DOCUMENT RESUME

ED 288 018		CE 048 874

TITLE	Development of Articulated Competency-Based Curriculum in Automated Systems/Robotics Technology. Final Report.
INSTITUTION	Luzerne County Community Coll., Nanticoke, Pa.
SPONS AGENCY	Pennsylvania State Dept. of Education, Harrisburg. Bureau of Vocational and Adult Education.
PUB DATE	30 Sep 87
CONTRACT	85-7012
NOTE	88p.
PUB TYPE	Guides - Classroom Use - Guides (For Teachers) (052)
EDRS PRICE	MF01/PC04 Plus Postage.
DESCRIPTORS	Articulation (Education); Community Colleges; *Competence; Competency Based Education; *Course Content; *Curriculum Development; Curriculum Guides; Fluid Mechanics; Manufacturing; *Robotics; Technological Advancement; Two Year Colleges; Vocational Education

ABSTRACT

A project was conducted at the Community College of Luzerne County (Pennsylvania) to develop, in cooperation with area vocational-technical schools, the first year of a competency-based curriculum in automated systems/robotics. Existing programs were reviewed by the task force and a list of sample competencies was developed and sent to area manufacturers for a rating of task importance. The results of these efforts and the curriculum itself are presented in three sections. The first section covers general business/industry trends; Automated Systems/Robotics Technology curriculum; articulation; and a proposed second-year course listing. The second section of the curriculum guide lists educational specifications for the robotics laboratory and the fluid power laboratory, and the final section lists equipment specifications. Appendixes to the report list the task force members, describe the literature search, and provide a task listing with manufacturers' ratings. Sample task force letters complete the report. (KC)

ED288018

FINAL REPORT

DEVELOPMENT OF ARTICULATED COMPETENCY-BASED CURRICULUM IN AUTOMATED SYSTEMS/ROBOTICS TECHNOLOGY
CONTRACT NUMBER 85-7012

Wesley E. Franklin, Project Director
Elizabeth H. Yeager, Project Coordinator

Community College of Luzerne County
Nanticoke, Pennsylvlania 18634

September 30, 1987

Pennsylvania Department of Education
Bureau of Vocational and Adult Education

CE 048 874

TABLE OF CONTENTS

SECTION I

SECTION VI -- ATTACHMENTS

SECTION VII -- SAMPLE TASK FORCE LETTERS

SECTION I

ACKNOWLEDGEMENTS AND ABSTRACT

Business-
Industry-Education
PARTNERSHIP

ACKNOWLEDGEMENTS

For most of us at the Community College of Luzerne County, this project involved the "breaking of new ground." We have all been involved, more or less, in various phases of curriculum development for several years. However, doing competency-based curriculum development, and doing it in areas that include most of the advanced technologies now being developed, was a difficult and time-consuming task. To be able to do what was done with curriculum development, while at the same time complete the planning for a new advanced technology center (82,000 square feet, $8 million) was an accomplishment that should be recognized. Listed below in alphabetical order are the names of those individuals involved; they are listed with the hope that the work they did will receive more substantial recognition when time and resources permit:

Regina Antonini	Director, Institutional-Based and Community-Based Special Programs and Task Force Coordinator
Elaine Brown	Assistant to the Project Director
Patrick J. Santacroce	Executive Director, Institute for Developmental Educational Activities
Elizabeth Yeager	Research Specialist and Task Force Coordinator
Stephen Yokimishyn	Coordinator, Customized Job Training Programs

A note of thanks also to the consultants Paul L. McQuay and Associates, and Alger, Dowling, and Paullin, and to members of the task force for their effective involvement and contributions.

A special note of thanks to Mr. Thomas J. Moran, President of the Community College of Luzerne County, for his patience, understanding, and flexibility. There were many times when other projects had to be deferred so work on this project could be completed.

Wesley E. Franklin
Project Director and
Director, BIE Partnership, IDEA
September 30, 1987

ABSTRACT

85-7012: Development of Articulated Competency-Based Curriculum in Automated Systems/Robotics

Elizabeth Yeager
Community College of Luzerne County
Prospect St. & Middle Road
Nanticoke, PA 18634

$37,627 Federal
7/1/86 to 6/30/87

The purpose of this project was to develop, in cooperation with area vocational-technical schools, the first year of a competency-based curriculum in automated systems/robotics.

OBJECTIVES

1. Establish an "automated systems/robotics task force" comprised of representatives from the community college, participating area vocational-technical schools, and the private sector.

2. Review materials on existing competency-based robotics technician programs (provided by PDE Resource Center) and identify secondary, post-secondary, and overlapping levels of instruction.

3. Inventory and list existing equipment, facilities, and courses available from all participating institutions related to proposed program.

4. Obtain private sector input on competencies needed by entry-level robotics technicians, and integrate into curriculum materials development activity.

5. Develop rationale/procedures for program articulation between each AVTS and the community college.

6. Develop competency based curriculum materials and review with PDE representatives.

7. Identify equipment and facilities needed to offer articulated programs at AVTS's and community college, with emphasis on non-duplication of high-cost items.

8. Prepare final draft of CBCM and review with deans and directors from each institution.

OUTCOMES

1. Task force was formed, met regularly throughout the year, and provided significant input into curriculum development/articulation process.

2. Curriculum materials and equipment information from other schools was obtained and reviewed; visits were made to two AVTS's and one community college offering similar programs(electro-mechanical).

3. Sample competency lists were developed and mailed to private sector for validation.

4. Consultants were used to develop first-year curriculum and facilities/equipment specifications.

5. Proposed curriculum and articulation process was reviewed and approved by AVTS directors and community college deans.

AUDIENCE

The resulting report and curriculum materials will be distributed to participating AVTS's, PDE, task force, community college, and private sector.

PUBLISHED MATERIALS ---- Final Report

SECTION II

NARRATIVE

METHODOLOGY

This curriculum materials development project began with the formation of a task force whose membership included representatives from the five area vocational-technical schools: Hazleton, Lackawanna, Susquehanna, West Side and Wilkes-Barre (see ATTACHMENT #1). In the initial grant proposal, the stated plan was to use vo-tech faculty (task force) to assist in curriculum development and in identification of equipment and facilities needed for the program. After several meetings with the task force during the fall semester, this approach did not appear to be feasible because of time and expertise limitations -- most of the members of the task force taught evening courses as well as teaching full-time during the day. Also, because the proposed program is a new technology, there was a significant amount of research that had to be done, both for the college and the task force.

For these reasons, it was decided to use expertise already available, namely consultants, and have the task force function in a review/reaction mode once there were materials/reports from the consultant to consider. This way, the task force's knowledge of the local educational and industrial training requirements could be used to make appropriate changes in the consultant's reports and recommendations so the proposed program would be in line with the needs of the college's service area. Also, representatives of the college's engineering and science departments, administration, and from the private sector were able to participate in the process and provided valuable input throughout.

ATTACHMENT #2 lists the various programs and publications that were reviewed as part of the project's data search. Upon completion of this review, a list of sample competencies was developed and sent to area manufacturers. A copy of the list, showing the summarized competency rankings, is included as

ATTACHMENT #3. As part of this process, the project coordinator, task force coordinator, and department director met with a representative from the Pennsylvania Department of Education who reviewed the requirements of the Bureau of Vocational Education for competency-based programs/courses.

Those materials found to be most pertinent, along with the results of the private sector reviews of the sample competencies, were then sent to the consultant as background for the proposed first-year curriculum. Also, one of the results of the task force's review process was the recommendation that the best articulation procedure would be one which provided advanced placement for competencies and/or knowledge rather than attempt to integrate a secondary with a post-secondary curriculum, trying to fit the student in wherever he or she happened to be on the competency continuum. The consultant agreed with this recommendation and included a separate section on articulation in his report. This report is included, in its entirety, under SECTION III.

ANALYSIS/EVALUATION

The proposed first-year program, along with the proposed equipment and facilities plan, were first evaluated by the task force. The task force made several recommendations to the consultants, which were incorporated into the final documents. These documents were then reviewed and approved by the appropriate community college administrators and the directors of the participating AVTS's.

DISSEMINATION

Copies of the final report will be distributed to the following:

Bureau of Vocational and Adult Education, PDE

Area Vocational-Technical Schools

Private Sector participants

Members of Task Force

Consultants

Ben Franklin Partnership

Pennsylvania Economic Development Partnership

Economic Development Council of Northeastern Pennsylvania

Because this is the first year of a two-year project, the final report for the second year will include the complete curricular program, including the associate degree and the certificate of specialization. Upon completion, approximately one year from now, that report will receive more widespread distribution. A listing of courses for the second year is included at the end of the consultant's report for this year

SECTION III

CONCLUSIONS AND RECOMMENDATIONS

AUTOMATED SYSTEMS/ROBOTICS

CURRICULUM

(One Year Program of Study)

LUZERNE COUNTY COMMUNITY COLLEGE

Nanticoke, Pennsylvania 18634

June, 1987

AUTOMATED SYSTEMS/ROBOTICS CURRICULUM

General Business/Industry Trends

In a joint study completed by the University of Michigan and the Society of Manufacturing Engineers entitled, Industrial Robots - A Delphi Forecast of Markets and Technology, it was estimated that by the end of the year 1990 there will be approximately 150,000 robots installed and working. To support the estimated population of industrial robots in 1990, the United States will be experiencing a need for between 11,000 and 20,000 robotic technicians.

