new technology into manufacturing operations. In the original grant application, the issues associated with the slow pace of technology integration in U.S. manufacturing firms were cited as complex and categorized as follows: 1) lack of management understanding; 2) large capital costs; 3) high costs of training to implement, operate, and maintain computer-controlled equipment; 4) non-technical barriers and resistance to automation; and 5) lack of a workforce adequately skilled in basic literacy, industrial/vocational trades, troubleshooting, and problem solving. All these barriers to success were present at Keystone. Through comprehensive AMTC programming customized to address their specific needs, Keystone personnel were able to remove key barriers to successful technology integration and plan for future automation investments. The Keystone program truly demonstrates the benefit of the technical expertise, programming, and facilities developed in this project.

Dent Manufacturing Company
Dent Manufacturing is a local job shop employing approximately 65 personnel. In the spring of 1991, the company requested training in CNC operations for their production personnel. At Dent's request, AMTC staff conducted an assessment of training needs related to the company's recent acquisition of computer numeric controlled equipment. The assessment included a math. test and interviews with management to determine the skills required for operation of Dent CNC equipment. As a result of the assessment, AMTC staff developed a customized training program for production personnel (9 total participants) in basic manufacturing processes and CNC operations. Following training, Dent management praised the assessment process and training, citing

customization of program content a key factor in the training program's success.

Tarkett Inc.
Tarkett Inc. is a local manufacturer of vinyl floor coverings employing 386 personnel. In the spring of 1991, the company requested training for the electrical maintenance personnel. In the fall, AMTC staff conducted a comprehensive assessment of their training needs and recommended a series of customized hands-on training programs. The purpose of the assessment was to define specific skills required by Class 1 electricians to perform their jobs, to evaluate skill levels of current employees, and to design a training program which addresses the fears associated with modernization and motivates personnel to participate. The assessment was based on the model developed for Keystone and included a skills survey and a series of interviews with management and electrical maintenance personnel. The Tarkett skills survey was more extensive than the original Keystone survey, increasing its usefulness as a tool for assessing employee skills. At the time of this writing, Tarkett management was still reviewing the proposed training series for for their electrical maintenance personnel. Training is expected to begin in January, 1992. Tarkett management was very pleased with the assessment process, believing it provided valuable data about their training requirements. Tarkett looks forward to the successful implementation of a training program which will enable their maintenance personnel to keep pace with the technical advances in their company.

(3) Develop and pilot a comprehensive matrix of training modules for the following groups of company employees: management, engineers and technicians, supervisors, maintenance personnel, and production operators. Involve at least 25 companies in training activities.

348 industry participants enrolled in 30 technology awareness and hands-on training programs representing 613.5 total hours of training (equivalent to approx. 76 eight-hour days). 20 industry training programs were public offerings at the College, and 10 were contracted programs. Programs involved 25 companies from the Lehigh Valley region. (Enrollment data may be compared with the original project goal to provide 76 days of training to 318 personnel from 25 companies). Grant courses are listed on the next page, and enrollment data may be found in the appendix.

18 courses and were developed, with 9 courses piloted twice and the remaining 9 courses piloted once [see starred courses on the next page]. (This may be compared with the original project goal to develop 8 training components for industry and pilot each twice.) With the exception of the apparel and APICS MRP programs, all public course offerings were scheduled twice. The second session for each of the following public courses was cancelled due to low enrollments: Competitive Manufacturing Strategy Series, Software Tools for Economic Justification, Process Control Systems, CNC Programming, and Computer Aided Manufacturing.

Manuals and/or extensive curriculum notes were developed for the 8

underlined courses (of 18 total) listed below. (This may be compared with the original project goal to develop manuals for 8 programs.) The remaining 10 programs utilized a variety of handout materials to reinforce classroom learning. Extensive laboratory exercises were developed for all hands-on training programs.

AUTOMATED MANUFACTURING COURSES

Management - Awareness Programs [public]
Competitive Manufacturing Strategy Series (12 hours) *
Software Tools for Economic Justification (4 hours) *
Supervising in a Modern Manufacturing Environment (6 hours)
Investment in Technology: A Survival Issue [apparel series] (6 hours) *
APICS: Materials Resource Planning (24 hours) *

Hands-On Training Programs [public]
Process Control Systems (40 hours) *
Basic Control Concepts (40 hours)
Programmable Logic Controllers (40 hours)
Troubleshooting Programmable Logic Controllers (40 hours)
PLC Basics (3 hours)
CNC Programming (40 hours) *
Computer Aided Manufacturing (24 hours) *

Customized Programs for Keystone Cement Company
Control Strategy for Management (4 hours)
Control Awareness (2 hours)
Supervising in a Modern Manufacturing Environment (16 hours)
Industrial Controls Refresher (12 hours)

Customized Program for Dent Manufacturing Co.
CNC Machining for Operators (48 hours) *

Customized Program for Instrument Society of America
Programmable Logic Controllers (6 hours) *

Notes:
(1) Management awareness programs were targeted for engineering management and designed to provide specific knowledge for evaluating alternate technology solutions for their firms. In conjunction with these programs, a series of two-hour technology awareness seminars funded by the Ben Franklin program was also offered to introduce specific technologies to manufacturing management and stimulate enrollment in other technology training programs.
(2) Starred programs (*) were piloted once. The remaining programs were piloted twice.
(3) AMTC curriculum materials for the underlined courses accompany this report.
(4) Enrollment data and outlines for the above programs may be found in the appendix.

Training program content was developed by technical consultants working in conjunction with curriculum development specialists. Advisory

committee members played an active role defining initial program content and evaluating course materials. Program participants provided feedback on course content and delivery, and their recommendations ware incorporated into course curricula.

(4) Develop a technological literacy training program for public school and community college administrators, teachers and guidance counselors. Offer this program to at least 2 groups of Northampton staff and 6 groups of public school personnel within the Lehigh Valley region.

63 college staff and 36 public school personnel enrolled in 7 technological literacy programs. (Enrollment data may be compared with the original project goal to provide training to 120 persons, with 2 sessions offered for college staff and 6 for public school personnel.)

Programs for Public School Teachers & Guidance Counselors

Technical Careers in the 90's (6.5 hours)	May 8, 1991
Technical Careers in the 90's (3.5 hours)	April 30, 1991
Technical Careers in the 90's (3 hours)	September 24, 1991

Programs for Northampton Faculty and Staff

Understanding Northampton Technologies (1.25 hours)
September 23, 24, 26, & 27, 1991

NOTES:

(1) The length of the technological literacy programs differed from that proposed in the original grant to address the varying interests and time availability of different audiences.
(2) Three additional classes were scheduled in the spring of 1991 but cancelled due to lack of enrollment.
(3) Outlines for the technological literacy programs may be found in the appendix.

The technological literacy programs were developed by AMTC staff. Program content included discussion of the manufacturing workplace of the 1990's, workforce training needs emphasizing Lehigh Valley needs, technical career opportunities, and educational requirements for technical careers. All programs included demonstrations in the manufacturing laboratories. The spring programs also included tours at local manufacturing facilities. Advisory committee members played a key role in the program's success--assisting with development of program content, speaking in sessions about workforce needs, and volunteering their facilities for tours. Feedback from public school educators participating in the spring programs was integrated into fall course curricula. Feedback in the fall from Diane Donahert, local director of the Vocational Industrial Club of America (VICA), confirmed spring reports that program content was on target and of benefit to public school educators.

(5) Develop 4 fifteen-minute industry-specific training videotapes -- for the mechanical products, electrical/electronics, process, and apparel/textile industries.

A request to produce 3 rather than 4 videotapes was approved in May, 1991. The three videotapes produced as part of this project include the following: (1) a marketing video highlighting Northampton's technical programs and manufacturing laboratory facilities, (2) a training video highlighting control applications in multiple industries ranging from control of one piece of equipment to plant-wide control, and (3) a video documenting the use of technology for business advantage in the apparel industry.

The apparel video was completed in September, 1991. The marketing and controls applications videos will be completed in early January, 1992.

Video programs were developed by AMTC staff and content specialists working in conjunction with contracted media specialists. Advisory committee members provided input on program content for the control applications and marketing videos. The Lehigh Valley Apparel and Textile Initiative played an active role in the development of the apparel video, advising on program objectives and content and recommending suitable sites for videotaping.

All three videos utilized footage from regional manufacturers. Local companies providing access to staff and facilities for videotaping include the following: Air Products & Chemicals, Inc., Binney & Smith Inc., Bru-Mar Manufacturing Co., Diane Fashions, ESSROC Materials, Gee-Kay Knit Products, Inc., the Greif Companies, W.F. Hofford, Inc., James River Corp., JIK, Ltd., Just Born, Linden Apparel Co., Stanley Vidmar, Sure-Fit Products Co., and Valerie Fashions.

The Lehigh Valley Apparel and Textile Initiative highly praised the apparel video and will encourage its use by regional firms to stimulate investment in technology and interest in careers in the apparel industry. Feedback on the marketing and controls application videos will be solicited from advisory committee members in early 1992. The marketing video will be disseminated broadly to companies with inquiries about technical capability and to economic development groups. The control applications video will be utilized in Northampton credit and non-credit courses and distributed to interested educational institutions and manufacturing firms for use in training.

(6) Develop and implement a marketing plan to promote the program to area manufacturers.

The Center marketed the full scope of its activities through the direct efforts of the Center's director, Northampton Center for Business and Industry (CBI) marketing professionals, and local economic development groups. Highlights of marketing activity included the following: (1) regional mailings featuring automated manufacturing courses (NCC tabloid, CBI catalog, CBI flyers featuring upcoming programs, AMTC brochures published quarterly, and flyers describing a specific program); (2) news releases and ads in newspapers and monthly

newsletters of regional technical society chapters (Society of Manufacturing Engineers [SME], SME Computer and Automated Systems Association [CASA], Instrument Society of America [ISA], and Society of Plastics Engineers [SPE]); (3) articles published in the Northampton County Development Corporation (NCDC) and Manufacturing Services Extension Center (MSEC) newsletters: (4) dissemination of program information at meetings of technical societies and business and professional groups (SME, SME CASA, ISA, SPE, NCDC, and two Lehigh Valley apparel conferences); (5) training programs and laboratory demonstrations conducted for regional technical associations (SME CASA, SME, and ISA); (6) company visits; and (7) ongoing dissemination of information about new programs to MSEC, Pennsylvania's Northeast Tier Ben Franklin Advanced Technology Center (NET/ATC), automated manufacturing advisory committee members, and industry donors. Additionally, the project director explored the possibility of making a presentation at a statewide meeting of industrial resource centers. Unfortunately, the meeting was cancelled due to state funding cutbacks.

Information about the project was further disseminated through presentations at the following state and national conferences:

* National Council for Occupational Education (Baltimore, MD; October, 1990)
* National Coalition of Advanced Technology Centers (Portland, OR; November, 1990)
* American Association of Community & Junior Colleges (Kansas City, KN; April, 1991).
* National Coalition of Advanced Technology Centers (Portland, OR; June, 1991).
* Surface Mount International (San Jose, CA; August, 1991).
* Deans Association of Pennsylvania Community Colleges (Fall, 1990 and Spring, 1991 conferences)

In November, 1990, following the NCOE conference, an article was submitted for publication to the Journal of Studies in Technical Careers. The article was not published. Additional articles featuring Northampton's manufacturing programs will be submitted for publication to professional journals in 1992.

