DOCUMENT RESUME

ED 330 841 CE 057 556

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 88
CONTRACT	85-8029
NOTE	233p.; For an earier report, see ED 288 018.
PUB TYPE	Guides - Classroom Use - Teaching Guides (For Teacher) (052)
EDRS PRICE	MF01/PC10 Plus Postage.
DESCRIPTORS	*Articulation (Education); *Automation; Community Colleges; *Competency Based Education; Computer Software; Course Content; *Curriculum Development; Equipment; Regional Schools; *Robotics; Secondary Education; Two Year Colleges; Vocational Schools
IDENTIFIERS	Luzerne County Community College PA

ABSTRACT

The project described in this report was conducted at the Community College of Luzerne County (Pennsylvania) to develop, in conjunction with area vocational-technical schools, the second year of a competency-based curriculum in automated systems/robotics technology. During the project, a task force of teachers from the area schools and the college developed courses and competencies for both secondary and postsecondary robotics programs. The task force also developed materials and equipment lists, supervised the layout of the laboratory in a new Advanced Technology Center, created a competency-based catalog of proposed courses, and implemented the program. Most of this document consists of the curriculum materials, including competencies for eight automated systems/robotics courses, recommendations for equipment/software selection, and recommendations for articulation. Attachments include a list of task force members, task force data and recommendations, the Advanced Technology Center brochure, a program brochure, and specifications for three pieces of equipment. (KC)

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FINAL REPORT

DEVELOPMENT OF ARTICULATED COMPETENCY-BASED CURRICULUM IN AUTOMATED SYSTEMS/ROBOTICS TECHNOLOGY

[redacted]

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

Community College of Luzerne County

Nanticoke, Pennsylvania 18634

September 30, 1988

PENNSYLVANIA DEPARTMENT OF EDUCATION
BUREAU OF VOCATIONAL AND ADULT EDUCATION
CURRICULUM AND PERSONNEL DEVELOPMENT SECTION

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Luzerne County Community College
PROSPECT STREET AND MIDDLE ROAD ● NANTICOKE, PENNSYLVANIA 18634

ACKNOWLEDGEMENTS

The completion of this curriculum development project was made possible through the hard work, diligence, and cooperation of the following, listed in alphabetical order:

Regina Antonini	Director, Community-Based and Institutional-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	Coordinator, Customized Job Training and Task Force Coordinator
Stephen Yokimishyn	Director, BIE Partnership

The work of the Curriculum Development Task Force (see Attachment #1 for a list of their names and institutions) also merits special recognition. Their cooperation and expertise have greatly facilitated the secondary/post-secondary partnership and articulation that have resulted from this project.

A special note of appreciation is due Mr. Thomas J. Moran, President of the Community College of Luzerne County. His interest and support were very important in pursuing the project to a successful completion.

Wesley E. Franklin
Project Director and
Executive Director, Advanced Technology Center
September 30, 1988

SECTION I:

ABSTRACT
AND
FINANCIAL SUMMARY

ABSTRACT

85-8029: Development of Articulated Competency-Based Curriculum in Automated System/Robotics Technology.

Libby Yeager
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$37,306 Federal
7/1/87 to 6/30/88

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

OBJECTIVES

1. Develop courses and competencies for second year of program, both secondary and post-secondary.

2. Develop equipment lists and instructional materials for second year, both secondary and post-secondary.

3. Review all developed materials and lists (by Task Force).

4. Layout Robotics lab in new Advanced Technology Center and develop plan to integrate proposed robotics equipment into AVTS electronics and related labs.

5. Integrate automated systems/robotics courses and competencies, using V-TECS model into one unified competency-based catalog.

6. Prepare and review first draft of final report.

7. Publish and disseminate final report.

OUTCOMES

1. Task force membership was continued from previous year, with addition of four science and math teachers from four area school districts and several faculty from LCCC science and engineering technology departments. Task force met periodically and prepared advanced placement competency testing, reviewed proposed textbooks, and reviewed proposed second year program.

2. New staff for new programs were incorporated into task force and prepared detailed equipment specifications for use in competitive bid process.

3. Construction of new advanced technology center was monitored, and task force along with secondary school guidance counselors toured new facility in April and May, 1988.