Although a robot is considered one of the highest forms of systems-integrated automation available to industry today, various other types of automated systems exist in the manufacturing environment. Major forms include numerically controlled machine tools, flexible manufacturing systems and automatic guided vehicles. Other classifications of automation systems are currently being adopted, or are being considered for adoption by the manufacturing, electronic assembly, petrochemical, food processing, warehousing and related industries. These classifications include: automatic storage and retrieval systems, automated materials handling and various programmable logic control systems. The majority of job openings created within these industries will include responsibilities associated with robots.

In 1985, the National Electrical Manufacturers' Association (NEMA) conducted a survey of small, moderate and larger firms. The findings of the survey indicate that eighty-two percent of the respondents plan to install some type of automated equipment over the next five years. Robotic manufacturing will create more than 50,000[1] jobs by 1995, including 25,000[1] maintenance workers and 12,000[1] programmers. Certainly, there are a limited number of people in the workforce today who possess the qualifications needed to fill these positions. However, many companies do not have employees with the skills necessary to operate and maintain automation systems. Therefore, providing for upgrading of current employees' skills, and/or identifying a source for obtaining new hires is a major factor a company must consider when planning to implement automated systems or when planning a transition from conventional to new technological methods of manufacturing. Industries are in need of skilled and knowledgeable technicians, namely those who have graduated from a properly structured curriculum, one which can meet the general needs of any automated industry.

[1]Taken from 'VICS-87'

AUTOMATED SYSTEMS/ROBOTICS TECHNOLOGY

Recommended Program of Studies
Leading to the A.A.S. Degree

The Automated Systems/Robotics Technology curriculum is designed to provide the student with knowledge and practical experience with electromechanical equipment and controls common to both robotic and automated systems. This program is designed to provide students with the broad background required of individuals seeking to enter and advance in job classifications involving installation, operation, service, maintenance, and programming of automated systems, including robots. The varied background obtained, as a result of having successfully completed this program, will also afford the individual an opportunity to pursue a career within one of the specific areas comprising the multi-disciplinary field of robotics/automated systems.
This curriculum can be completed in a manner conducive to affording those individuals wishing to pursue advanced studies the opportunity to transfer credit hours to an institution of higher learning. However, specific planning, involving the assistance of an advisor, is recommended in each case.

First Semester

	Credits
English Composition I ENG 101	3
Technical Math I MAT 111 (or higher level substitute)	5
Technical Drafting and Print Interpretation GET ___	2 (1 hr lect/ 2 hr lab)
Manufacturing Processes Lab I GET ___	3 (2 hr lect/ 2 hr lab)
D.C. and A.C. Fundamentals CEL 101	4
	17

Second Semester

	Credits
Introduction to Robotics	3 (3 hr lect)
Technical Math II MAT 112 (or higher level substitute)	5
Technical Physics I PHY 123 or PHY 131 GEN PHY I	4
Fundamentals of Speech SPE 125	3
Electronic Devices CEL 135	3
	18

ROBOTICS/AUTOMATED SYSTEMS TECHNOLOGY
PROGRAM COMPETENCIES

Upon successful completion of this program, the student should be able to:

*** demonstrate the ability to apply accident prevention practices and procedures while performing operations basic to various manufacturing processes.

*** apply concepts and theories associated with mathematics and physics to provide a solution for technical problems related to electromechanical systems.

*** incorporate the use of sketching, drafting, print interpretation and written reports to communicate and solve problems of a technical nature.

*** describe the actuation and operational characteristics of a robot to include power supplies, arm configuration, and control architecture.

*** utilize basic AC and DC electricity theory, along with the theory of electronic devices to troubleshoot electromechanical systems.

*** elaborate on the differences between open and closed loop control systems.

*** discuss the aspects of how humans interface with robots and automated systems.

Course Competencies For:

1. Title: Technical Drafting with Print Interpretation — GET____ — 2 credits, One Hour Lecture, Two Hours Laboratory

2. Course Description: This course is designed to provide instruction conducive to the development of knowledge and skills required to complete and interpret mechanical drawings. Likewise, the student will become familiar with symbols and drafting techniques relevant to the interpretation of basic graphs, electrical, electronic and piping diagrams. Upon successful completion of this course, the student should be able to:

3. Course Competencies/Behavioral Objectives

Competency 1: Freehand sketch and, with the aid of mechanical drafting instruments, create drawings representing the shape, size, features and relationships of common objects and interpret same, including:

1.1 demonstrate the techniques of line creation and the aspects of proportionality required to create a freehand sketch.

1.2 identify and demonstrate the use of drafting equipment.

1.3 describe the various elements of a completed drawing, noting the considerations that are necessary for proper planning and layout of a drawing.

1.4 utilize common mechanical instruments to create line drawings.

1.5 interpret basic sketches and drawings.

Competency 2: Apply the rules of drafting and the principles of geometric construction to portray and interpret information regarding manufactured or fabricated objects.

2.1 identify and utilize the American National Standards Institute's standards for line conventions and lettering.

2.2 describe the purpose of each type of line on a drawing and why line weight is important to the viewer.

2.3 demonstrate how to combine geometric elements and construction techniques to describe geometric shapes.

2.4 plan, layout and construct drawings.

2.5 utilize skills and knowledge associated with drafting techniques to interpret drawings.

Competency 3: Utilize the techniques of orthographic projection, multiview, auxiliary, and sectional views to describe and interpret aspects of part shape, size, and configuration, and to clarify part features, including:

3.1 describe the difference between pictorial, multiview, and auxiliary drawings and identify when the use of each is appropriate.

3.2 cite the considerations one should make when selecting views for part-feature representation.

3.3 describe when the use of sectioning, revolution, or break techniques is warranted.

3.4 select appropriate views and complete multiview drawings of objects.

3.5 define terms associated with projection views and demonstrate layout tecnniques required to complete projections.

3.6 use auxiliary and isometric views of an object to clarify part features and details.

3.7 identify the various types of sectional views and elaborate on the particular circumstances under which each would be used.

Competency 4: Prepare and interpret working drawings with detailed dimensions and notes, applying the American National Standards Institute's (ANSI) rules for symbology for geometric tolerancing, including:

4.1 distinguish between detail and assembly drawings and identify the various types of assembly drawings.

4.2 identify and elaborate on the definition of each of the four basic types of the ANSI geometric tolerancing symbols; namely, geometric characteristic, material condition (modifying), feature control frame, and supplementary symbols.

4.3 identify and elaborate on the definition of each of the five types of the ANSI geometric tolerances; namely, form, profile, orientation, runout and location.

4.4 create detail drawings employing appropriate ANSI geometric tolerancing symbols and descriptions.

4.5 use knowledge and skills associated with the construction of working and detailed drawings to interpret drawings of moderate complexity.

Competency 5: Demonstrate the ability to construct and interpret charts and graphs commonly associated with the processing and manufacturing industries, including:

5.1 construct and utilize common graphs to derive information relevant to the solution of practical problems.

5.2 construct and interpret specific graphs plotted for establishing methods of assuring quality control; namely, Pareto, histogram, normal distribution, scatter diagram, and Average and Range ($\bar{x}$ & R) charts, and attribute control charts.

5.3 derive information from graphs and charts in manufacturer's handbooks and technical manuals.

Competency 6: Identify relevant symbols and interpret schematic diagrams of weldments as well as electrical, electronic and piping systems, including:

6.1 identify various piping symbols in accordance with the ANSI symbol definition.

6.2 identify various electrical symbols in accordance with local and National Electrical Code.

6.3 identify various electronic component symbols and interpret electronic diagrams.

6.4 identify various elements associated with welding symbols -- in accordance with the American Welding Society's symbol standards.

6.5 derive specific information from building riser and wiring prints and schematic diagrams.

Required Course Textbook:

<u>Drafting Technology</u>
Earle, James H., Addison-Wesley

Required Course Workbook:

<u>Drafting Technology Problems</u>
Earle, James H., Creative Publishing

Equipment:

(See attached list) to include -- standard drafting room furnishings.

Recommended Course Instructor's Reference Textbooks (SPC Charts):

<u>Basic Manufacturing Processes</u>
Kazanas, H.C. & others
McGraw-Hill, N.Y.

<u>An Introduction to Basic Statistical Process Control</u>
Garrity, Susan M.
Tech Center Courseware Company

<u>Statistical Process Control -- A Guide for Implementation</u>
Bergo, Roger W. & Hart, Thomas H.
ASQC Quality Press, Milwaukee

<u>Statistical Quality Assurance</u>
Guldner, Francis J.
Delmar, N.Y.

Other:

Delmar Publishers and others series of blueprint reading modules

Various manufacturer's handbooks of tables, charts and manuals

SUGGESTED EQUIPMENT AND SUPPLIES

Required Equipment for Drafting Laboratory Class Work:

Plastic or Ruby Eraser
Erasing Shield
Irregular (French) Curve Set
8-Inch 45° Triangle
10-Inch 30°/60° Triangle
6-Inch Protractor
Combination Scale, or Architect's and Engineer's Scales
Metric Scale
6-Inch Bow Compass (Large Bow)
Lead Holder (two recommended) and Lead Pointer (any type)
Leads: 4H, 2H, H
Drafting Tape (Masking tape may be used)
Ames Lettering Instrument
Pad of Cross-Section Paper, 8-1/2 x 11 inches (1/4" or 1/8" squares)

Optional Equipment:

Adjustable Triangle
Dusting Brush
Gum Bag (dry pad) Cleaner
Dividers
Architect's and Engineer's Scales,
Tracing Paper
Templates (Circles, Ellipses; Symbols: Welding, Piping, etc.)