Marketing efforts will intensify during the 1991/92 academic year. A technical brochure highlighting the full scope of Center activities, a slide presentation, and a marketing video were developed with grant funds. These will be utilized in the coming months by CBI staff to showcase technical expertise and laboratory capability.

INDUSTRY SUPPORT

Strong industry support was the key to the project's success. An advisory committee established specifically for the automated

manufacturing training center grant, industry focus groups, technical consultants, and equipment donors provided ongoing input regarding program focus and direction, course content, laboratory facility development, marketing, and overall project evaluation.

Between January, 1990, and September, 1991, industry support for the Center, including in-kind contributions and donated and loaned equipment, exceeded $280,000. 33 corporate sponsors provided in-kind contributions and equipment donations and loans valued in at $281,116. Corporate sponsors included the following: Air Products & Chemicals Inc., Allen-Bradley, Binney & Smith, Inc., Bru-Mar Manufacturing Co., Cali Sportswear Co., Inc., Crowder Engineering, Inc., Diane Fashion Inc., The DuPont Company, Engineered Systems, Inc., ESSROC Materials, Inc., Fischer & Porter Company, Follett Corporation, Gee-Kay Knit Products, Glemser Technologies Corp., The Greif Companies, W.F. Hofford, Inc., IBM Corp., Integrated Facilities Corp., James River Corp., Jenkins Machine Inc., JIK Ltd., Just Born, Linden Apparel, Inc., Nicolet Instrument Co., Pennsylvania Power & Light Co., SI Handling Systems, Inc., Stanley Vidmar, Sure Fit Products Co., Telemecanique, Inc., Texas Instruments Inc., Valerie Fashions, Victaulic Co., and Westinghouse Electric Corp. The Atlantic Apparel Contractors Association and the Valley Apparel and Textile Association provided cash and in-kind support valued at $695 for the technology training series. The Manufacturing Services Extension Center provided engineering support for program development valued at $4320. It should be noted that in many cases in-kind support was not documented. Thus, the true value of industry support exceeds that reported.

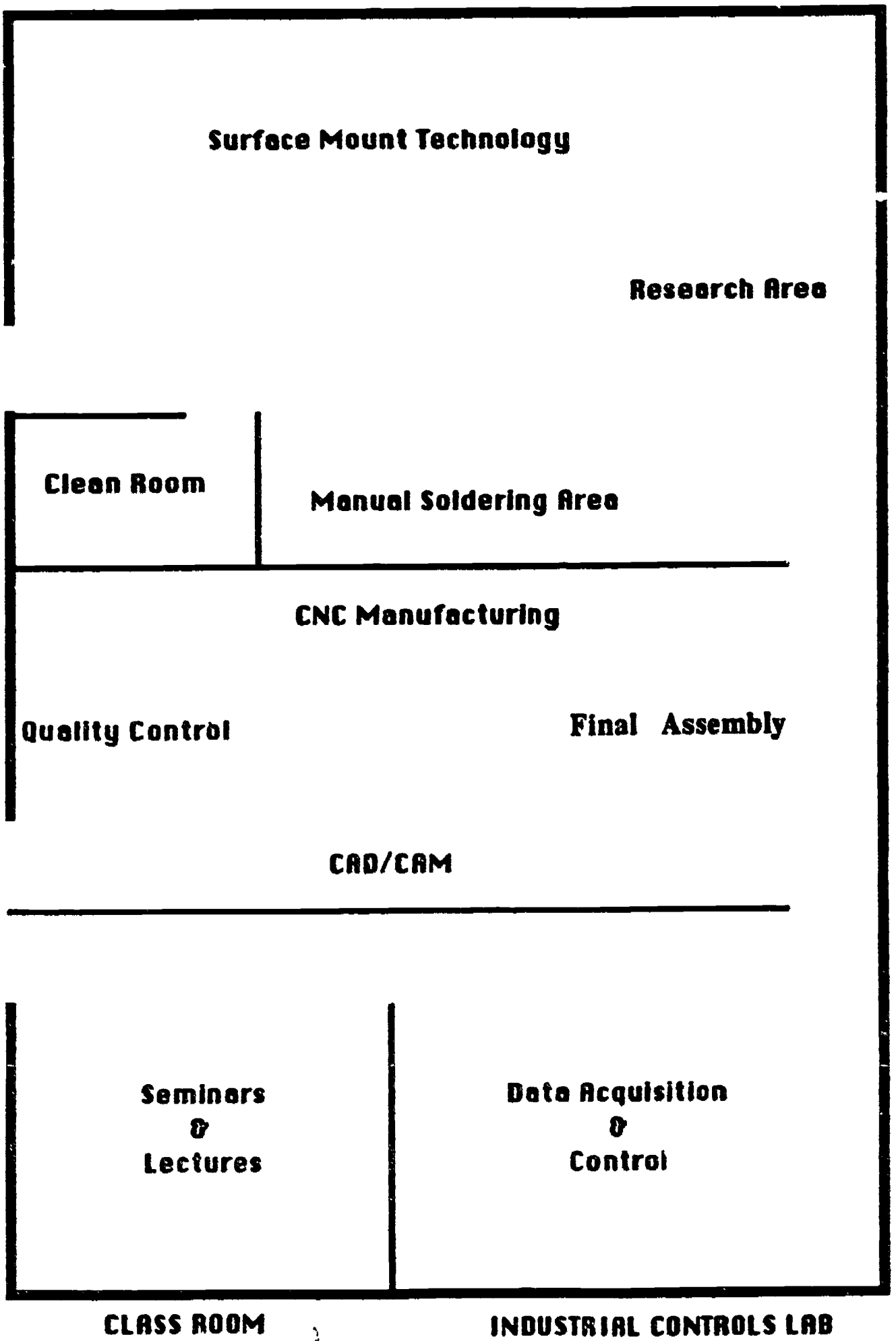
THE FUTURE

Northampton Community College has been recognized nationally as one of the leading postsecondary institutions providing technology transfer to small and medium-size manufacturing firms. The U.S. Department of Education provided the seed money for development of NCC's surface mount and automated manufacturing programs. In the future, Northampton will continue to offer the automated manufacturing courses described in this report, expanding program offerings to address industry need. Comprehensive services will be available to assist regional firms with the integration of automation into their production operations. These services will be marketed to industry as an area of unique technical expertise within the College's Center for Business and Industry.

In 1991/92 and 1992/93 additional seed dollars for program operations will be provided by Pennsylvania's Ben Franklin Partnership Program, with the goal that the program be self-supporting in 1993/94. Revenue to support ongoing operations will be generated from program tuition, consulting, and industry projects.

amtc/le/55

NORTHAMPTON COMMUNITY COLLEGE
MANUFACTURING FACILITIES



Appendix

- Evaluator's Report
- Grant Courses & Enrollment
- Course Outlines
- Automated Manufacturing Grant Advisory Committee
- Industry Donors

EVALUATOR'S REPORT

EVALUATION OF THE AUTOMATED MANUFACTURING TRAINING CENTER AT NORTHAMPTON COMMUNITY COLLEGE

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December, 1991

EVALUATION OF THE AUTOMATED MANUFACTURING TRAINING CENTER AT NORTHAMPTON COMMUNITY COLLEGE

INTRODUCTION

This is a report of the evaluation of the Automated Manufacturing Training Center (AMTC) at Northampton Community College. The center was made possible by a grant which extended from January 1, 1990 to September 30, 1991. It was primarily funded through the Cooperative Demonstration Project in High Technology from the U.S. Department of Education.

The Automated Manufacturing Training Center had 4 major goals: (a)to make accessible to area industry an automated manufacturing demonstration training center, (b)to provide training for managers of small companies to assist them in making decisions about implementing automation, (c)to improve technical and troubleshooting skills of workers in these companies, and (d)to increase technological awareness of educators so that they may promote to their students careers in manufacturing technology.

Planned project activities included: (a)soliciting equipment loans from vendors in order to fully equip the training center, (b)developing a training assessment model for determining company training needs, (c)developing a matrix of training components for different personnel levels, (d)developing four industry-specific training video tapes, (e)developing a technology awareness training session for educators, and (f)developing and implementing an extensive marketing plan to promote the program to business and industry.

Program targeted participants were employees of manufacturing firms involved in upgrading skill training in manufacturing technology and public school and community college teachers, administrators and guidance counselors.

Projected outcomes were: (a)increased number of small companies automating their manufacturing processes, (b)increased technological awareness and skill level among employees so that they may be more effective in their jobs, (c)increased awareness of technology and career options among educators so that students may receive better career counseling, (d)development of a training assessment model, curriculum models, training manuals and training video tapes for use locally and for national dissemination.

The program targeted manufacturing firms in four industry groups: (a)mechanical products; (e.g., metal, plastics); (b)electrical/electronics; (c)process (e.g., chemical, food, cement); and, (d)apparel/textiles.

Priority was given to meeting the needs of upgrading technical skill training of current workers to help them remain competitive. A second priority was establishing an automated manufacturing demonstration training facility.

EVAULATION DESIGN

The external evaluator was not involved in the project until February, 1991. Therefore, it was not possible to arrive at a design which would give desirable control of data collection to measure changes. It was not feasible to reconstruct a control group. No time series data were readily available. No systematic data was available about the level of technology of the companies nor the skill levels of the workers prior to the program. The design agreed upon emphasized primarily recall data from the key participants. Both formative and summative evaluation activities were included in the evaluation design.

This was a developmental project. Therefore, the design included collecting evidence by staff to help make decisions about changes or adaptations which should be made in the training curriculum and the laboratory. The staff needed to constantly scrutinize and rethink assumptions and activities which were a part of the program. Decisions were made about alternative courses of action and on more effective ways to implement the program.

Up to the time the external evaluator was on board, the college staff with the assistance of the advisory committee focused primarily on formative evaluation to help make decisions as the project was developed. Decisions about overall staffing, lab facilities, needs assessment, curriculum materials, videos, and marketing strategies required feedback information from relevant participants and advisory groups. Formative evaluation activities resulted in changes, modifications, and additions throughout the life of the project. The process and specific decisions which were influenced by formative evaluation will not be documented in this report. However, it is important to note that such evaluations were instrumental in creating an effective and efficient training project. Feedback from industry representatives, students, and staff was asked for and used when feasible. The formative data helped in making decisions during planning and implementation of the project.

The summative evaluation attempted to determine to what extent the goals of the project as projected in the proposal were met. Most of the evidence to answer this question came from data that was routinely collected in training classes or interviews with staff and advisory committee members. Reports written by staff were also used in documenting the project activities and results. Pre and post date to measure changes was not available. Reactions of workers at the end

of classes and judgments of staff and advisory committee members provided qualitative data to measure the outcomes. Anecdotal data and reports became the major sources of evidence with regard to evaluation of goal accomplishment. Evidence about performance of the workers at the work place after their skill training was available directly from two firms contracting for customized programs (Dent and Keystone) and indirectly from the committee members who had workers in the program. No evidence was collected directly from the workers themselves. Since this was a development project, the major short-term outcome was building a capacity to carry out training programs in the long run. Designing and building the laboratory and developing the curriculum were the means to providing automated technology training in the future. Training of workers and working with pilot companies were instrumental for testing the curriculum and needs assessment models. Building the credibility of the college to provide technology training was also a short term goal. Large scale training of workers and increased automation could only occur after the capacity to do so was in place. The length of the project did not permit time to bring about major changes in the technology levels of companies in the area.

The external evaluator visited the college six times from February to November, 1991. Observations by the evaluator were limited to classes, the laboratory, and one of the companies which served as a pilot case (for developing the needs assessment model, the curriculum, the laboratory, and the teaching activities).