Necessary Equipment for Homework and Practice Outside of Laboratory:

Drawing Board
T-square

Course Competencies For:

1. Title: Manufacturing Processes Laboratory I GET___ 3 credits
Two Hours Lecture
Two Hours Laboratory

2. Course Description: This course is designed to provide the student with theoretical and selected practical exercises dealing with various manufacturing operations and processes. The degree of exposure to individual operations and processes will range from assigned textbook and reference readings to laboratory exercises. Topics of coverage will include inspection, hot and cold forming, welding, fastening, machining, casting, molding, finishing, assembly, material handling, packaging, process flow, statistical process control, planning, economic justification and related topics. Conventional and newer methods of production will be covered with an emphasis of how computerized equipment can be integrated into the factory environment. Field trips to various industries will supplement instruction.

3. Course Competencies/Behavioral Objectives

Competency 1: Describe the various principles, equipment, operations and materials used to produce cast and molded parts, including:

1.1 determine the classification of casting and molding processes, methods, and materials.

1.2 determine the nomenclature associated with cores, molds, patterns, dies, and the function associated with each.

1.3 determine the procedures involved in the various types of molding processes.

1.4 determine the procedures for melting, pouring and cleaning of cast materials.

Competency 2: Describe, in general terms, the materials forming and removal (machining) processes, including:

2.1 describe the principles of operation for hot, cold and special forming equipment.

2.2 identify the sub-processes and categories comprising the materials forming processes.

2.3 discuss terms such as machinability, chip formation, cutting-tool materials, cutting-tool geometry and coolants.

2.4 describe the basic geometric shapes that can be produced by machine tools and identify the operations/specific machines required to produce a given part feature.

2.5 identify the relatively new category of chipless, special material removal processes.

Competency 3: Describe various fastening, joining and welding processes, including:

3.1 discuss the methods of mechanical fastening, types of fasteners available, and the application for each.

3.2 describe the principles involved with the process of adhesives bonding and the use/dispensing of sealants.

3.3 describe the common types of adhesives available and the limitations associated with each.

3.4 describe the various welding processes and the physical phenomena associated with each.

3.5 describe the inspection and testing techniques commonly associated with welding.

3.6 describe the various solder/brazing processes and discuss related equipment and materials.

3.7 discuss the basic types of joints used in brazing and welding.

Competency 4: Describe the basic principles involved with surface preparation, finishing, painting and plating, including:

4.1 describe the equipment and techniques associated with the in-process cleaning of parts.

4.2 discuss the equipment, processes and techniques associated with part surface coating and finishing.

4.3 identify the reasons for plating a product.

Competency 5: Discuss the aspects of design, planning, common data base creation, sharing of information and organizational structure required for the manufacture/distribution of a product, including:

5.1 discuss, in general terms, the nature, properties and types of materials used in the manufacture of various products.

5.2 describe how modern production methods have evolved with regard to manufacturing systems and automation.

5.3 discuss the concept of product design for ease of manufacture and reduction of costs (in regard to modern production, assembly, materials handling).

Competency 6: Describe the concepts associated with, and the measures taken to perform cost benefit analysis, justification, and quality control assurance in a processing or manufacturing environment, including:

6.1 discuss the fundamentals of investment analysis, identification of types of costs and break-even analysis, and perform a case study.

6.2 describe a general procedure for performing project evaluation and justification.

6.3 describe the role that specifications and standards play in maintaining the quality of products.

6.4 describe the tools/equipment techniques and procedures (with applications), commonly used for inspection purposes and quality control.

6.5 discuss the concepts associated with quality control and assurance techniques.

6.6 discuss the general principles of operation, types of parts capable of being processed, capacities, etc. for various machines/machine tools, packaging, and materials handling equipment found in a modern production environment.

Competency 7: Discuss, in general terms, the various considerations associated with special purpose equipment, mass production, hard and soft automation, assembly techniques, materials handling, storage, and product identification as they relate to the process flow of a product through manufacture, including:

7.1 describe the "special" machinery processes which have evolved over the last forty years.

7.2 describe the terms--primary and secondary operations, and describe the impact of such operations as they relate to the process flow of manufacture and assembly of piece-parts.

7.3 describe the concepts associated with mass production.

7.4 describe the term "dedicated equipment" and give an example of a function that can be performed with such equipment in the manufacture of a part.

7.5 describe the difference between special purpose or dedicated equipment and flexible or reprogrammable equipment.

7.6 describe the role of the control system in automation.

7.7 describe the two basic types of assemblies.

7.8 describe the two methods employed in mechanized assembly of parts.

7.9 describe the concepts involved with designing components for automatic assembly.

Required Course Textbook:

<u>Basic Manufacturing Processes</u>
Kazonas, H.C. & others
McGraw-Hill, N.Y.

Recommended Instructor's Reference Textbook:

<u>Materials and Processes in Manufacturing</u>
DeGarmo, E. Paul & others
MacMillan, N.Y.

Course Competencies For:

1. Title: <u>Introduction to Robotics</u>

3 credits
Two Hour Lecture
Two Hour Laboratory

2. Course Description: This course is designed to provide instruction on industrial robots and the work cell systems in which they operate. Robots and associated cell equipment will be defined and classified. The advantages and disadvantages of various pieces of equipment and various systems will be discussed. An overview of sensors and programming languages will be provided. Basic accident prevention practices and procedures, as well as human factors associated with robots and automated systems, will also be addressed.

3. Course Competencies/Behavioral Objectives

Competency 1: Provide an overview of the historical developments associated with the field of robotics. In order to attain this competency, the student should be able to:

1.1 Cite key events in the recent history of robots.

1.2 Identify major advances in mechanization in automation since the industrial revolution.

1.3 Describe the relevance that computerized numerically controlled machine tools hold for the progression of those technologies resulting in the development of the robot.

1.4 List the names of key individuals and their accomplishments in furthering the field of robotics.

1.5 Provide the Society of Manufacturing Engineers definition of an industrial robot and explain the subset of definitions associated with the descriptive characteristics therein.

1.6 Elaborate on the variables associated with productivity, competition and profit which are key factors associated with the drive to develop "steel collar" workers.

Competency 2: Describe the various schemes by which robots are classified and cite particular descriptions relating to manufacturer's specifications.

In order to attain this competency, the student should be able to:

2.1 Define basic terms associated with a robot.

2.2 Provide a basic description of a robot system.

2.3 Cite the major groups into which robots are classified.

2.4 Describe the various subgroup categories within the classification of work envelope coordinate systems.

2.5 Describe the various subgroup categories within the classification of power sources.

2.6 Elaborate on the subgroup categories within the classification of control techniques, controller intelligence, and path control.

2.7 Discuss classification subgroups within the areas of applications.

Competency 3: Elaborate on the general characteristics of end effectors and end-of-arm tooling (EOAT).

In order to attain this competency, the student should be able to:

3.1 List the various types of end effectors and grippers.

3.2 Describe the application and basic design requirements for each type of gripper.

3.3 List the various types of EOAT.

3.4 Describe the applications and basic design requirements for each type of EOAT.

3.5 Discuss the purpose, design and application of commonly used special purpose tooling.

3.6 Differentiate between the types of tooling systems (active and passive) and explain the basic designs involved with each, citing typical applications for both types.

Competency 4: Demonstrate a basic knowledge of control systems and their operation.

In order to attain this competency, the student should be able to:

4.1 Provide a definition for, and cite the five reference frames commonly associated with a robot, providing an explanation of how reference frames are incorporated into a robot control system.

4.2 Identify and differentiate between internal and external devices utilized for position control in open loop systems.

4.3 Cite the advantages of open loop control systems.

4.4 Identify and differentiate between internal and external devices utilized for position control in closed loop systems.

4.5 Cite the advantages of closed loop control systems.

4.6 Describe, in general terms, the architecture for both servo and nonservo robot controls.

Competency 5: Compare and contrast the basic types of sensors/transducers and their interface systems as utilized in robotic applications.

In order to attain this competency, the student should be able to:

5.1 Describe the basic physical/electrical properties and operational characteristics of limit switches and tactile devices.

5.2 Describe the basic physical/electrical properties and operational characteristics of proximity, photoelectric, vision, and other process sensors.

5.3 Provide a definition for "interface" and cite (in general terms) the basic interface requirements for the various types of sensors found in a robotic system.

5.4 Distinguished between a "simple" and a "complex" interface and list guidelines for elimination of potential problems associated with simple and complex sensors.

5.5 Discuss how the robot controller interfaces with the physical objects within the work envelope of the robot.

5.6 Explain how the robot controller interfaces with the manipulator or robot arm.

5.7 Summarize the basic requirements of and identify a control configuration for a simple and complex sensor interface.

Competency 6: Discuss the types of communication languages available on robots, the development techniques associated with each, and classification of design requirements associated with various controls.

In order to attain this competency, the student should be able to:

6.1 Identify the system functions for which robot computers are responsible for overseeing.

6.2 Describe how robot designers approach language selection and explain the criteria upon which language constructs are developed.

6.3 Explain language classifications to include: joint control, primitive and structured languages.

6.4 Differentiate the various methods of actually programming a robot.

6.5 Prepare sample programs.

6.6 Analyze sample programs.

Competency 7: Define criteria relevant to incorporating robots into an accident prevention program.

In order to attain this competency, the student should be able to:

7.1 Cite sections of the Occupational Safety and Health Act of 1970 which are applicable to robotic work cells.

7.2 Interpret and apply the American National Standards Institute's standard for "Industrial Robots and Robot Systems -- Safety Requirements" ANSI/RIA R15.06-1986 during the construction, installation, care, and use of industrial robots and industrial robot systems.

7.3 Compile a list of guidelines appropriate to enhancing safety consciousness and advising workers of hazards associated with robotic work cells.

Competency 8: Cite the human factors generally associated with robotics.

In order to attain this competency, the student should be able to:

8.1 Compile a list of distinct training activities that should be conducted during the implementation phase of an automated system.

8.2 Describe the basic content requirements for a general training program.

8.3 Assist in the development of specific training guidelines for operator, programmer, and maintenance personnel.

8.4 List various reasons for resistance to and the encouragement for robot automation.

Required Course Textbook:

Introduction to Robotics - A Systems Approach, Rheg, James. Prentice Hall, NJ 1985
ISBN 0-13-495581-1 01

Recommended course reference text materials (for instructor) for portions of course presentation covering OSHA, Safety, and Accident Prevention:

1. General Industry OSHA Safety and Health Standards (29CFR1910) OSHA 2206
   Department of Labor, Occupational Safety and Health Administration
   (available at no cost from local OSHA office)

2. The OSHA Act of 1970 - OSHA 2001 - No cost - Local OSHA office.

3. American National Standard for Industrial Robots and Robot Systems--Safety Requirements. ANSI/RIA R15.06-1986
   American Standards Institute, N.Y.

Methods of Instruction:

Lecture and discussion, assignments, demonstration.

Methods of Evaluation:

Quizzes, written assignments, class discussion, final examination.

Equipment:

Standard classroom/media projection equipment. Appropriate laboratory robot, sensors, controllers, etc.

Recommended Agencies for Instructional Materials:

Society of Manufacturing Engineers
One SME Drive
P.O. Box 930
Dearborn, Michigan 48121 (313)271-1500

Robotic Industries Association
P.O. Box 3724
Ann Arbor, Michigan 48106 (313)994-6088

Automation Training Systems
P.O. Drawer 1750
Greenwood, SC 29648

Science Media
P.O. Box 910
Boca Raton, Florida 33432 (305)391-0332

Other--Various manufacturers and vendors of robots and automated equipment.

ARTICULATION

(Secondary and Post-Secondary Education)

Vocational/occupational education supports the needs of local business and industry and prepares workers with entry-level skills. The need for articulation of programs is becoming more apparent due to growing local and national concerns for efficiency in education, rising costs of education, elimination of duplication of effort and demands from the public for accountability.

Coordination of secondary and post-secondary programs was a major theme of the 1976 Federal educational legislation. The 1983 efforts of the Pennsylvania Advisory Council on Vocational Education fostered, among other things, stronger business and industry linkages with vocational programs and articulation efforts between secondary and post-secondary and adult vocational education programs.

In 1983, the Pennsylvania Advisory Council on Vocational Education made a recommendation on articulation agreements. The recommendation, as it addressed articulation, stated:

4. Articulation agreements between comprehensive schools, community colleges, colleges, universities and AVTS should be established. These agreements should stimulate joint efforts in facilities' utilization, curriculum planning, providing customized job training, utilizing business/industry contracts, etc. These agreements would be considered in the approval process for receiving state and federal vocational education funds.

Further, articulating programs between secondary area vocational-technical schools and the local community college would maximize the efforts and efficiency of our state educational system. This integration would be efficient and economical in terms of better use of facilities, staff and equipment, reduced length of study time, and the ability to address employer needs in a systematic plan.

In the development of this curriculum, the Automated Systems/ Robotics Technology Program, it was intended to build upon maximum integration of at least two major state education delivery systems, the community college and the secondary vocational-technical system. With this articulation plan and cooperation in mind, a decision must be made as to which students could profit the <u>most</u> from this learning experience.

Generally speaking, secondary students with a mechanical, electronics and/or drafting background seemed to have many of the basic skills necessary for a smooth articulation. These general categories suggest students from course selections such as:

* Drafting and Design
* Machine Shop
* Welding
* Appliance Repair
* Computer Service.

* Electronics
* Welding, and other courses as deemed appropriate by a joint committee of the community college and the area vocational-technical school.

Specific courses which seem to be appropriate or reasonable starting points of exploration of articulation include:

* Technical Drafting,
* Technical Mathematics,
* Technical Physics,
* First Aid/Safety, and
* Industrial Processes Laboratory

While no one student would be expected to possess the background and/or competencies in all of the above courses, different students from various courses (programs) would have completed parts of or complete courses. Again, the determination of breadth, depth and evaluation of the articulation process should be determined by the joint committee.

Other courses not mentioned above should also be waived by students possessing competency in that area. Usually most institutions have an evaluation mechanism to assess that background.

PROPOSED SECOND YEAR COURSE LISTING

LUZERNE COUNTY COMMUNITY COLLEGE

Automated Systems/Robotics
Second Year

Third Semester

Course	Credits
Introduction to Computer Programming GET 234	3
Physics II PHY 124	4
Digital Circuits IEL 205	3
Prog. Logic Controllers GET ____*	3 (2 hr lect/ 2 hr lab)
Electro Mechanical Devices GET ____*	3 (2 hr lect/ 2 hr lab)
Health/Physical Education	1
	17

Fourth Semester

Course	Credits
General Psych PSY 103	3
Industrial Safety GET ____*	1
Robotics Laboratory GET ____*	4 (2 hr lect/ 4 hr lab)
Fluid Power GET ____*	3 (2 hr lect/ 2 hr lab)
Tech Report Writing ENG 261	3
	14

SECTION IV

ROBOTICS AND FLUID POWER LABORATORIES

EDUCATIONAL SPECIFICATIONS

ROBOTICS LAB

H. GENERAL DEVELOPMENT OF PHYSICAL PLANT

1. Climate Control

   a. A temperature of 65 degrees should be maintained during the winter months.
   b. This area should be air conditioned.
   c. The space should have a separate thermostat.

2. Acoustical Factors

   This laboratory is a low to medium noise level area and requires a STC rating of 42.

3. Illumination Factors

   a. This laboratory requires 50 to 70 footcandles at the working surface.
   b. Each work station to have an illuminated magnifier type bench lamp.

4. Aesthetic Factors

   Should be similar to high quality spaces in industry.

5. Storage Facilities

   a. Storage requirement size is stated under Support Space. This space will be utilized to store test equipment, tools and components.
   b. Provide wall mounted coat hangers sized to accommodate 24 students.

6. Vertical Instructional Surfaces

   a. Provide (1) 4' x 8' whiteboard in the laboratory.
   b. Provide (2) 4' x 4' tackboards in the laboratory.

7. Utility Considerations

   a. Electrical

      1) Provide 110v. duplex outlets at 4'-0" o.c. around the perimeter of the laboratory.
      2) Provide 240v., 1 phase.
      3) Provide 240v., 3 phase.
      4) Provide 100 psi air wall outlets, 30 psi duster heads, one outlet required.

5) Provide CCTV cabling and jack plate in the lab.
6) Provide master emergency switches in all circuits with lock out.
7) Provide a ground fault circuit interrupter.
8) Provide computer cabling and jack plate in lab and instructor's office.
9) Provide a telephone line in the laboratory.
10) Provide a wall mounted analog clock (electric) in the lab.

b. Mechanical

1) Provide hot and cold water.
2) Provide a floor drain.

NOTE: All utilities should be overhead. All 110v. power must be clean.

8. Sanitation Requirements

Provide in counter sink for clean-up.

9. Display Areas

No special requirements.

10. Provisions for Handicapped Students

General architectural provisions as required and special equipment where possible.

11. Special Entrances or Exits

See "Door Considerations".

12. Special Built-in Equipment

See equipment lists.

13. Outside Lab Considerations

No special requirements.

14. Material Receiving and Shipping Requirements

No special requirements.

15. Type and Size of Outdoor Areas

No special requirements.

16. Surface Types

a. Masonry walls should be painted with oil base semi-gloss enamel.
b. Plaster and gypboard walls should be painted with semi-gloss enamel and have a 7'-0" high epoxy wainscot.
c. Floors should be sealed concrete.
d. Ceilings should be acoustically treated.
e. Provide a vision panel the entire length 32" above finished floor between robotics lab and industrial cell.

17. Door Considerations

a. All single doors to be 40" minimum.
b. A 10' x 10' overhead door is required to lab and between robotics and industrial cell.

18. Ceiling Height

The ceiling height should be 12' minimum.

19. Window Considerations

Vision panels from corridor.

I. MAINTENANCE AND SAFETY FACTORS

1. Unusual Maintenance Problems

No special requirements.

2. Safety Factors

a. Panic or emergency electrical shut-off.
b. Emergency eyewash.
c. Special safety considerations for robots (pressure pads, electric eye, barriers, etc.)

FLUID POWER LAB

H. GENERAL DEVELOPMENT OF PHYSICAL PLANT

1. Climate Control

   a. A temperature of 65 degrees should be maintained during the winter months.
   b. The laboratory should be air conditioned.
   c. Lab should be individually controlled with a thermostat.