Personal interviews were conducted with the advisory committee and staff members by the external evaluator at the end of the project. The advisory committee consisted of 34 members who were representative of all industry groups in the area. Some members represented local economic development organizations. Companies on the committee usually had experience with automation and had some previous contact with the college.

The committee had close working relationships with the staff in planning and carrying out the project. Members became major stakeholders and participated both formally and informally in counseling and providing staff and material resources.

The project took place within a context of an economic decline in the community, within the organizational structure of a community college, and within an informal structure which built linkages between the private sector and the college. Inputs included staff, materials, and financial resources plus an informal organization which resulted in a close working relationship between the college and the advisory committee. The process included the activities in

planning and implementing the training project, such as, needs assessment, curriculum development, training, marketing, and acquisition of resources. The products or outcomes of the project are the laboratory, the curriculum materials, the needs assessment model, and a marketing plan.

FINDINGS

Was an automated manufacturing training center made accessible to the area industry?

A model of a manufacturing facility with a flexible manufacturing cell and multiple demonstrations was developed for targeted audiences. The teaching facility allows students and workers to experiment with a "real" automation application in a simulated factory environment. Over the life of the grant various equipment (valued at over $300,000) was assembled to complete the laboratory for demonstrations and hands-on training. The lab was developed jointly with local industries. The equipment in the lab includes:

- nine computer work stations which are operational with Computer Aided Drafting/Computer Aided Manufacturing (CAD/CAM)
- a set of nine classroom TI 435 Texas Instrument Programmable Logic Controllers (PLC)
- Mech-El automatic wire bonder
- nine Allen-Bradley SLC 500/02 PLCs
- Bridgeport vertical end mill Computer Numerical Control (CNC) and Emco Turet Lathe CNC
- coordinate measuring machine (CMM), operational for connection with CAM
- Westinghouse and Gould Modicon PLCs
- Scorbot and Rhino robots
- industrial grade Puma robots
- Siemens automatic placement equipment
- software loaded in the machines and operational
- a flexible manufacturing cell operational but not yet at 100% capacity

The PLCs were donated by the manufacturers and the wire bonder by DuPont, and the other equipment was purchased at a reduced price. Local industry provided staff for presentations in classes. Teaching is done both at the college and "on site." Staff and the advisory committee members feel the laboratory is very adequate and will meet the technological needs of most small industries.

Were needs assessment models developed and piloted?

The original proposal projected conducting 7 needs assessment at 5 small and 2 large companies. In March 1991 this goal was changed from seven to three. Three companies were identified for developing the needs assessment models. A needs assessment model was developed and implemented at

Keystone Cement Company. Components of the model included a skills questionnaire administered to electrical maintenance personnel and interviews with top management, supervisors, production personnel, and maintenance personnel. From the results, staff proposed a comprehensive training program for Keystone employees. A series of courses was conducted to help prepare the company to implement automation at the firm. It was the opinion of the staff that three assessments would provide ample opportunity for further refinement and testing of the assessment model. Needs assessments were also conducted at Dent Manufacturing and Tarkett Inc.

Were training modules developed and piloted?

Four industry groups were targeted for developing the training programs: (a)mechanical, (b)electrical, (c)process, and (d)apparel. While the courses generally targeted these industries, the programmable automation training was generic and will be relevant across area industries. Developing curriculum materials consumed much staff time. Teaching materials were developed with assistance and advice of area industries. The content was reviewed by business employees and much of the teaching was performed by industry personnel employed as instructors.

The industry developed and taught over the period of the grant were: Competitive Manufacturing Strategy Series; Software Tools for Economic Justification; Process Control Systems; Basic Control Concepts; Computer Numerical Control (CNC) Programming; Programmable Logic Controllers (PLCs); Troubleshooting Programmable Logic Controllers; PLC Basics; Supervision in Modern Manufacturing Environment; APICS Materials Requirements Planning; Apparel Technology Series. Programs customized for keystone Cement were: Keystone Supervising in a Modern Manufacturing Environment; Keystone Industrial Controls Refresher; Keystone Control strategy; and Keystone Control Awareness. Keystone Cement was the primary firm with which the staff worked in piloting needs assessment tools and developing courses and training programs.

There were approximately 300 workers enrolled in the courses. Almost all students were white males. Almost half of the students were over 40 and only 1% were 22 or under. Almost all were proficient in English and almost all were currently employed. Only about 10% had not graduated from high school. In fact, about 40% had college training. The primary educational goal was for job promotion. Several wanted vocational certification; several were motivated to obtain college credit; and, several wanted to qualify for job placement. The typical method of teaching was hands-on training. Many of the workers were employed by organizations represented on the advisory committee. Practically all successfully completed the courses.

At the end of each course students completed a program evaluation form which asked their overall rating of the course, program strengths and weaknesses, whether they would recommend the course to someone else, their evaluation of the content, and suggestions for improvement. Data were available for 23 courses with 187 students. Forty-seven percent rated the course as being excellent, 43% as good and very few as fair or poor. These data indicate very high satisfaction with the courses. When asked if they would recommend the course to someone else, 96% said yes. When asked if the content of the coursed met their expectations, 91% said yes. Ninety-three percent felt the program facility was good or excellent. No tests were given in the classes so it was impossible to measure change in knowledge, attitudes, or skills.

A technology literacy training program for educators was developed. Project administrative and technical staff developed and taught the courses. Most seminars included tour(s) at local manufacturing facilities. The advisory committee identified sites. Five sessions were scheduled for intermediate units and five for college faculty and administrators. Technical literacy training for educators provided two classes in the Spring of 1991 with an enrollment of 16. Two spring classes for intermediate units were cancelled. In the Fall of 1991, six programs were offered to 20 high school educators and 70 college staff and administrators. Staff were satisfied with the number enrolled from the colleges, but not with the number of high school staff participating, (including vocational advisors).

Were the four videotapes developed?

The project proposed four industry-specific videotape productions. Work was first carried out in the apparel industry. The project goals were changed from four videotapes to three and the content of each was changed. One videotape was developed for the apparel industry, one for marketing the program, and one for educating students about control applications in industry. The apparel videotape, which is 20 minutes long, is completed. The marketing videotape will be completed by mid-December, 1991. This videotape promotes automation and its benefits plus describes the college program which resulted from the project. The controls applications videotape is also nearing completion and should be finished in early January. Industry consultants helped to write the scripts and review the content.

Was a marketing plan developed and implemented?

An advisory committee was established. Visits were conducted at target industries to identify needs. An initial marketing plan was developed. A data base was established and will be

kept current. Newspaper ads were used. Mail brochures were used extensively. Course descriptions were incorporated into college publications. Information about the program were disseminated at several technical societies meetings. Also, information was disseminated to several business and economic groups in the local area. Program information was disseminated at regional, state, and national conferences. One article about the project was submitted to a professional publication. Both staff and advisory committee feel an aggressive marketing plan is their number one priority for future program success. The advisory committee is very active in helping to strategize a marketing plan.

REFLECTIONS OF STAFF

Four key staff members were personally interviewed by use of an interview guide (Appendix). The interviewees included the director, the curriculum developer, the marketing manager, and the engineer who worked with the lab and was a liaison with the teachers. They were asked for their perceptions of the overall project, and what was most successful, what was least successful, extent to which the goals were accomplished, problems encountered, and goals for the future.

All had very positive attitudes about the project. The most successful perceived outcome was the establishment of the industry training lab as a demonstration and teaching facility. Other successful activities included establishing an industry partnership between the college and the community and assembling an effective and efficient credible staff. The staff perceived themselves as highly qualified and high in production. Establishing a set of courses which were needed by industry was identified as a major benefit of the project. Company managers were thought to be satisfied with the courses. Staff felt the worker participants benefited.

Staff felt the laboratory was and continues to be a major resource to the community. The laboratory makes it possible to demonstrate the most up-to-date automation. Setting up the laboratory took place over a short time span and it is now fully equipped. The feedback from industry has been positive. The laboratory resources have been effectively supplemented by those of the microelectronics laboratory. The laboratory serves a unique need. The laboratory supplements work of the vo-tech schools and activities at Lehigh University. Since it is not feasible for small industries to shut down their plants to experiment with a new process or product, the laboratory provides that opportunity. Specific cases were cited where industry had used the laboratory for problem solving and product development.

One staff member suggested de-emphasizing management consulting with more emphasis on technical service to industry.

The videos are not all complete but filming has been done for all of them. The apparel video is complete; the control and marketing videos are in production.

A full scale marketing effort was postponed because this was a development project so that a product had to be available to disseminate. Testing was needed before it could be sold. There is a feeling that everything is in place to develop an aggressive marketing program. During the grant period, the only problem seemed to be timing in that the project was always evolving so that marketing became difficult. The lab was constantly being developed and new courses prepared. The activities now can be sequenced into a package for marketability.

Publicity about the project was disseminated locally, within the state, and at national technical society conferences.

In the future, the target industries will be the small and medium sized ones. The geographic area served will be the eastern portion of Pennsylvania. The demonstration training center will be marketed using mass media, meetings, and personal visits. The goal will be to create an image of Northampton Community College as a major actor in industrial training. This will result in industry perceiving the college as being credible and relevant to meeting their technical training needs. For ongoing financing of automated manufacturing programs, resources include tuition, consulting fees, public funds, and contracts with specific industries.

In summary, the staff felt the project was very successful in attaining the purpose of the grant. A lab was developed and courses developed to meet the technical training needs of small industries in the area. The college formed a close working partnership with the industries. Industry contributed staff and management resources plus financial assistance. The students were highly satisfied with the training. A model is in place and there is much optimism that will maximize utilization of the training center.

REACTIONS OF ADVISORY COMMITTEE MEMBERS

An advisory committee comprised of area industry managers and executives worked with the staff in planning and developing the training center. The board met three times per year, but sub-committees met more often. The number of members was 34. Personal interviews by telephone were conducted with 27 of them during the months of August and September. An interview guide was used and included questions about overall reaction to the grant project, perceived purposes, most and least beneficial parts, how they participated in the project, perceived benefits, and changes they would suggest for the future (Appendix). All members were very willing to talk

about the project even though they varied considerably on how much they or their employees were involved.

When asked how they felt in general about the project, almost all were very positive in their response. They felt the project was going well, the employees who participated were enthusiastic, it was a good service for regional businesses, it is a good resource which will go further, it is a good resource for technical training in the area, the staff is excellent, good relations were established between businesses and the college, and the college has made excellent progress in the last year to set up the lab, develop courses, and form a viable partnership with industry. Only one member had a negative assessment of the project primarily because he did not agree with timing of working on the goals.

The perceived purposes of the project focused on helping local industries with adoption of automated technology in order to compete in the market place. Most members mentioned the practical training for engineers and technicians. Using the lab as a training resource was noted by several. A few mentioned skills enhancement. One said the project helped businesses make decisions about what technology to use and how to use it. Quite similar, one said the project helped companies utilize automated equipment to control manufacturing processes and advise management on issues related to technology.

Members were asked what was most beneficial. The general response included the idea of a college working with local industries to address specific practical training needs. Some members mentioned specific technologies, such as, CAD, CNC and Programmable Logic Controller applications. The value of a customized needs assessment was mentioned. One said having the faculty show industry how to integrate technology and educate industry on how to maintain good quality. Having academics involved provided unbiased training and advice on a practical level was perceived as beneficial. The quality staff were mentioned. Several said the environment is ready for this resource.