2. Acoustical Factors

   This is a moderately noisy area and requires a STC rating of 47.

3. Illumination Factors

   a. General task lighting should be provided at 50 to 70 foot-candles.
   b. Specific task lighting should be provided for extremely fine and detailed work.

4. Aesthetic Factors

   This area should be painted in light neutral tones and could have supergraphics provided to identify the area.

5. Storage Facilities

   A storage room should be provided.

6. Vertical Instructional Surfaces

   a. Provide (1) 4' x 4' tackboard at the primary entrance of the lab.
   b. Provide (1) 4' x 16' whiteboard.

7. Utility Considerations

   a. Electrical

      1) Provide 120v. duplex outlets at 10'-0" o.c. around the perimeter of the lab.
      2) Provide 240v., 1 phase.
      3) Provide 240v., 3 phase.
      4) Provide panic switches at 50'-0" o.c. around the lab.
      5) Provide central master switch.
      6) Provide a telephone line.
      7) Provide a wall mounted analog clock (electric) in the lab.
      8) Provide CCTV cabling and jack plate in lab.

b. Mechanical

1) Provide hot and cold water.
2) Provide 100 psi air.
3) Provide floor drains.

8. Sanitation Requirements

A half round Bradley should be provided close to the main entrance of the lab.

9. Display Areas

No special requirements.

10. Provisions for Handicapped Students

General architectural provisions as required.

11. Special Entrances or Exits

See "Door Considerations".

12. Special Built-in Equipment

See equipment list.

13. Outside Lab Considerations

No special requirements.

14. Material Receiving and Shipping Requirements

No special requirements.

15. Type and Size of Outdoor Areas

No special requirements.

16. Surface Types

a. The floor in the lab should be sealed concrete.
b. Masonry walls should be painted with oil base semi-gloss enamel.
c. Plaster and gypboard walls should be painted with semi-gloss enamel and have a 7'-0" high epoxy wainscot.
d. The ceiling in the lab should be exposed deck (acoustically treated).

17. Door Considerations

a. Provide (1) 6'-0" double door with astragal.
b. All man doors should be 40".

18. Ceiling Height

The minimum ceiling height for the lab is 12'0".

19. Window Considerations

No special requirements.

I. MAINTENANCE AND SAFETY FACTORS

1. Unusual Maintenance Problems

No special requirements.

2. Safety Factors

a. Ventilation should be provided to meet OSHA and other regulatory agency requirements.
b. An emergency eyewash should be provided.

SECTION V

AUTOMATED SYSTEMS/ROBOTICS TECHNOLOGY AND FLUID POWER

EQUIPMENT SPECIFICATIONS

ALGER, DOWLING, PAULLIN, INC.
P.O. BOX 2907
GRAND RAPIDS, MI 49501

PROGRAM: Automated Systems/Robotics

DRAWING NO.:

ROOM NO.:

ORIGINATION DATE: 2-13-87

REVISIONS 4-17-87

ITEM NO.	QTY.	DESCRIPTION	COST	M/F/E	SIZE L x W x H	ELECTRICAL H.P.	VOLTAGE	PHASE	AMPS	CONN. C/D	MECHANICAL AIR	EXHAUST	GAS	WATER	FL. DR.	COMMENTS:
	1	Master Electrical Control	NA	F												By Elec. Contractor
	3	Panic Electrical Control	NA	F												By Elec. Contractor
	12.	Air Outlets, 100 PSI	NA	F												By Mech. Contractor
	1	Monorail System, 1 ton cap., electric	NA	F		1	208	3		D						By Gen. Contractor
	AR	Cable Trays for Data/Control Distribution throughout lab and to cam lab	NA	F												By Elec. Contractor
	1	Projection Screen, wall mtd.	$150.00	F												
	12	Benches, robotics trainers type	$4,080.00	M	84"x36"x36"		120	1	20	D						
	6	Cabinets, storage type, locking, various sizes	$1,500.00	M	36"x24"x84"											
	6	Tool and Accessory Carts, port.	$1,800.00	M												
	30LF	Shelving, storage	$2,500.00	M	See Plan											
	21LF	Storage Unit, drawer type	$1,750.00	M	See Plan											
	1	Cabinet, flammable materials storage	$700.00	M	36"x24"x58"											Vent per code
	6	Oily Waste Cans	$204.00	M												
	6	Safety Cans	$156.00	M												
	21LF	Pegboard, wall mtd.	$300.00	M												

ALGER, DOWLING, PAULLIN, INC.
P.O. BOX 2907
GRAND RAPIDS, MI 49501

PROGRAM: Automated Systems/Robotics, cont.

DRAWING NO.:

ROOM NO.:

ORIGINATION DATE:

REVISIONS

ITEM NO.	QTY.	DESCRIPTION	COST	M/F/E	SIZE L x W x H	ELECTRICAL H.P.	VOLTAGE	PHASE	AMPS	CONN. C/D	MECHANICAL AIR	EXHAUST	GAS	WATER	FL. DR.	COMMENTS:
	1	Robot, industrial, pneumatic type, 5-axis, elec., servo	$28,600.00	M	44"x48"x9' dia.		208	3	50	D						Data link to LAN
	2	Robot, industrial training type, electro-hydraulic, 6 axis, with controller and software	$136,000.00	M	44"x28"x9' dia.		208	3	50	D	X					100 PSI; Data link to LAN
	8	Microprocessor/Computer, ruggedized, off-line programming w/printer, plotter, and digitizer for interface w/robots and cam lab, IBM AT/XT	$72,000.00	M			120	1	10	C						Data link to LAN
	8	Tables, computer type	$2,400.00	M	48"X36"											
	8	Programmable Controller, for use with robots, industrial type, portable	$102,400.00	M			120	1	5	C						
	1	Machine Vision System for robotic applications, 30, grayscale type	$60,000.00	M	28"x16"x67"		208	1	*	C						* 600 VA
	1	Hand and Power Tools and Accessories Storage Cabinet, w/tools	$1,800.00	M	60"x34"x84"											
	24	Chair, posture type	$6,000.00	M												
	4	Conveyor System, small parts assembly, motorized	$28,000.00	M	See Plan	(3) 1/4	120	1		C						
	4	Conveyor System, pallet type, small parts machining and assembly, motorized, programmable	$140,000.00	M	See Plan	(3) 1/4	120	1		C						

58

57

ITEM NO.	QTY.	DESCRIPTION	COST	M/F/E	SIZE L x W x H	ELECTRICAL H.P.	ELECTRICAL VOLTAGE	ELECTRICAL PHASE	ELECTRICAL AMPS	ELECTRICAL CONN. C/D	MECHANICAL AIR	MECHANICAL EXHAUST	MECHANICAL GAS	MECHANICAL WATER	MECHANICAL FL. DR.	COMMENTS:
	10	Robot Trainers, 5-axis, bench mtd., with controller, teach pendant and software, portable	$40,000.00	M			120	1	5	C						See bench load
	2	Robot Trainers, scara arm type, bench mounted w/controller, teach pendant and software, portable	$20,000.00	M			120	1	5	C						*See bench load
	1 lot	Safety Fencing and Alarms, for use with robots	$8,000.00	M	See Plan											
	2	Safety Floor Mats, for use with robots	$1,000.00	M	See Plan											
		FIXED TOTAL	$150.00													
		MOVABLE TOTAL	$658,590.00													
		GRAND TOTAL	$658,740.00													

ALGER, DOWLING, PAULLIN, INC.
P.O. BOX 2907
GRAND RAPIDS, MI 49501

PROGRAM: Fluid Power

DRAWING NO.:

ROOM NO.:

ORIGINATION DATE: 2-13-87

REVISIONS

4-17-87

ITEM NO.	QTY.	DESCRIPTION	COST	M/F/E	SIZE L x W x H	ELECTRICAL H.P.	VOLTAGE	PHASE	AMPS	CONN. C/D	MECHANICAL AIR	EXHAUST	GAS	WATER	FL. DR.	COMMENTS:
	24LF	Markerboard	$1,000.00	F												
	8LF	Tackboard	$200.00	F												
	1	Projection Screen, wall mtd.	$150.00	F												
	1	Wash Sink	NA	F										H&C		By Mech. Contractor
	1	Master Keyed Electrical Control for Lab	NA	F												By Elec. Contractor
	3	Panic Type Electrical Controls	NA	F												By Elec. Contractor
	1	Sink, janitor, floor type w/oil trap	NA	F,										H&C		By Mech. Contractor
	1	Data Distribution System, intra-lab with interface to facility local area network	NA	F												By Elec. Contractor; Data link to LAN
	12	Compressed Air Outlets, wall, floor and/or overhead type	NA	F							X					By Mech. Contractor; 100 PSI
	12	Hydraulic and Pneumatic Controls Technology Bench Units, each with basic, intermediate and advanced hydraulic and pneumatic components	$147,600.00	M	96"x30"x36"	1	208	3		C	X					*100 PSI
	12	Electro-Fluid Power Controls Technology Units, for use with bench units above	$50,400.00	M	Portable		NA									
	12	Basic Mechanisms Units, for controls technology units above	$24,000.00	M	Portable		NA									

61 62

ALGER, DOWLING, PAULLIN, INC.
P.O. BOX 2907
GRAND RAPIDS, MI 49501

PROGRAM: Fluid Power, cont.

DRAWING NO.:

ROOM NO.:

ORIGINATION DATE: 2-13-87

REVISIONS 4-10-87

ITEM NO.	QTY.	DESCRIPTION	COST	M/F/E	SIZE L x W x H	ELECTRICAL H.P.	VOLTAGE	PHASE	AMPS	CONN. C/D	MECHANICAL AIR	EXHAUST	GAS	WATER	FL. DR.	COMMENTS:
	2	Electro and Hydraulic Servo Controls Units, for use with controls technology unit	$24,000.00	M	Portable		NA									
	2	D.C. Electric Servo Controls Unit, for use with controls technology unit	$9,120.00	M	Portable		NA									
	2	Resolver Electronic Unit, for position transducer system for use with controls technology unit	$4,800.00	M	Portable		NA									
	2	Digital Computer Interface Units	$2,400.00	M	Portable		NA									
	2	Analog Computer Interface Units	$1,500.00	M	Portable		NA									
	2	Programmable Controller Interface Units	$720.00	M	Portable		NA									
	2	Programmable Electronic Controllers for use with controls technology units	$13,200.00	M	Portable		NA									
	2	Microcomputers, ruggedized type, for use with controls technology units	$6,000.00	M	Portable		120	1	10	C						Data link to LAN
	3	Work Stations, microcomputer type, port.	$2,100.00	M	Portable											
	24LF	Storage Shelving, steel type, heavy duty	$2,000.00	M	See Plan											
	6	Storage Cabinets, double locking doors	$1,500.00	M	See Plan											
	15LF	Storage Units, bin type	$1,250.00	M	See Plan											
	15LF	Storage Units, drawer type	$1,250.00	M	See Plan											

ALGER, DOWLING, PAULLIN, INC.
P.O. BOX 2907
GRAND RAPIDS, MI 49501

PROGRAM: Fluid Power, cont.

DRAWING NO.:

ROOM NO.:

ORIGINATION DATE: 2-13-87

REVISIONS

4-17-87

ITEM NO.	QTY.	DESCRIPTION	COST	M/F/E	SIZE L x W x H	ELECTRICAL H.P.	VOLTAGE	PHASE	AMPS	CONN. C/D	MECHANICAL AIR	EXHAUST	GAS	WATER	FL. DR.	COMMENTS:
	6	Workbenches, with vises	$2,700.00	M	72" x 48"											
	1 set	Hydraulic and Pneumatics Hand Tools and power tools with storage unit	$2,000.00	M	60"x24"x84"											
	1 set	Electrical and Electronics Hand Tools with storage unit	$2,000.00	M	60"x24"x84"											
	24LF	Pegboard for component storage, wall mounted	$300.00	M	See Plan											
	1	Servo Valve Test Unit, port., Servoscope	$675.00	M			NA									
	12	Controls Technology Student Work Stations to interface w/training units, programmable controllers and microcomputers	$24,000.00	M	84"x36"x36"		120	1	20	C						
	2	Plotters, single pen, A/B size for use with microcomputers	$8,000.00	M			120	1	*	C						*100 watts; Data li to LAN
	2	File Cabinets, four drawer	$600.00	M	15" x 28"											
	1	Platform Cart, 400 lb. cap.	$400.00	M			NA									
	12	Microcomputer Software, for controls technology applications	$14,400.00	M												
	12	Microcomputer Software, for programmable controller applications	$24,000.00	M			NA									

65

66

ALGER, DOWLING, PAULLIN, INC.
P.O. BOX 2907
GRAND RAPIDS, MI 49501

PROGRAM: Fluid Power, cont.

DRAWING NO.:

ROOM NO.:

ORIGINATION DATE: 2-13-87

REVISIONS

4-17-87

ITEM NO.	QTY.	DESCRIPTION	COST	M/F/E	SIZE L x W x H	ELECTRICAL H.P.	ELECTRICAL VOLTAGE	ELECTRICAL PHASE	ELECTRICAL AMPS	ELECTRICAL CONN. C/D	MECHANICAL AIR	MECHANICAL EXHAUST	MECHANICAL GAS	MECHANICAL WATER	MECHANICAL FL. DR.	COMMENTS:
	6	Electronic Sensor Applications Units for use with controls technology units	$8,800.00	M			NA									
	6	Air Logic Controllers for use with controls technology units	$16,000.00	M			NA									
		FIXED TOTAL	$1,350.00													
		MOVABLE TOTAL	$427,715.00													
		GRAND TOTAL	$429,065.00													

67

68

SECTION VI

ATTACHMENTS

Citizens' Voice, Wilkes-Barre, Pa. Wednesday, September 17, 1986 — 42

LCCC,

LC

Representatives from
schools met recently w
Community College for
planning for developmen
eral new advanced techno

Among the area vo-tec
ing, held at the school'
were Hazleton, Lackawa
Wilkes-Barre. The curric
ject include Computer In
Repair Technology,
Assisted Design and Robo

The project between th
schools is designed to de
which a student can beg
technical school legel an
college level without an in

Among those in atten
from left, were: James
Wilkes-Barre AVTS; G
James Davis, Lacka
Zmitrovich, Hazleton A
Lyons, West Side AVTS
director of busines/In
LCCC; Ben Roodeman
Haggerty, Wilkes-Barre

area vo-techs plan technologies programs

LCCC and vo-tech school representatives meet in joint session

rom five area vocational-technical y with officials at Luzerne County for the purpose of beginning the joint ment of curriculum materials for sev- chnology programs.

-tech schools represented at the meet- hool's Educational Conference Center, awanna, Susquehanna, West Side and rricular programs involved in the pro- r Integrated Manufacturing, Computer , Laser/Electro-Optics, Computer Roboltics/Automated Systems.

n the community college and technical o develop competency-based curricula begin at the secondary or vocational- l and continue at the post-secondary or an interruption in studies.

ttendance for the meeting, first row, nes Newell and Edward A. Shedlock, ; Gray Bossi; Henry Stachura and ckawanna County AVTS; Joseph n AVTS, and James Kane and David VTS; second row: Wesley E. Franklin, s/industry/education partnership at man ...awanna AVTS; James ... Walter Rounds and Paul Liptay, Lackawanna AVTS; Linda M. Thomas, educational programmer at LCCC; Jo Anne S...alske, video producer, LCCC, and Bill Karloltski, production engineer at LCCC; third row: Nathan Williams, Wilkes-Barre AVTS; Carol Adukaitis, Susquehanna AVTS; Dominic Pino, John Lenchak, Nicholas St. Maray, Hazleton AVTS; GFene Frick and Joseph Kasztejna, Lackawanna AVTSS; Ormo..d Lolng, Wilkes-Barre AVTS; Libby Yeager, research specialist at LCCC; Regina Antonini, director of special services p;rogram at LCCC, and Kenneth G. Kirk, Pensylvania Department of Education.

One of the main purposes of the joint planning effort, approved by the Pennsylvania Department of Education, Bureau of Vocational and Adult Education, with funding from the Perkins Vocational Education Act of 1984, is to develop competency-based curricula. LCCC would develop programs so high school graduates without a technology background could also enroll in them.

Coordinating the project at LCCC is Wesley E. Franklin. Said Franklin, "This represents a major collaboration between the five technical schools and LCCC, establishing a model for joint planning between secondary and post-secondary educational institutions in the development of what is known as the '2 + '2 concept. This concept provides for instructional continuity between the first two years of a program offered at the secondary level and the next two years at the community college."

Recognizedd by the Pennsylvania Department of Education, Bureau of Vocational Education, as a unique, innovative approach, this synergistic effort will help to eliminate duplication of expensive advanced technololgy equipment, maximize the instructional resources of all participating institutions, and open new or expand existing channels of communication and cooperation between the vocational technical schools and LCCC.

"The directors of each vocational technical school were instrumental in the development of the project and provided essential impetus in involving members of their staffs," noted Franklin. "The project will also draw heavily on the expertise of local business and industry in establishing what technological tasks should be included in each program and what level of competency is acceptable for each."

Franklin concluded: "One of the primary reasons for creating such a project was the emphasis of the Pennsylvania Department of Education on program development in advanced technologies, supported by the very strong indicators in economic and industry data that the technologies included will be essential components of Northeastern Pennsylvania's future labor force."

For further information on the project, contact Franklin at 829-7380, or Nancy Kosteleba, director of the Center for Instructional Development at LCCC, at 829-7355.