A few were concerned about low attendance in some seminars and courses, especially those for school counselors and administrators. Several felt that marketing needs to be given priority.

Most members liked the generic approach to the training rather than customizing the training to each factory or plant whereas a few cited the benefit gained from custom designing a program for each unit. Most felt technicians can adapt to different machines if they are taught the basics.

The college is seen as listening to the local industries and to meeting their needs on a practical basis. Most had

suggestions for aggressively marketing the project. The unit has been well supported by the administration within the college.

One mentioned the need for the college to continue and expand their working relationships with other groups in the area; such as, Chambers of Commerce, vo-tech schools and Lehigh University. One said the project shows "mom and pop" what they need to do to survive. Several said they would be glad to help in further marketing the program. They emphasized that mass media alone will not do it. There must be more face-to-face promotion and demonstrations at the lab for industries. The college is serving as a mediator between producers of new technology and companies who might use it.

One member from a computer firm helped develop Software Tools for Economic Justification. He received much personal satisfaction from being involved in the project. He and his colleague felt their contributions were appreciated and respected by the college staff. They felt they made a difference in shaping the project. They suggested a more structured format for some courses and case studies. Financial statements and strategic objectives should be integrated, using a spreadsheet-based model.

One member provided facilities for a training program, gave some equipment, and did design engineering work. He felt the center has meaningful objectives and provides and element of the real world mixed in with college training. He was impressed with the lab and is more than willing to participate in the program. He was surprised to see a lab with state of the art hi-tech engineering. He felt some of the management seminars could be strengthened. Another member from a large company felt the program was badly needed in the community. The company had four workers in a PLC class. They plan to send more for the CAD system. He felt the courses were well presented and teachers were very knowledgeable. The workers were very satisfied with the courses. He perceived the college course emphasis as programming, not operations. He felt a negative stigma among youth about the factory work image and the programs will help overcome this image.

As a result of the grant project, the members feel a sense of loyalty and commitment to the College. The board overwhelmingly supports the automated manufacturing programs, feels they meet a real need, perceives the project as being successful, and is committed to helping further develop this resource.

Reactions from an industry which helped pilot the project

One of the industries with which the project provided an opportunity to test and develop automated manufacturing

programs was Keystone Cement, a manufacturer of cement. A needs analysis was conducted at the plant, management attended seminars on technology, and workers attended training courses. An interview was conducted with the supervisor of the electricians and the evaluator visited the company site. The supervisor was very enthusiastic about the project. He felt he benefited as well as the company. He said the college is doing an outstanding job. He measured benefits by three criteria: technical people became more proficient in their work; people adjusted to the new technology with positive attitudes; and workers exhibited greater skills in using the new technology. His perception at the beginning of the project was that training should be 90% technical and 10% human relationships. At the end he felt it should be 60% human relationships and 40% technical.

The business operates 24 hours per day. The supervisor said the workers have improved their performance. He rated the courses as A+. He has developed skills to read the book and solve problems of repairing new equipment. Prior to the training he did not have the skill or confidence to do this. He has gained skills in setting up a training program. He came to understand how to modernize and why. About 60 people were involved at all levels. The training program developed a positive attitude among the workers about using new equipment. They no longer resent it. There was in-house training as well as at the college. The supervisor felt the workers increased skills in problem solving so that he deals with only a few problems. The operators can trouble shoot with the training they have received. They are putting in a screen and flow meter. The operator knows why the read light goes on. He has had no negative feedback from the workers and felt the money they spent on training was well worth it.

He felt their problems in using new technology were not unique. He felt all companies need to keep up it technology advanced. He observed that the workers became more loyal to the company and have a more favorable attitude as a result of Northampton's training.

SUMMARY AND CONCLUSIONS

Northampton Community College developed an Automated Manufacturing Training Center made possible by a grant from the United States Department of Education. The training center had four major goals: (a)to develop an automated manufacturing demonstration center, (b)to help managers make decisions about automation, (c)to improve technical skills of workers, and (d)to increase technological literacy of educators. Major planned activities were to solicit equipment in order to equip the laboratory; to develop a training assessment model; to develop a training curriculum for company management and workers; to develop training

videotapes; to develop technology training sessions for educators; and to market the program to potential users.

The 21 month project was evaluated using both formative and summative activities. Decisions about the development of the laboratory, curriculum, and training of technicians, management, and education personnel made use of evidence collected throughout the project. The summative evaluation collected evidence about the extent to which the goals were achieved. Most of the data was reflective in that key participants were asked for their judgments of project outcomes and their overall impressions of the project. Students completed questionnaires at the end of the courses to determine their satisfaction.

The major organizational strategy used was a linkage between the college and an advisory committee of area industry representatives. As a result, the college and the private sector collaborated in planning and carrying out the project. The industries feel a sense of ownership in the training center. The college has made commitments to support the center even after outside funds end, using internal resources and tuition as primary funding sources.

An automated manufacturing training center has been adequately equipped to provide training and demonstrations in automated manufacturing. Students and workers can experiment with a "real" automation applications in a simulated factory environment.

Several courses were designed and offered to students, both technicians and management, during the period of the grant, both at the college and in-plant. In at least one case, the training programs were customized for the company. Students said the content of the courses met their needs and they said they would recommend the courses to others. Courses for educators, both public school and college, were offered with larger attendance from the college faculty. Additional efforts are being made to reach more high school counselors encourage students to consider technology careers.

Three videotapes were developed, one for training in the apparel industry, one on the Programmable Logic Controller, and one for marketing the program.

Marketing activities were planned and initiated during the grant period, but the major emphasis on marketing will occur during the 1991/92 academic calendar year, following completion of the grant. During the grant period awareness of the need for automation to compete in the national and world markets was communicated using brochures and other forms of mass media. Also, personal visits were used to publicize the training programs and technical expertise available at the College. In 1991/92 priority efforts will

be on marketing, since the laboratory and curricula are in place for effective training delivery.

Both staff and advisory committee members were very satisfied with the project. The advisory committee said the training programs meet a real need in the local area. They felt the collaboration between the college and the local industries on this project was very productive and has great potential for the future. They felt the training programs will help local industries adopt automated technology in order to compete in the market place. Staff and company representatives felt the automation being demonstrated and taught is the latest technology. The staff and the college have high credibility. Marketing this resource in the community to small and medium sized companies will be given priority. A longer range goal will be counseling youth in order to prepare them for the automated technology of the future.

APPENDIX

STAFF INTERVIEW GUIDE FOR EVALUATION OF THE NORTHAMPTON COMMUNITY COLLEGE AUTOMATED MANUFACTURING TRAINING CENTER

September,1991

1. How do you feel about the Automated Manufacturing Training Center project? Why?

2. What do you consider to be the most successful activities of the project? The least successful?

3. How well were the following goals achieved? a) make accessible an automated demonstration training center; b) increase management knowledge about automation and application; c) determine training needs; d) improve skills of workers; e) increase knowledge of educators about technology.

4. What strategies were most successful in carrying out the project? The least successful?

5. What problems did you encounter in carrying out the project?

6. What goals should be pursued in continuing this project? Which ones should be de-emphasized?

7. Should the project model be disseminated to other potential adopters? How?

8. What were your responsibilities for carrying out this project?

APPENDIX

Advisory Committee Interview Schedule
Northampton Community College
Automated Manufacturing Training Center

1991

1. In general, how do you feel about the Northampton Community College Automated Manufacturing Training Program?

2. What do you see as the purposes of this project?

3. What are the most beneficial parts of the project? Least beneficial?

4. What part of the project is most valuable to your company?

5. In what ways have you and your company participated in the project?

6. Can you identify any benefits from this participation?

7. What do you feel are the most important training needs of your company?

8. What training needs can be served by this project?

9. To what extent is the manufacturing community informed about the project?

10. What can be done to create awareness and interest in this project among the manufacturing community?

11. How can the project be changed in order to better serve the training needs of manufacturers in this area?

GRANT COURSES
AND
ENROLLMENT

NORTHAMPTON COMMUNITY COLLEGE
AUTOMATED MANUFACTURING TRAINING CENTER
PROJECT # V100A00063-90

GRANT COURSES & ENROLLMENT

INDUSTRY TRAINING PROGRAMS	# Times Offered	# Stus.
Management Awareness Programs		
Competitive Manufacturing Strategy Series (12 hrs)	1	20
Software Tools for Economic Justification (4 hrs)	1	5
Supervising in a Modern Manufacturing Environment (6 hrs)	2	31
APICS: Materials Resource Planning (22.5 hrs)	1	14
Apparel Technology Training Series (8 hrs)*	1	21
Hands-On Training Programs		
Process Control Systems (40 hrs)	1	3
Basic Control Concepts (40 hrs)	2	30
Programmable Logic Controllers (40 hrs)	4	50
Troubleshooting Programmable Logic Controllers (40 hrs)	2	21
PLC Basics (3 hrs)	3	30
CNC Programming (40 hrs)	1	6
Computer Aided Manufacturing (24 hrs)	1	5
Customized Programs for Keystone Cement Company		
Control Strategy for Management (4 hrs)	2	28
Control Awareness (2 hrs)	2	29
Supervising in a Modern Manufacturing Environment (16 hrs)	2	23
Industrial Controls Refresher (12 hrs)	2	8
Customized Program for Dent Manufacturing Co.		
CNC Programming for Operators (48 hrs)	1	9
Customized Program for Instrument Society of America		
Programmable Logic Controllers (6 hrs)	1	15
Totals	30	348
PROGRAM FOR EDUCATORS		
Technological Literacy (1.25, 3, & 6 hours)	7	99

* 2 courses were offered in this series. Because course length was short, it is counted here as one program.

COURSE OUTLINES

NORTHAMPTON COMMUNITY COLLEGE
AUTOMATED MANUFACTURING TRAINING CENTER
PROJECT # V100A00063-90

OUTLINES

INDUSTRY TRAINING PROGRAMS

Management Awareness Programs
Competitive Manufacturing Strategy Series (12 hours)
Software Tools for Economic Justification (4 hours)
Supervising in a Modern Manufacturing Environment (6 hours)
APICS: Materials Resource Planning (22.5 hours)
Apparel Technology Training Series (8 hours)

Hands-On Training Programs
Process Control Systems (40 hours)
Basic Control Concepts (40 hours)
Programmable Logic Controllers (40 hours)
Troubleshooting Programmable Logic Controllers (40 hours)
PLC Basics (3 hours)
CNC Programming (40 hours)
Computer Aided Manufacturing (24 hours)

Customized Programs for Keystone Cement Company
Control Strategy for Management (4 hours)
Control Awareness (2 hours)
Supervising in a Modern Manufacturing Environment (16 hours)
Industrial Controls Refresher (12 hours)

Customized Program for Dent Manufacturing Co.
CNC Programming for Operators (48 hours)

Customized Program for Instrument Society of America
Programmable Logic Controllers (6 hrs)

PROGRAM FOR EDUCATORS

Technological Literacy (1.25, 3, & 6 hours)

Northampton Community College

COMPETITIVE MANUFACTURING STRATEGY SERIES

The Privately Held Manufacturing Firm and The Need to Make Capital Investments

Outline of Topics

Session I: Corporate Planning "SHOULD" Drive Demand for Capital Investments

1. Examples of Capital Investment Decisions in a Manufacturing Company Environment
2. Clearing-up the "Fog-Factor" in the Jargon of Corporate Planning
3. Never Running Out of Ways to Invest Capital in the Domain of Strategic Planning, Tactical Planning and Operational Control
4. Introduction to the AMEDCO Case