ATTACHMENT #1

AUTOMATED SYSTEMS/ROBOTICS AND COMPUTER ASSISTED/COMPUTER INTEGRATED MANUFACTURING

LITERATURE SEARCH

Automated Systems Technology (March 1986)	North Iowa Area Community College 500 College Drive Mason City, IA 50401
Robotics/Automated Systems Technician Training (1985)	Center for Occupational Research and Development 601C Lake Air Drive Waco, TX 76710
Electromechanical Drafting	Idaho State University School of Vocational-Technical Education Pocatello, ID 83209-0089
CAD/CAM CIM	Camden County College P.O. Box 200 Blackwood, NJ 08012
Automation/Robotics Technology	Catawba Valley Technical College Hickory, NC 28601
Fundamentals of Industrial Robotics - Video Tape Teacher's Guide	Meridian Education Corporation 205 East Locust Street Bloomington, IL 61701
Electronics Diagnostic Technician	Hawkeye Institute of Technology 1501 East Orange Road Waterloo, IA 50704
A Catalog of Performance Objectives and Performance Guides for Electromechanical (Robotics) Technician (Copyright 1984 V-Tec)	Associated Educational Consultants, Inc. Pittsburg, PA 15237 and Pennsylvania Department of Education Harrisburg, PA 17108

Preparing for High Technology CAD/CAM Programs A Guide for Community Colleges Robotics Program	The National Center for Research in Vocational Education The Ohio State University 1960 Kenny Road Columbus, OH 43210
Computer-Aided Drafting and Design	York College York, PA
Hydraulic Technician Industrial Pneumatic Technology	State Department of Vocational and Technical Education CIMC Stillwater, OK
Robotics Training Systems Concepts and Applications	Buck Engineering Company for Lab-Volt
Professional Teacher Education Module Develop Program Goals and Objectives Conduct an Occupational Analysis Develop a Course of Study Develop Long-Range Program Plans	American Association for Vocational Instructional Materials The University of Georgia Athens, GA 30602

DIRECTIONS:

RATE EACH TASK ON A SCALE OF 1 TO 5 WITH 1 - LEAST IMPORTANT AND 5 - MOST IMPORTANT.

A - Electrical/Electronic

1. Use manufacturers' parts list and drawings concerning replacement parts for Robotics/Automated Systems to

   3.63 a. Identify part numbers
   2.13 b. Order replacement parts
   3.38 c. Install replacement parts

2. Adjust, troubleshoot, repair, and/or replace:

   3.63 a. Power supplies
   3.25 b. Servo amplifiers
   3.38 c. Motor control circuits
   3.38 d. Electronic sensors
   3.13 e. Transducers

2.50 3. Attach and replace connectors to wire and fiber optic cables.

2.38 4. Install low and high voltage and interconnecting signal (wire and fiber optic) cables.

2.63 5. Troubleshoot and repair wire and fiber optic system cable faults.

3.38 6. Conduct routine preventive maintenance on electrical and electronic equipment in accordance with manufacturer's recommendations.

3.38 7. Troubleshoot electronic failures to the circuit board level; replace defective circuit board.

2.50 8. Conduct routine preventive maintenance on AC and DC motors in accordance with manufacturer's recommendations.

9. Install, adjust, troubleshoot and repair or replace to manufacturer's specification:

   3.50 a. Control devices
   2.88 b. Relays (electromechanical and solid state)

3.50 c. Sensors
3.25 d. Limit switchers
3.25 e. Transducers
3.63 f. 1 and 3 electrical equipment

2.50 10. Connect fiber-optic cables to electronic equipment.

3.25 11. Troubleshoot and repair or replace fiber optic components/systems.

3.63 12. Program stepper motors.

3.13 13. Apply bridge circuits to measuring voltages and currents.

3.00 14. Replace components on circuit boards.

3.25 15. Solder and desolder electrical connections.

2.88 16. Install and remove circular (multipin), coaxial, and in-line plugs and receptacles.

17. Measure and set voltages and currents.

2.75 a. Facility power
3.25 b. Equipment power supply

B - Pneumatic

3.13 1. Maintain pressure regulators.

2. Install, adjust troubleshoot and repair or replace pneumatic:

2.88 a. Airlines
3.38 b. Pumps
3.00 c. Gages
3.25 d. Filters
3.75 e. Control valves
3.50 f. Actuators
3.25 g. Cylinders
3.63 h. Pressure switches
3.63 i. Positioner relays

3.38 3. Adjust a pneumatic-sensor temperature controller to a specified mixed air temperature.

3.50 4. Properly use dampers, thermostats, switches, pneumatic positioners, linkage assemblies and accessories in pneumatic systems.

3.13 5. Conduct routine preventive maintenance on pneumatic equipment in accordance with manufacturer's instructions.

C - Hydraulic

1. Install, adjust, troubleshoot, and repair or replace hydraulic:

   3.13 a. Lines
   3.38 b. Pumps
   3.13 c. Gages
   3.63 d. Filters
   3.25 e. Accumulators
   3.50 f. Volume controls
   3.63 g. Servo valves
   3.38 h. Directional control valves
   3.25 i. Pressure control valves

3.00 2. Test for hydraulic oil quality and use external filter system to purify.

3.50 3. Control oil pressure and temperatures.

3.63 4. Null hydraulic system pressure losses.

3.63 5. Conduct routine preventive maintenance on hydraulic equipment in accordance with manufacturer's specifications.

D - Mechanical

3.75 1. Set and adjust mechanical stops.

4.00 2. Set actuators to proper end positions.

3.63 3. Install and maintain linkage.

3.25 4. Install and maintain gear trairs.

3.13 5. Conduct routine preventive maintenance on mechanical equipment in accordance with manufacturer's specifications.

E - Computer

3.00 1. Troubleshoot malfuctions in computer system to circuit board level.

2. Install, troubleshoot, remove and replace:

   3.13 a. Memory devices
   3.13 b. Displays
   3.38 c. Control circuits
   3.25 d. Keyboards and printers
   3.63 e. Central processing unit (CPU)

3. Install input/output (I/O) devices in accordance with manufacturer's specifications:

   3.25 a. Cathode-ray tubes (CRTs)
   3.13 b. Printers
   3.00 c. Tape drives
   3.00 d. Disk drives
   3.13 e. Plotters
   3.00 f. Flat screen displays (including gas plasma displays)

3.13 4. Install module or board-mounted RAM and ROM memory devices in accordance with manufacturer's specifications.

4.00 5. Load and run diagnostic routines.

3.88 6. Interpret diagnostic printouts.

4.38 7. Install programmable controllers.

2.75 8. Use diagnostic routine program language written in machine language(s).

9. Program and/or reprogram PCs (drum, relay, and microprocessor types) for specific sequence of events in performing an application.

   3.38 a. Prepare a flow chart for a specific sequence of events in performing given application.

   3.88 b. Enter instructions into control unit.
   3.75 c. Run program to see if control unit executes properly.

4.00 d. Edit or debug program as necessary.
4.00 e. Download and upload system.
3.75 f. Recognize and resolve hardware/software impedance matching problems.

3.75 10. Write, enter, and debug programs in one structered language.

3.25 11. Install, set up, calibrate, troubleshoot and repair or replace data transmissions systems.

F - Electromechanical

1. Install, adjust, troubleshoot and repair or replace:

3.75 a. Servo motors
3.25 b. AC pump motors (vacuum and pressure)
3.00 c. Speed-reduction units
3.00 d. Clutches
3.88 e. Stepping motors
3.38 f. Mechanical drives for feedback system

2. Install, adjust, troubleshoot and repair or replace sensors for:

3.50 a. Flow control
3.38 b. Liquid-level control
3.75 c. Ultrasonic control
3.50 d. Optoelectric
3.13 e. Tactile
3.38 f. Video

G - General

3.75 1. Effectively select and utilize such test equipment as time-domain reflectometers, oscilloscopes, spectrum analyzers, function generators, chart recorders, and multimeters for troubleshooting and repair of electronic circuits.

3.38 2. Identify and demonstrate proper operation, care and maintenance of hand power tools.

3.25 3. Select and install the proper fastener for a given job.

3.50 4. Identify and use appropriate lubricant.

4.00 5. Use manual's troubleshooting charts to aid fault isolation/repair.

3.75 6. Maintain work log sheets.

3.63 7. Draw logic diagrams.

3.75 8. Read, understand and comply with requirements of service bulletins.

3.25 9. Convert measurements between English and SI systems.

3.63 10. Use both inside and outside micrometers.

4.13 11. Use manufacturer's manuals as a guide to troubleshoot, repair, test and operate a failed machine.

4.13 12. Use manufacturer's manuals to determine a machine's normal operating characteristics.

4.00 13. Using a manual, identify operational/functional systems.

H - Automated Systems

2.88 1. Measure robot performance (distance, positioning, accuracy, and repeatability).

2.88 2. Use teaching pendant for testing, editing and setup.

3.00 3. Disassemble, repair, test and return to service robots which have failed.

4. Install, adjust, troubleshoot, repair or replace:

   3.50 a. Industrial robots
   3.00 b. End effectors
   3.50 c. Smart actuators

3.50 5. Coordinate the operation of several pieces of automatic equipment.

6. Adjust feedback loops that include:

- 3.63 a. Encoders/decoders
- 3.63 b. Optical sensors
- 3.63 c. Electronic sensors
- 4.00 d. Microprocessor
- 3.75 e. Count stepper-motor pulses
- 3.25 f. Optoelectronics
- 3.25 g. Hall-effect devices
- 3.25 h. Velocity sensors
- 3.63 i. Position detectors

3.50 7. Interconnect robots and other equipment.

3.63 8. Adjust machines for accuracy and repeatability.

3.00 9. Set up machine vision systems.

4.00 10. Match off-the-shelf and effectors to the requirements of various manufacturing operations.

3.63 11. Analyze robot task requirements of a manufacturing operation.

3.50 12. Analyze and select appropriate robot sensing requirements for certain manufacturing operations.

4.00 13. Start-up and debug a robot system.

3.88 14. Start-up and shut down an automated production systems.

4.00 15. Specify safety considerations for personnel, work area, operations, and maintenance.

3.63 16. Test wiring of each subassembly of a robot; test the overall, connected wiring of the total robot.

4.50 17. Install a programmable controller and its input/output devices.

4.00 18. Follow troubleshooting procedures recommended by the manufacturer to diagnose, isolate and repair a robot/automated system.

3.88 19. Analyze operating difficulties of installed robots; perform necessary corrective adjustments to return system to normal operation.

3.25 20. Perform field testing of a robot and chect to assure that its peformance is in accordance with specifications.

3.13 21. Perform electrical adjustments on servo power amplifiers.

3.13 22. Perform zeroing of encoders.

3.50 23. Specify the robot coordinate system.

3.63 24. Develop material handling specifications for a work cell.

3.38 25. Specify the robot-to-material interfaces.

3.25 26. Define the human interface with a robot.

3.38 27. Define axis control and feedback specifications.

3.50 28. Set up, program, troubleshoot a system comprised of a minimum of two transfer lines, one robot, and at least one machining center.

3.63 29. Set up, etc., robot to either remove parts from transfer line and palletize them or to depalletize parts and place them on a transfer line.

30. Given the above setups, the instructor will install a programming error. The student (team) will diagnose and correct the problem and test the solution.

3.50 a. Programming
3.13 b. Mechanical stops
3.25 c. Electrical
3.38 d. Hydraulic power supply

3.25 31. Set up a robot to either paint parts on a moving line or weld parts on a moving line (line will stop for welding cycle).

32. Set up, etc., a robot to assemble two parts--use at least three fasteners:

3.38 a. Index
3.15 (7) b. RCC
2.75 (8)

3.38 c. Pick up
3.00 d. Fasteners
3.25 e. Install parts

3.25 33. Configure a system for counting regular/irregular shaped objects moving on an overhead track.

2.72(7) 2.38(8) 34. Define signal-sensing-control and poser interfaces involved in the first two problems.

35. Operate the following equipment:

3.25 a. End affectors
3.38 b. Grippers
3.00 c. Magnetic pickups
2.75 d. Vacuum pickups
2.75 e. Compliance devices

36. Adapt the following to robotic application:

2.75 a. Welder
2.50 b. Adhesive applicators
2.75 c. Paint sprayers
2.00 d. Grinders

37. Adapt the following to work with automated systmes:

2.75 a. Conveyors
2.38 b. Bulk feeders

38. Set up, operate, troubleshoot, and repair automated:

3.00 a. Warehousing systems
3.75 b. Machinery operations
3.00 c. Coating/application systems
3.75 d. Assembling stations
3.63 e. Material handling systems

2.88 39. Program a host computer to control several "lower-level" computers that in turn control portions of an automated system.

I - Design

3.25 1. Create two-dimensional drawing using the graphics terminal, digitizer, and plotter as design and drafting tool.

3.13 2. Sketch views not shown in a drawing.

SECTION VII

SAMPLE TASK FORCE LETTERS

HAZLETON AREA VOCATIONAL-TECHNICAL SCHOOL

23rd & McKinley Streets
Hazleton, Pa. 18201-1597

DANIEL C. PARRELL
Superintendent of Schools

DALE H. LONG
Director

June 18, 1987

Mr. Wesley E. Franklin
Director, BIE Partnership
Luzerne County Community College
Prospect Street and Middle Road
Nanticoke, PA 18634

Dear Mr. Franklin:

My involvement with the C.I.M. Task Force has been an enjoyable one. It is very pleasing to know that the Luzerne County Community College is making a very positive effort to bring a taste of Advanced Technology to the area.

I have been involved with High-Tech Manufacturing for the last nine years and I can see the need for well trained High-Tech people.

I feel that we have put forth a very well-balanced Competency-Based curriculum. All of the materials were gone over again and again in order to maintain the best possible course of study.

The meetings along with the educational trips were most important in order to meet our goal.

I would feel honored to be involved with the Advanced Technology Center in any way, whether it be in curriculum development, as a machine purchasing consultant, or on the instructional end.

Finally the people who were in charge of each committee acted in a very hospitable, professional manner.

Hope to see you in the fall.

Yours truly,

Leonard J. Tarapchak

Leonard J. Tarapchak

LACKAWANNA COUNTY AREA VOCATIONAL-TECHNICAL SCHOOL

ROBERT D. MUZZI
Administrative Director
3201 Rockwell Avenue
Scranton, Pennsylvania 18508
(717) 346 5955

CHARLES G. THOMAS
Assistant Director
Dr. Peter M. Mensky Center
Old Newk Road
Mayfield, Pennsylvania 18433
282-6780 or 876-4061

ARTHUR M. LUCARELLI
Assistant Director
Henry J. Dende Center
3201 Rockwell Avenue
Scranton, Pennsylvania 18508
Main Office 346 8471
Practical Nursing 346-8728

June 16, 1987

Mr. Wesley E. Franklin
Luzerne County Community College
Prospect and Middle Road
Nanticoke, Pa. 18634

Re: Robotics/Automated System Task Force

Dear Wes:

I would like to express my thanks for letting me be a part of your task force. I hoped my participation helped you meet your goals. In my opinion we came a long way.

After we got past the preliminaries concerning CBE definitions and activities we had solid direction for our own activities. I must commend Libby on her thorough research of related materials and the timely presentation of same. The material was very appropriate and certainly not lacking in quantity. Libby did an excellent job on the competency verification. The visit to Lancaster Vo-Tech and Harrisburg Community College along with Dave Rohm's presentation was extremely helpful as it related to equipment needs, interactive problems between the two institutions and problems related to the academic section.

We are at a point now where specific goals can be established within a determined time line. Meetings should be held to meet these goals which at this time could be more often than in the past.

I will be glad to participate next year if the need arises. The project which included needs determination and curriculum content certainly is required before program implementation. There certainly is a need for continuation of this project.

I would like to add the following comments and/or suggestions:

1. The 2 + 2 concept soundad good initially, however, as time went on it became obvious it is not practical at L.C.C.C. or A.V.T.S. level.

2. The task force is at a point where Dr. McQuay's work is required. Emphasis should be placed on his completing the draft copy of the entire curriculum.

3. The establishing of new course(s) should be considered. Assuming a course can automatically apply to a program is not accurate.

Example: Why does a robotics technician need to have knowledge of drafting techniques and occupations when a Sketching/Blueprint Reading Course will suffice? The depth of the Industrial Process courses is also questionable.

4. L.C.C.C. and the A.V.T.S. should develop a joint effort to change the image of vocational education. This I know influences your enrollments as well as ours. Prime target should be guidance staff.

Again I thank you for the opportunity to have input.

Sincerely,

Ben Rondomanski

Ben Rondomanski
Supervisor of Voc. Ed.

BR/cn
cc: E. Yeager

West Side Area Vocational-Technical School
75 EVANS STREET
PRINGLE BOROUGH
KINGSTON, PENNSYLVANIA 18704-1899
PHONE: 717-288-8493

Member School Districts:
NORTHWEST AREA
LAKE-LEHMAN
DALLAS
WYOMING AREA
WYOMING VALLEY WEST
And Services to:
GREATER WILKES-BARRE AREA

Administrative Director
GEORGE W. PYLE
Principal
THOMAS F. FEENEY
Business Manager
BRUCE W. GERMAN
Data Processing Services Manager
ROBERT D. POWELL

June 10, 1987

Mr. Wesley E. Franklin
Curriculum Materials Development Task Force
Luzerne County Community College
Prospect & Middle Roads
Nanticoke, PA 18643

Dear Wes:

I understand you will be writing the final report soon on "our" project. What a good idea to get input from area vocational-technical high school teachers before setting up your new technology center. Who is better able to tell you what is needed in regard to classrooms, equipment, shops, students, courses, etc. Hopefully, I have been of some help. I also think it was a good idea to visit vocational-technical schools in other areas of the state to see how they were coping with the new technologies.

Northeastern Pennsylvania needs this center badly. We need it to induce new industry to our area, so our young people don't have to leave to find a decent job. We in the vocational high schools need it to induce college-bound students to attend our school, to help dispel the myth that vocational students don't go to college.

Please contact me if I can be of any further assistance. The success of this center is important; not only to the college but to all of us who live in this area.

Sincerely yours,

Kathy Heltzel

Kathy M. Heltzel, Instructor
Data Processing

KMH/kk

*"He who hath a trade, hath an estate"**

** Attributed to Benjamin Franklin*

WILKES-BARRE AREA VOCATIONAL-TECHNICAL SCHOOL

P.O. Box 1699 North End Station
Jumper Road, R.D. 2 Plains Township
Wilkes-Barre, Pennsylvania 18705
[717] 822-4131

GEORGE T. YANIK, CHAIRMAN
JOINT OPERATING COMMITTEE

ROBERT G. ELIAS
ADMINISTRATIVE DIRECTOR

LEO E. SOLOMON
CHIEF SCHOOL ADMINISTRATOR

June 10, 1987

Mr. Wes Franklin
Luzerne Community College
Nanticoke, Pa. 18634

Dear Sir,

It has indeed been a pleasure to serve on your Curriculum Committee for the new High Tech Center which is being constructed at the college.

The materials covered were extensive, well prepared and presented in a manner which was in the best of everyone's interest.

The days and times of the meetings were always agreed to so that everyone could attend without any hardships incurred.

I believe much was accomplished and look forward to more productive meetings in the future.

Yours Truly,

Al Grabowski

Al Grabowski,
Wilkes-Barre Area Vo-Tech
Adult Evening Coordinator