Session II: A Case Study of a High Technology Manufacturing Firm

1. A Review of Case Background -- Organization, Customers/ Marketplace, Competition, and Technologies
2. Critical Decisions About Capital Investments in AMEDCO -- Past, Present, and Future
3. Learning From "Monday-Quarterbacking"

Session III: The Total Analysis Technique (NOT JUST FINANCIAL) for Evaluating Capital Investment Opportunities

1. Establishing the Benchmark Valuation of a Going Concern's Cash Flows and Required Investments
2. Driving the Numbers (NOT DRIVEN BY) and the Arithmetic of Finance to Account for Time and Risk Considerations
3. A Potpourri of Manufacturing Investment Opportunities

SOFTWARE TOOLS FOR ECONOMIC JUSTIFICATION

I. Financial Justification

- A. Definition
- B. Quantitative vs. Qualitative Justification
- C. Risk vs. Return
- D. Scopes of Justification

II. The Justification Process

- A. Verify Business Goals
- B. Define and Quantify All Benefits (Tangible and Intangible)
- C. Define and Quantify All Costs
- D. Evaluate and Retire Risks
- E. Calculate Financial Rate of Return

III. Automation Case Study: Using Lotus Spreadsheet

SUPERVISING IN A MODERN MANUFACTURING ENVIRONMENT

Course Outline

I. Introduction & Welcome

II. The Modern Manufacturing Environment

- A. The Global Marketplace
- B. Total Quality Management
- C. Technological Change

III. Workforce Implications

- A. Organizational Impact
- B. The Increased Need for Flexibility
- C. Impact on Job Skill Levels
- D. The Need for Team Building
- E. Impact on Union/Management Relations

IV. Job Design

- A. Job Enlargement
- B. Job Enrichment
- C. Worker Motivation
- D. Cross Training Employees

V. Maraging Change

- A. Nature of Change
- B. Understanding Resistance to Change
- C. Overcoming Resistance to Change
- D. The Supervisor as a Change Agent

VI. Generating Employee Involvement / Team Building

- A. The Advantages of Working in a Group
- B. Group Dynamics
- B. Group Problem Solving Exer ise
- C. Group Planning for Change

VII. Dealing with Conflict

- A. Influence of Personal Background & Attitudes on Perception
- B. Definitions (Winner/Loser)
- C. Approaches for Handling Conflicts

VIII. Managing Stress

- A. Definitions
- B. Productive & Unproductive Responses to Change/Stress
- C. Effective Coping Techniques

super/le/54

APICS - MATERIAL REQUIREMENTS PLANNING

I. Concepts and Principles

- A. Fundamentals
- B. Order Point and Priorities
- C. Input/Out

II. Interfaces

- A. Engineering
- B. MPS
- C. PAC
- D. CRP
- E. Purchasing
- F. Finances
- G. Just-in-Time Considerations

III. System Characteristics

- A. Basic Design Specs and Frequencies
- B. Priority Planning
- C. Order and Safety Policies
- D. Firm Planned Orders
- E. Bill of Material Structuring

IV. Logic

- A. Sources of Requirements
- B. Item-related Data
- C. Updated Time-phased Data
- D. Product Structure Processing

V. Functions

- A. Material Planning
- B. Replanning
- C. Simulation

VI. Implementation and Operation

- A. Justification and Organization
- B. Education and Training
- C. Prerequisites
- D. Design and Development Methodology
- E. System Testing

APPAREL TECHNOLOGY TRAINING SERIES
NORTHAMPTON COMMUNITY COLLEGE
BETHLEHEM, PENNSYLVANIA

Sessions:

April 22 — Keystone 217 & 218

INVESTING IN APPAREL TECHNOLOGY
- . New World, New Rules: Competing Through Technology
- . Evaluating Technology Alternatives
- . Financial Resources

April 29 — College Center 261 & 262
REALIZING BUSINESS GOALS I: REDUCING THROUGHPUT TIME
- . Preproduction Planning
- . Electronic Data Interchange (EDI)
- . Real-Time Production Control

May 6
ATLANTIC APPAREL CONTRACTORS ASSOCIATION MACHINE SHOW

May 13 — College Center 261 & 262
REALIZING BUSINESS GOALS II: IMPROVING QUALITY
- . Quality Improvement
- . Unit Production Systems
- . Pressing, Finishing, & Packaging
- . Commercially Available Automated Equipment

May 20
TECHNOLOGY IMPLEMENTATION — College Center 261 & 262
- . Changing Work Culture
- . Training
- . Equipment Maintenance
- . Conclusion: Technology Impact on Bottom Line Performance
- . Resources / Next Steps

* * * *

Special thanks to the Apparel Technology Subcommittee
for spearheading development of this program.

Walter Bastinelli Jr., A & H Sportswear
Brant Carlton, Participative Systems
Robert Cavallucci, The Greif Companies
Arnold Delin, Atlantic Apparel Contractors Assocation
Antoine ElChaar, A & Z Industries
Lin Erickson, Northampton Community College
Charles Krasnov, Gee-Kay Knit Products
Michael Shay, Participative Systems
Mark Stutz, Bru-Mar Manufacturing
Dave Taylor, Manufacturing Services Extension Center

APPAREL TECHNOLOGY TRAINING SERIES
SESSION I: INVESTING IN APPAREL TECHNOLOGY

Location: Northampton Community College
Keystone 217 & 218

Date & Time: April 22, 1991
4 - 9 p.m.

Agenda:

4:00 p.m. **INTRODUCTIONS & WELCOME**

Lin Erickson, Center for Business & Industry/
Northampton Community College
Michael Shay, Participative Systems

4:15 p.m. **NEW WORLD, NEW RULES: COMPETING THROUGH TECHNOLOGY**

Prakash Bhatt, Vanity Fair

5:30 p.m. **EVALUATING TECHNOLOGY ALTERNATIVES**

Matthew Mehrman, Philadelphia College of Textiles
Robert Cavallucci, The Greif Companies
Walter Bastinelli Jr., A & H Sportswear

6:00 p.m. **DINNER**

7:00 p.m. **EVALUATING TECHNOLOGY ALTERNATIVES (cont.)**

7:50 p.m. **FINANCIAL RESOURCES**

Jack Cook, Northampton County Development Corp.
Sandra H. Landino, Small Business Development Center

8:50 p.m. **CLOSING**

APPAREL TECHNOLOGY TRAINING SERIES
SESSION I: INVESTING IN APPAREL TECHNOLOGY
APRIL 22, 1991

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APPAREL TECHNOLOGY TRAINING SERIES
SESSION II: REDUCING THROUGHPUT TIME

Location: Northampton Community College
College Center 261 & 262

Date & Time: April 29, 1991
4 - 8 p.m.

Agenda:

4:00 p.m. **INTRODUCTIONS & WELCOME**

Lin Erickson, Center for Business & Industry
Northampton Community College

4:05 p.m. **PRODUCTION PLANNING**

Matthew Mehrman, Philadelphia College of Textiles

5:15 p.m. **ELECTRONIC DATA INTERCHANGE (EDI)**

Stephen R. Harper, Sure Fit Products Co.
Shawnee Kemmerer, A & H Sportswear

6:15 p.m. **DINNER**

6:50 P.M. **REAL-TIME PRODUCTION CONTROL**

Dr. Emory Zimmers, Lehigh University
Shandu Marathe, Lehigh University

7:50 p.m. **CLOSING**

APPAREL TECHNOLOGY TRAINING SERIES
SESSION II: REDUCING THROUGHPUT TIME
APRIL 29, 1991

Presenters:

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PROCESS CONTROL SYSTEMS

I. Introduction

- A. Class Composition
  1. Experience
  2. Individual objectives
  3. Training/education
- B. Overview
  1. Course outline
  2. Review of objectives
  3. Scope of course
  4. Background of controls

II. Control System Basics

- A. Process Control Definitions
- B. Types of Control
  1. Control classifications
  2. Control actions
  3. Models
- C. Classical Description of Control Systems
  1. Transfer functions
  2. Block diagrams
  3. Response characteristics
- D. Modern Systems
  1. Description of complex systems
  2. Linear & non-linear systems
  3. Adaptive controls
  4. Neural networks

III. Components

- A. General
  1. Scope of section
  2. Component guidelines
  3. Hierarchy of components and control devices
- B. Sensors
  1. Evaluation criteria
  2. Methods for selection
  3. Types of sensors
  4. Vendor presentations - banner, A-B vision
- C. Actuators
  1. Evaluation criteria
  2. Methods for selection
  3. Types of actuators
  4. Vendor presentation - Compumotor, ?

D. Analog and Digital Devices
   1. Analog signal conditioning
   2. A/D and D/A converters
   3. Digital devices
   4. Logic functions

E. Information Processing
   1. Requirements analysis
   2. Programming alternatives
   3. Operating system constraints
   4. Data base considerations
   5. Alternatives

F. Processors for Control Systems
   1. Applications
      a. general functions
      b. types of devices
      c. scope of installations
   2. Features
      a. operations
      b. I/O capability
      c. software/firmware
   3. Devices
      a. Single Board Computers (SBCs)
      b. Programmable Logic Controllers (PLCs)
      c. Personal Computers (PCs)
      d. Micro Computers
      e. Mini Computers

IV. Control System Structure and Design

A. Structure of Control Systems
   1. Control vrs information systems
   2. Hierarchy of information
   3. Control hierarchy

B. Communications
   1. General concepts
   2. Network topologies
   3. Common protocols

C. The Analysis and Design Process
   1. Basis - existing systems are the basis of the analysis process.
   2. The analytical process
   3. Functional description
   4. Flow diagrams
   5. Structured definitions
   6. Logical statements
   7. Design specifications

V. Models and Simulations

A. General Considerations
   1. Definitions
   2. Objective of models, simulations, and emulations
   3. Mathematical models vrs graphic models

B. Theoretical Models
   1. Math based upon empirical data
   2. Mathematical approximations
   3. Tests of model

C. System Modeling
   1. Use of math for reference
   2. Best approximation of real world
   3. Comparison of math to practical model
   4. Examples of modeling programs available

VI. Applications

A. The Project Life Cycle

B. Specific System Applications
   1. Automated manufacturing lines
   2. Special applications

CLASS EVALUATIONS & CLOSURE

BASIC CONTROL CONCEPTS

I. INTRODUCTION TO BASIC CONTROL CONCEPTS

- A. Introduction to Course
  - 1. Introduction of Course Participants
  - 2. Review of Course Objectives
  - 3. Review of Course Outline
- B. Control Definitions
  - 1. Process Control Systems
  - 2. Feedback (Closed Loop) Control System
  - 3. Open Loop Control System
  - 4. Servo System

II. CONTROL SYSTEM BASICS

- A. Classifications of Control
- B. Control Actions (Bivalue/PID)
- C. Response Characteristics

III. NUMBER SYSTEMS/BINARY CODES

IV. DOS PRIMER

- A. Booting
- B. Common commands

V. CONTROL SYSTEM COMPONENTS

- A. General
  - 1. Definitions
  - 2. Evaluation Criteria
- B. SENSORS
  - 1. Types of Sensors
  - 2. Methods for Selection
- C. MOTORS
  - 1. Types
    - a. steppers
    - b. servos
    - c. linear
  - 2. Methods for Selection
  - 3. Operation
  - 4. Motor Controls (PC, PLC, PID)
- D. ACTUATORS OTHER THAN MOTORS
  (Hydraulic/Pneumatic Linear, Gear Driven Cams, emphasis on Solenoids, & Relays, Solid State Relays and Optal Isolators)

E. ANALOG AND DIGITAL DEVICES

1. A/D Converters
2. D/A Converters
3. Digital Devices
4. Logic Functions

F. PROCESSORS

1. Alternatives: Single Board Computer, PLC, PC, Micro and Mini Computers
2. Operating Systems
3. Memory (RAM, ROM, PROM, EPROM)
4. Programming Alternatives
5. Database Considerations
6. Selection Process/Requirements Analysis (Discuss using examples of control problems at their plants.)

VI. COMMUNICATIONS

A. General Concepts
1. Network
2. Bandwidth
3. Response time
4. Serial
5. Parallel

B. Common Protocols
1. RS 232
2. RS 422/423
3. Current loop
4. ethernet loop (802.3)
5. MAP (802.4)
6. Token ring (802.5)
7. SNA (IBM)
8. Proprietary

C. Buses

VII. PROGRAMMABLE LOGIC CONTROLLERS

A. PLC Applications
B. Logic Concepts
C. Basic Principles of Operation
D. Hardware
E. Ladder Logic

VIII. OPERATOR INTERFACE TERMINALS

A. Types
B. Methods for Selection

IX. STRUCTURE OF CONTROL SYSTEMS

A. Control vs. Information Systems
B. Hierarchy of Information
C. Control Hierarchy
D. Example: Distribution Center

X. APPLICATIONS

A. Automated Manufacturing Lines
B. Numerical Control Production Systems
C. Robots: Assembly, Inspection, Degrees of Freedom
D. Material Handling Systems
E. Automatic Inspection Systems
F. Flexible Manufacturing Systems

XI. TROUBLESHOOTING

PROGRAMMABLE LOGIC CONTROLLERS
(40 hours program)

I. INTRODUCTION TO PROGRAMMABLE LOGIC CONTROLLERS
- A. Definition
- B. Historical Background
- C. Basic Principles of Operation
- D. PLCs vs Other Types of Controls
- E. Typical Areas of PLC Applications
- F. PLC Size & Application
- G. The Benefits of Using PLCs

II. PREREQUISITE MATHEMATICAL UNDERSTANDING
- A. Number Systems & Binary Codes
- B. Logic Concepts

III. BASIC PRINCIPLES OF OPERATION
- A. Processors, Power Supply System, & Programming Devices
  1. Processors & Processor Scan
  2. Subsystems, Error Checking, Diagnostics
  3. The System Power Supply
  4. Programming Devices
- B. The Memory System & I/O Interaction
  1. Memory Types
  2. Memory Structure & Capacity
  3. Memory Organization & I/O Interaction
  4. Memory Map Example and I/O Addressing
  5. Memory Considerations

IV. DISCRETE INPUT/OUTPUT SYSTEMS
  1. I/O Rack Enclosures and Table Mapping
  2. Remote I/O Systems
  3. Discrete Inputs
  4. Discrete Outputs
  5. Interpreting I/O Specifications

V. BASICS OF PLC PROGRAMMING
- A. Basic PLC Instructions and Addressing
  1. Types of instructions
  2. Instruction addressing
  3. Branch instructions
- B. Programming Timers
- C. Programming Counters
- D. Program Flow Control Instructions
- E. Program Data Manipulation Instructions
- F. Entering a Ladder Diagram
- G. PLC System Documentation

VI. IMPLEMENTING & PROGRAMMING THE PLC
- A. Control Definition
- B. Control Strategy
- C. Implementation Guidelines
- D. Programming Organization

VII. GUIDELINES FOR INSTALLATION, START-UP, AND MAINTENANCE
- A. System Layout
- B. Power Requirements and Safety Circuitry
- C. Noise, Heat, and Voltage Considerations
- D. I/O Installation, Wiring, and Precautions
- E. PLC Start-up, and Checking Procedures
- F. PLC System Maintenance
- G. Basic Troubleshooting

VIII. PLC SYSTEM SELECTION GUIDELINES
- A. PLC Sizes and Scope of Applications
- B. Process Control System Definition

PROPOSED LABORATORY EXERCISES:

RECOMMENDED TEXT: Programmable Controllers: Theory & Implementation/Industrial Text Co.

TROUBLESHOOTING PLC'S

I. Introduction to PLC's and Hardware

- A. Introduction
- B. PLC Basics Review
  1. PLC exam overview
  2. Pretest
- C. Hardware Review
  1. PLC components
  2. I/O modules
  3. I/O devices
  4. Programming devices
  5. PLC logic & symbology
  6. I/O addressing

II. Software Hardware & Electrical Considerations

- A. Schematic/Logic Review
- B. PLC Software
- C. Utilizing a Personal Computer
- D. Hardware Configurations
- E. Layout of a Cabinet
- F. Electrical Considerations
- G. Safety Circuits
- H. E-Stop and MCR Control

III. Logic Concepts & PLC Diagnostics

- A. Control Logic Concepts
  1. Entry
     a. on/off, stop/start
     b. timer/counter
     c. digital I/O
  2. Modification
- B. PLC Diagnostics
  1. Hardware faults
  2. I/O & cabling faults
  3. Logic faults & interrupts
  4. Forced I/O

C. Real World Applications
   1. Basic conveyor
   2. Material handling
   3. Machine control "assembly"

IV. Control Circuits and Networking

A. Analog and Register I/O and Control Circuits
   1. Pressure or flow
   2. Speed control/demand
   3. Thumbwheel setpoint
   4. LED readout/display
   5. Multiplexing

B. Networking, "Distributed Control" and Remote I/O
   1. Methods
   2. Advantages/disadvantages

V. Programming Sensors & Interface

A. Structured Programming Basics
   1. Function block
   2. Top/Down techniques
   3. Ladder logic vs. boolean exercises

B. Discussion of Sensors
   1. Types
   2. Applications

C. Use of Operator Interface Devices
   1. Control interfaces
   2. Diagnostics and displays
   3. Graphics packages

PLC BASICS SEMINAR OUTLINE

1. WELCOME AND PERSONAL INTRODUCTION

2. WHAT IS A PLC?

3. HISTORY OF THE PLC
   - A. ORIGIN
   - B. ORIGINAL INTENT OF THE PLC
   - C. FLEXIBILITY AND SIMPLICITY
   - D. ARE PLC'S COST EFFECTIVE?
   - E. WHEN, WHERE, HOW AND WHY

4. BASIC COMPONENTS OF A PLC
   - A. CENTRAL PROCESSING UNIT
   - B. POWER SUPPLY
   - C. I/O SYSTEM

5. LOGICAL FORMAT
   - A. HAND LOADERS, CRT'S, DATA LOADERS AND PC'S/PC SOFT WARE
   - B. LADDER LOGIC
   - C. STATEMENT LOGIC
   - D. STRUCTURED PROGRAMMING

6. REVIEW OF BASIC CONTROL CIRCUIT DIAGRAMS
   - A. RELAY LOGIC EXAMPLES
   - B. PLC WIRING DIAGRAM EXAMPLE
   - C. PLC LADDER LOGIC EXAMPLES
   - D. PLC STATEMENT LIST LOGIC EXAMPLES

7. EMERGENCY STOP AND SAFETY CIRCUIT CONTROL

8. ELECTRICAL NOISE PROBLEMS AND POTENTIAL SOLUTIONS

9. PLC APPLICATIONS AND EXAMPLES

10. QUESTION AND ANSWER

NOTES:

OVERHEAD SLIDES WILL BE UTILIZED

UTILIZE HANDOUTS SUCH AS THE WESTINGHOUSE PLC ARTICLES AND THE PLC EXPERT EXAM

INTERACTION WITH THE CLASS WILL BE ENCOURAGED

CNC PROGRAMMING
[INSTRUCTOR NOTES]

OUTLINE

CLASS 1: INTRODUCTION / HISTORY / COORDINATE SYSTEMS

1. Bridgeport Demo. PROGRAMS :5005; 9 Spirals
   :5007; Surface Program

2. Introductions: Personal introduction & teaching style
   Course content and materials
   Students as to background and/or reasons

3. Class Lecture:

   1. What is NC, CNC & Programming

   2. History of NC to the present; (show OH)

   3. Advantages/Disadvantages of NC, CNC; (show set of OH)

   4. Machine Control Unit; (show 2 OH)
      a. measurement systems; optical, magnetic encoders
      b. drive system; stepper, servo AC/DC
      c. ball screw vs lead screw and others
         [open machine control unit]

   5. Programming Languages; word address, APT, others

   6. Coordinate Systems & Basic CNC Programming Concepts
      a. coordinate systems
         1. rectangular (Cartesian) X,Y,Z
         2. polar system R,Θ,Z
         3. spherical system R,Θ,Φ
      b. zero points
         1. machine zero
         2. program zero
         3. local zero
      c. absolute (G90) vs incremental (G91) definition
      d. basic machine motions
         1. G00 - rapid
         2. G01 - linear
         3. G02,03 - circular interpolation

7. HOMEWORK: Absolute & Incremental Definition

CNC PROGRAMMING
[INSTRUCTOR NOTES]

OUTLINE

CLASS 2: WORD-ADDRESS FORMAT/BASIC PROGRAMMING/TRIG REVIEW

1. Review homework assignment #1 (absolute vs incremental)

2. Review of Rectangular & Polar Coordinate Systems

3. Trigonometry Review:
   Handout to class on trig functions
   homework assignment #2 (polar coordinates)

4. Word-Address Format Structure (G-Code Programming)

5. Active G-Codes on start up (initial conditions)

6. Decimal Point Requirement

7. Basic Programming Codes:
   G90 - Absolute
   G91 - Incremental

   G00 - Rapid Traverse
   G01 - Linear Interpolation
   G02 - CW Circular Interpolation
   G03 - CCW
   G04 - Dwell

   M (Miscellaneous) Codes

8. Starting a Program / Ending a Program

9. Demonstration of concepts with step by step explanation of each programming code.

10. Sample Program Assignment

CNC PROGRAMMING
[INSTRUCTOR NOTES]

OUTLINE

CLASS 3: DRILLING / MACHINE OPERATION / PROGRAM ENTRY

1. Review of Assignments:
   a. Polar Coordinates
   b. Sample Program

2. Polar Positioning:
   a. Definition of Pole Center, (I,J,K) values
   b. Absolute versus Incremental, A or B values

3. Hole Making Codes:
   G80 - Drill Cycle Off
   G81 - Simple Drill (Feed In, Rapid Out)
   G82 - Spot Face (Feed In, Dwell, Rapid Out)
   G83 - Peck Drilling (Feed In, Retract to Clr Plane, Feed In)
   G84 - G89 Other Drilling, Tapping, Boring Cycles

4. Machine Operation in Set Up Mode:
   a. Manual Operation
   b. Reference Point
   c. Clearance Point
   d. TLO - Tool Length Offset
      1. what is it?
      2. how is it done
   e. Diameter & Radius Information
      1. how are they used by the CNC control?

5. Program Entry into the CNC

6. Program Editing for the R2E4
   a. Handout of editing codes

7. Drilling Assignment

8. Demonstrations:
   a. Hole Making Cycles
   b. Machine Operations
   c. Program Entry & Operations

CNC PROGRAMMING
[INSTRUCTOR NOTES]

OUTLINE

CLASS 4: CANNED CYCLES

1. Canned Cycles for Using in Milling Operations
   a. what are they & how do they work
   b. why do we use they in CNC
   c. problems in use:
      1. defined by machine
      2. interface with CAM programs

2. Row of Holes (Simple) (G81 - G89)

3. Bolt Circle Drilling (G81 - G89)

4. Row of Hole (Complex) (G181 - G189)

5. Frame of Holes Commands (G191 - G199)
   a. how do we relate these commands to the viewing of part prints prior to programming?

6. Frame, Pocket & Slot Milling Cycles
   G170 - O/S Frame Mill
   G171 - I/S Frame Mill
   G172 - Pocket Frame Mill
   G173 - O/S Face Mill
   G174 - I/S Face Mill
   G175 - O/S Circle Mill
   G176 - I/S Circle Mill
   G177 - Circle Pocket Mill
   G178 - Slot Mill

7. Program Running / Prove Out

8. Assignment: Holes & Pocket Program

9: Demo Prog: 5009; Hole Drilling

CNC PROGRAMMING
[INSTRUCTOR NOTES]

OUTLINE

CLASS 5: MACROS / LOOPS / VARIABLES

1. Review of Hole and Pocket Assignment
   (run completed programs)

2. Macros -
   1. The reasons for use in CNC programming
   2. Definition of the macro in the program
      a. global and local macros
   3. Variables in macros programs
      a. What is their purpose and power
      b. Family of Parts Concept (GT)

3. S Word - Spindle Speed Setting

4. Looping -
   1. Why and how it is used
   2. Definition of a LOOP command

5. T Word - Tool Changes
   1. How and when it is used in the program
   2. Considerations in use
      a. TLO - Tool Length Offset
      b. Diameter

6. Demonstration of Concepts

CNC PROGRAMMING
[INSTRUCTOR NOTES]

OUTLINE

CLASS 6: CUTTER COMPENSATION MODE

1. Cutter Comp Mode (G40, G41, G42)
   a. the most powerful of programming modes
   b. how do we use cutter comp?
      1. structure
      2. limitations
      3. use of TLO and Diameter information from CNC
   c. extensive demos

2. Cutter Comp Assignment

3. Modify Feed Rate & Constant Surface Speed Programming (G44, G45)

4. INCH / METRIC OPERATION (G70, G71)

CLASS 7: OPEN LAB PERIOD

1. Student will work as a group to check their cutter comp assignments. Then prove out and run them during class.

CNC PROGRAMMING
[INSTRUCTOR NOTES]

OUTLINE

CLASS 8: ADVANCED CODING

1. Helical & Spirical Interpolation (G12/G13)
   a. uses and considerations

2. Rotation & Scaling (G72/G73)
   a. uses and considerations

3. Fixture Offset (translation) (G97)
   a. uses and considerations

4. Mirror Image Commands (G30,31,32)
   a. uses and considerations

5. Plane Selection (G17,18,19)
   a. uses and considerations

6. Cutter Compensation Assignment

7. Advanced Programming Assignment
   Students will design a sample part in which they can use many of the concepts taught in class a way to produce an efficient part program.

CNC PROGRAMMING
[INSTRUCTOR NOTES]

OUTLINE

CLASS 9: EFFECTIVE PROGRAMMING / PROGRAM DOCUMENTATION

1. Effective Programming for Industry
    a. limits of your machine control
    b. analysis of your present parts
    c. analysis of your future parts
    d. interfacing with other systems

2. Program Documentation
    a. storage of programs
    b. proper explanation of program structure
    c. common constructs to be used company wide
        1. tooling identification
        2. program notation
        3. program comments

3. Work on Cutter Comp & Advanced Program Assignment

CLASS 10: OPEN LAB

1. Students will finish the programs that they have started in the two previous assignments.

OUTLINE: COMPUTER AIDED MANUFACTURING

I. INTRODUCTION

1. CAD/CAM Hardware
2. CAD/CAM Software
3. CAD-to-CAM Interface
4. CAM-to-CNC Interface

Objective: Give the student a perspective of CAM that includes why CAM is used, how it is implemented, and how it affects other areas of the company.

II. SMARTCAM

1. User Interface
2. Module Overview
3. Job Plan: Milling
4. Shape: Milling (2 1/2 Axis)
5. Editing G code file
6. Code Generators

III. CAM REQUIREMENTS ANALYSIS

1. Part Analysis
2. CNC Machine Tools
3. CAM Requirements
4. CAD System
5. Workforce

IV. CAM SOFTWARE ANALYSIS

1. General Operation
2. System Types
3. Editing
4. CAD Interfaces
5. Post Processors
6. User Support
7. Cost Estimates

KEYSTONE CEMENT COMPANY
CUSTOMIZED
TRAINING PROGRAM

CONTROL STRATEGY

Customized for Keystone Cement Company

I. Introduction

- A. Overview of the Cement Process
- B. Materials & Their Origin
- C. Use of a Model to Understand the Operation
- D. Model Characteristics & Usage

II. The Keystone Process Model

- A. Quarry Operation
- B. Raw Grinding
- C. Clinker Production
- D. Clinker Storage
- E. Finish Grinding
- F. Packaging & Shipping
- G. Support Services

III. Quantification of Current Operation

- A. Cost of Operation
  1. Direct labor & supervision
  2. Materials
  3. Power
  4. Maintenance
  5. Training
- B. Measures of Efficiency
- C. Quality Control
- D. Outside Influences
  1. Market demand
     a. Dolomite
     b. Cement
     c. Disposal service
     d. Dust (StableSorb)
  2. Labor Resource Pool
  3. Raw Materials
  4. Environmental
- E. Planning Model
  1. Review of the process model
  2. Assignment of values
  3. Identification & evaluation of opportunities
  4. Project design & specification
  5. Project ROI

The Cement Process
&
Keystone Cement Co.

Outline

I. Introduction
   - A. Overview of Cement Process
   - B. Materials and their Origin
   - C. Use of the Model to Understand the Operation
   - D. Model Characteristics and Usage

II. Keystone Business Objectives
   - A. Overview
     1. What is Keystone's business?
     2. What is necessary to maintain and expand those businesses?
     3. What current problems require attention?
   - B. Improvements for Current Operation
     1. Quality Control
     2. Efficiency
   - C. Relationship to each operation

Outline (continued)

III. The Keystone Process Model - Detail Operations
- A. Keystone Flow Model
- B. Quarry Operation
- C. Crushing Operation
- D. Raw Grinding
- E. Clinker Production
- F. Clinker Storage
- G. Finish Grinding
- H. Packaging and Shipping
- I. Support Systems
  1. Power Distribution
  2. Laboratory
  3. Maintenance
  4. Administration

IV. Summary
- A. The Keystone Process
- B. The Challenge

KEYSTONE SUPERVISORY TRAINING

I. Introductions and Overview

II. Communication Skills

- A. Maintaining a Sense of Self-esteem
- B. Focusing on Behavior
- C. Encouraging Participation
- D. Listening
- E. Nonverbal Messages

III. Understanding Individual Styles - Utilizing the Myers Briggs Type Inventory

- A. Presentation
- B. Interpretation
- C. Application and Implications

IV. Leadership Skills

- A. Delegation
- B. Communicating with your Boss
- C. Motivation
- D. Performance Appraisals

V. Team Building Skills

- A. Resolving Conflict
- B. Problem-solving
- C. How to Make Meetings Work

VI. Getting the Work Done

- A. Planning, Organizing, Directing
- B. Time Management

VII. The Nature of Work in the 1990's

- A. The Change Process
- B. A Look at Organizations who have made Successful Changes

KEYSTONE CEMENT
INDUSTRIAL CONTROLS REFRESHER

I. Language
II. Fundamentals
III. Measurements and Instruments
IV. Conductors
V. Electromagnetism
VI. AC Theory - Electrical Power Systems
VII. Transformers, Inductors, Capacitors
VIII. Motors
IX. AC Motors
X. Sensors & Switches
XI. Solid State
XII. Components to PC's
XIII. RS-232 Discussion
XIV. DOS Primer

DENT MANUFACTURING CUSTOMIZED TRAINING PROGRAM

CNC Machine Operation
for
Dent Manufacturing

I. Numerical Control (NC)/Computer Numerical Control Background
   - A. Definition and History
   - B. Capabilities
   - C. Advantages and Disadvantages of NC, CNC
   - D. The Machine Control Unit
   - E. Programming Languages
   - F. Coordinate Systems and Trigonometry Applied to Basic CNC Programming

II. Operating Procedures
   - A. Bridgeport CNC
     1. Auxiliary Machine Control Functions
     2. Startup - Shutdown
     3. Operator Controls and Indicators
     4. Operation Setup Mode
     5. Safety
     6. Machine Demonstration
   - B. Anilam Lathe
     1. Auxiliary Machine Control Functions
     2. Startup - Shutdown
     3. Operator Controls and Indicators
     4. Operation Setup Mode
     5. Safety
     6. Machine Demonstration

III. Basic Programming on the Bridgeport and Anilam
   - A. Word Address Format Structure
   - B. Active G Codes on Startup
   - C. Decimal Point Requirements
   - D. Basic Programming Coding Specific to Dent Mfg.
   - E. Demonstration of Concepts
   - F. Sample Program Assignment

IV. Specific Machining Operatiors/Program Entry on Bridgeport
   - A. Polar Positioning
   - B. Specific Codes
   - C. Machine Operation in Setup Mode
   - D. Program Entry
   - E. Program Editing
   - F. Review and Demonstration of Dent Programs
   - G. Operational Assignment

V. Specific Machining Operations/Program Entry on Anilam Lathe
   A. Polar Positioning
   B. Specific Codes
   C. Machine Operation in Setup Mode
   D. Program Entry
   E. Program Editing
   F. Review and Demonstration of Dent Programs
   G. Operational Assignment

VI. Review and Demonstration of Competency by Students

INSTRUMENT SOCIETY of AMERICA
CUSTOMIZED
TRAINING PROGRAM

PROGRAMMABLE LOGIC CONTROLLERS

COURSE DESCRIPTION

This six-hour course provides an introduction to programmable logic controllers, including their capabilities, principles of operation, selection considerations, and industry applications. Through lecture and demonstration, participants will learn how to program, operate, and monitor a PLC application using PLC programming software and a variety of input and output devices.

COURSE CONTENT

- .Introduction to Programmable Logic Controllers
- .Basic Principles of Operation
- .Discrete Input/Output Systems
- .Basics of PLC Programming
- .LAB DEMONSTRATION
- .Guidelines for Installation, Start-Up, and Maintenance
- .PLC System Selection Guidelines

This program is one of several automated manufacturing courses offered by the Center for Business and Industry at Northampton Community College. Support for the development of these courses has been provided by the U.S. Department of Education Cooperative Demonstration Project, the N.E.T. Ben Franklin Advanced Technology Center, and the Manufacturing Services Extension Center.

INSTRUCTOR

Gerard Insolia, manager of engineering services at Integrated Technologies Corp., has extensive experience in the design of electro-mechanical equipment, control systems for automated equipment, and CNC programming. Mr. Insolia is the inhouse technical consultant for Northampton's automated manufacturing training programs.

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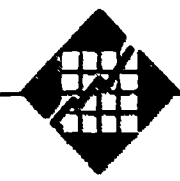
TECHNOLOGICAL LITERACY

Agenda for
1 1/4, 3 and 6 hour programs



One and one-quarter hour program for College educators

UNDERSTANDING NORTHAMPTON TECHNOLOGIES
Workshop for NCC Faculty & Staff

Program Agenda

I. Lehigh Valley Industry **-Local Companies & Jobs** **-Credit programs** **-CBI/NTCu programs** **-Orientation to manufacturing facility** **(Penn 133)**	**Paul Pierpoint** **Lin Erickson**
II. The Use of Computers & Microprocessors in Manufacturing **-Product Design (CAD/CAM)** **-Programmable Logic Controllers (PLC's)** **(Penn 133a)**	**Skip Todora**
III. Automated Parts Fabrication & Assembly **-CNC Machining Cell** **-Final Assembly** **(Penn 135)**	**Steven Zaharakis**
IV. Electronics Design & Assembly (SMT) **(Penn 136)**	**Ebrahim Ahmadizadah** **John Kratz**

techfin/1/49

Three hour program for public school teachers

TECHNICAL CAREERS IN THE 1990'S

AGENDA

11:30	**Welcome & Introductions** **Lin Erickson, Director, CBI Applied Technologies**
11:35	**The Competitive Marketplace** **John Kratz, Technical Consultant**
12:10	**The Changing Workforce** **Lin Erickson, Director**
12:20	**Academic Response** **Lin Erickson, Director** **Steve Zaharakis, Assistant Professor**
12:35	**Laboratory Demonstration** **John Todora, Engineering Technician** **John Kratz, Technical Consultant**
1:05	**Lunch**
1:30	**Depart for Manufacturing Site Tour**
1:45	**Tour of Just Born** **Burt Schaffer, Director of Operations**

tecagenda/1/46

Northampton Community College

Three hour program for public school teachers

Technical Careers — Workshops for Teachers
September 24, 1991

Program Agenda

Keystone Hall, R. 218

7:30 a.m.	Breakfast	
8:10 a.m.	Welcome & Introductions	Mardi Closson
8:15 a.m.	Introduction of Industry Speaker	Lin Erickson
8:20 a.m.	The Competitive Marketplace	Craig Kauffman Binney & Smith
8:40 a.m.	The Changing Workforce	Lin Erickson
9:00 a.m.	Academic Response -Credit Programs -Technical Careers Video -NCC Teaching Factory	Paul Pierpoint Lin Erickson
9:20 a.m.	Walk to manufacturing facility Split into groups	

Penn Hall, Rms. 133-136

9:30 a.m.	Demonstrations	Technical Staff

tea/1/49

National Training Center for Microelectronics

3835 Green Pond Rd., Bethlehem, Pennsylvania 18017 (215) 861-5486 FAX (215) 861-5060

Northampton Community College

TECHNICAL CAREERS -- WORKSHOP FOR TEACHERS
September 24, 1991

LAB DEMONSTRATIONS
9:30 - 10:30 a.m.

I. The Use of Computers & Microprocessors in Manufacturing
-Product Design (CAD/CAM)
-Programmable Logic Controllers (PLC's) — Skip Todora

(Penn 133a)

II. Automated Parts Fabrication & Assembly — Steven Zaharakis
-CNC Machining Cell
-Final Assembly

(Penn 135)

III. Electronics Design & Assembly (SMT) — Ebrahim Ahmadizadeh, John Kratz

(Penn 136)

techfin/1/49

National Training Center for Microelectronics

3835 Green Pond Rd., Bethlehem, Pennsylvania 18017 (215) 861-5486 FAX (215) 861-5060

Six hour program for public school teachers

TECHNICAL CARKERS IN THE 1990'S

AGENDA

8:30 **Welcome & Introductions**

Lin Erickson, Director, CBI Applied Technologies

8:40 **The Competitive Marketplace**

John Kratz, Technical Consultant

9:30 **The Changing Workforce**

Lin Erickson, Director

9:50 **Academic Response**

Lin Erickson, Director
Steve Zaharakis, Assistant Professor

10:10 **Laboratory Demonstration**

John Todora, Engineering Technician
John Kratz, Technical Consultant

11:15 **Organize Lunches and Directions to Tour Sites**

11:30 **Depart for Tour Sites**

11:45 **Lunch at Greif Companies with Introduction to the Operations**

Tour of Greif Companies

Bob Cavallucci, Director of Engineering Services

1:25 **Depart for Stanley-Vidmar**

1:40 **Arrival and Tour of Stanley-Vidmar**

Richard Bucholtz, Vice President of Manufacturing

tecagenda/1/46

AUTOMATED MANUFACTURING GRANT ADVISORY COMMITTEE

Air Products & Chemicals, Inc.
Charles Ackerman
PO Box 538
Allentown, PA 18105
481-6414 FAX: 481-5210

Allen-Bradley Co
Richard J. Dost
3005 Brodhead Rd
Bethlehem, PA 18017
868-3131 FAX: 866-3696

Allen Organ
Jeff McGinley
Route 100
Macungie, PA 18062
966-2200 FAX: 965-3098

Bell & Howell
Dave Brong
795 Roble Rd
Allentown, PA 18103
264-4510 FAX: 266-4532

Binney & Smith
Craig Kauffman
1100 Church Ln
Easton, PA 18042
253-6271 Ext 516 FAX: 559-2633

Burron Medical
Ron Zelezen
901 Marcon Blvd
Allentown, PA 18103
266-0500

Cooper Industries
Bruce Smith
2200 Northwood Ave, PO Box 389
Easton, PA 18044
258-5351

ESSROC Materials
Rick Parker
VP Manufacturing
PO Box 32
Nazareth, PA 18064
837-[illegible]25 FAX: 837-9614

Crowder Engineering, Inc.
Miles Knecht
Dir of Systems Engineering
PO Box 659
Allentown, PA 18103
791-9966 FAX: 791-3879

Engineered Systems
Lewis Ballew, Sales Manager
1849 Butler St
Easton, PA 18044
258-5528 FAX: 258-5936

Fastman
Dr. Michael Tucker
1414 Millard
Bethlehem, PA 18018
691-2577 FAX: 865-3987

Fischer & Porter
Charles Cianfrani
125 E. County Line Rd
Warminster, PA 18974
674-6800 FAX: 674-7183

Follett Corp
Steve Massee
801 Church Ln, PO Box D
Easton, PA 18044
252-7301 FAX: 250-0696

GEE-Kay Knit Products
Charles Krasnov
VP Operations
333 E. Court St, Unit 2
Allentown, PA 18101
435-7222 FAX: 435-7819

Greif Companies
Bob Cavallucci
939 Marcon Blvd
Allentown, PA 18103
266-2200 FAX: 266-2478

IBM Corp
John Russo
1770 Bathgate Rd
Bethlehem, PA 18018
865-7500 FAX: 865-7697

Ingersoll Rand Co. #1 Pump Place
William Bakey
PO Box 656
Allentown, PA 18105
776-6205

Integrated Facilities Corp
Bernard Daday, Pres
178 Deborah Ln
Schnecksville PA 18078
767-5443 FAX: 767-8076

James River Corp
Marci Babicz
605 Kuebler Rd
Easton, PA 18042
250-1581 FAX: 250-1558

Jamison Plastics
Victor Cara Cappa
5001 Crackersport Rd
Allentown, PA 18104
391-1400 FAX: 391-1414

Jenkins Machine, Inc.
Walter D. Jenkins, Pres
5901 Colony Dr
Bethlehem, PA 18017
837-6723 FAX: 837-6724

Just Born
Burton A. Schaffer
Dir of Operations
Box 1158
Bethlehem, PA 18016
867-7568 FAX: 867-3210

Pennsylvania Power & Light
Nick Salamida
Rte 22 & 309
POB 3500
Allentown, PA 18106-0500
774-3279 FAX: 774-3260

Rexroth Corp.
Industrial Hydraulics Div
Tom Frankenfield
Automotive Marketing Manager
2315 City Line Rd, PO Box 25407
Lehigh Valley, PA 18002-5407
694-8295

SI Handling Systems
Ken Buck
Dir of Human Resources
PO Box 701
Easton, PA 18042
252-7321 FAX: 250-9677

Stanley Vidmar
Richard Buchholz *
VP Manufacturing
11 Grammes Rd
PO Box 1151
Allentown, PA 18105
797-6600 FAX: 776-3895

Victaulic Company of America
Al Piccotti
4901 Kesslersville Rd, PO Box 31
Easton, PA 18042
252-6400 FAX: 250-8817

Manufacturing Services Extension Center
Tony Tlush
301 Broadway
Bethlehem, PA 18015
758-5599 FAX: 758-4716

Net Ben Franklin Technology Center
Joe Lane
125 Goodman Dr
Bethlehem, PA 18015-3715
758-5200

Iacocca Institute
Larry Hecht, Executive Dir
Lehigh University
Tower Bldg #111
Bethlehem, PA 18015
758-5452

* Chairperson

INDUSTRY DONORS

NORTHAMPTON COMMUNITY COLLEGE
AUTOMATED MANUFACTURING GRANT (Project #V100A00063-90)
PROJECT MATCH

CORPORATE SPONSORS	EQUIPMENT	IN-KIND	CASH	TOTAL
AIR PRODUCTS & CHEMICALS	$3,525.00	$387.00		$3,912.00
ALLEN-BRADLEY	$41,475.00	$9,680.00		$51,155.00
BINNEY & SMITH		$2,000.00		$2,000.00
BRU-MAR MANUFACTURING		$250.00		$250.00
CALI SPORTSWEAR		$225.00		$225.00
CRONDER ENGINEERING		$348.00		$348.00
DIANA SPORTSWEAR		$225.00		$225.00
DUPONT	$20,000.00	$0.00		$20,000.00
ENGINEERED SYSTEMS		$120.00		$120.00
ESSROC MATERIALS	$3,000.00	$700.00		$3,700.00
FISCHER & PORTER	$14,433.00	$12,650.00		$27,083.00
FOLLETT		$6,470.00		$6,470.00
GEE-KAY KNIT PRODUCTS		$3,375.00		$3,375.00
GLENSER TECHNOLOGIES		$29,971.00		$29,971.00
GRIEF COMPANIES		$350.00		$350.00
H.F. HOFFORD		$318.75		$318.75
IBM		$1,725.00		$1,725.00
INTEGRATED FACILITIES		$4,350.00		$4,350.00
JAMES RIVER		$160.00		$160.00
JENKINS MACHINE		$1,060.00		$1,060.00
JIK		$250.00		$250.00
JUST BORN		$2,500.00		$2,500.00
LINDEN APPAREL		$350.00		$350.00
NICOLET INSTRUMENT	$50,000.00			$50,000.00
PENNSYLVANIA POWER & LIGHT			$20,000.00	$20,000.00
SI HANDLING		$1,200.00		$1,200.00
STANLEY VIDMAR		$10,000.00		$10,000.00
SURE-FIT PRODUCTS		$857.43		$857.43
TELEMECANIQUE	$4,615.00	$1,780.00		$6,395.00
TEXAS INSTRUMENTS	$22,635.00	$1,700.00		$24,335.00
VALERIE SPORTSWEAR		$450.00		$450.00
VICTAULIC		$590.00		$590.00
WESTINGHOUSE ELECTRIC	$7,391.00	$0.00		$7,391.00
Subtotal	$167,074.00	$94,042.18	$20,000.00	$281,116.18
NON-PROFIT ASSOCIATIONS				
ATLANTIC APPAREL CONTRACTORS' ASSOC.		$300.00	$225.00	$525.00
VALLEY APPAREL & TEXTILE ASSOC.		$80.00	$90.00	$170.00
Subtotal		$380.00	$315.00	$695.00
STATE SUPPORT (PA)				
BEN FRANKLIN ADVANCED TECH CENTER			$102,950.00	$102,950.00
MANUFACTURING SERVICES EXTENSION CENTER		$4,320.00		$4,320.00
Subtotal		$4,320.00	$102,950.00	$107,270.00