4. Changes in lab layouts and specifications were made as a result of task force recommendations.

5. Second year of competency-based curriculum was approved by task force, College Senate, and President Moran, and included in 1988-89 College Catalog.

6. Program was implemented and began accepting enrollments for the 1988 Fall Semester.

7. Final report was completed and distributed to ask force, AVTS's, private sector participants, and appropriate agencies.

FINANCIAL SUMMARY

LUZERNE COUNTY COMMUNITY COLLEGE
AUTOMATED SYSTEMS/ROBOTICS
CURRICULUM MATERIALS DEVELOPMENT
1987-1988

AUTOMATED SYSTEMS/ROBOTICS

	APPROVED	EXPENDED	BALANCE
SALARIES	- 19363.00	10708.46	8654.54
BENEFITS	- 6777.00	2223.95	4553.05
HONORARIA	- 6400.00	10290.67	-3890.67
SUPPLIES - COMM	- 400.00	551.68	- 151.68
PRINTING	- 500.00	568.75	- 68.75
TRAVEL	- 426.00	870.48	- 444.48
AUDIT	- 677.00	0.00	677.00
INDIRECT COST	- 2763.00	2017.12	745.88
TOTAL	- 37306.00	27231.11	10074.89

SECTION II:

PROJECT APPROACH/ METHODOLOGY

METHODOLOGY

This curriculum materials development project began in 1986-87 and continued in 1987-88 with the assistance of a task force whose membership included representatives from the five area vocational-technical schools: Hazleton, Lackawanna, Monroe, 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. This process was continued during 1987-88.

ATTACHMENT #2 summarizes the work of the Task Force regarding program changes, textbook reviews, and advanced placement testing for certain first-year courses. Because this task force was integrated with other task forces for certain aspects of the curriculum development project, this attachment presents an integrated perspective.

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 under SECTION III, which provides a total program report.

ANALYSIS/EVALUATION

The proposed second-year program, along with a revised 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 college administrators, the College Senate, and President Moran.

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

This is the final year of a two-year project and includes the complete curricular program. This program has been implemented in the college's new Advanced Technology Center, see ATTACHMENT II, for the 1988 Fall Semester.

SECTION III:

PROJECT SUMMARY

AUTOMATED SYSTEMS/ROBOTICS (ASR) TECHNOLOGY

CURRICULUM

(Two Year Program of Study)

LUZERNE COUNTY COMMUNITY COLLEGE

Nanticoke, Pennsylvania 18634

June, 1988

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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

Course	Credits
English Composition I ENG 101	3
Technical Math I MAT 111	5
Sketching & Print Interpretation GET 108	2
Manufacturing Processes I GET 121	3
D.C. Electricity IEL 131	4
	17

Second Semester

Course	Credits
Introduction to Automated Systems/Robotics ASR 101	3
Technical Math II MAT 112	5
Technical Physics I PHY 123	4
Introduction to Computer Programing GET 234	3
AC Electricity IEL 132	3
	18

Third Semester

Course	Credits
Technical Report Writing ENG 261	3
Technical Physics II PHY 124	4
Digital Circuits IEL 205	3
Programmable Controllers ASR 203	3
Electronic Devices IEL 135	3
Health/Physical Eduction HPE	1
	17

Fourth Semester

	Credits
Electromechanical Devices ASR 205	3
Social Science Elective	3
Industrial Safety GET 112	1
Automated Systems/ Robotics Applications ASR 201	4
Fluid Power Applications ASR 207	3
Fundamentals of Speech SPE 125	3
	17

AUTOMATED SYSTEMS/ROBOTICS 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 freehand sketching techniques, 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: Sketching & Print Interpretation — GET 108 — 2 credits
One Hour Lecture
Two Hours Laboratory

2. Course Description: This course is designed to provide instruction conducive to the development of knowledge required to interpret mechanical drawings. Likewise, the student will become familiar with symbols 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 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 describe the various elements of a completed drawing, noting the considerations that are necessary for proper sketching of pictoral representations of objects, diagrams and schematics.

1.3 utilize templates and basic drafting instruments to create line drawings.

1.4 interpret basic sketches and drawings.

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

2.1 identify and interpret the American National Standards Institute's standards for line conventions and notes.

2.2 describe the purpose of each type of line on a drawing.

2.3 demonstrate how geometric elements are combined with construction techniques to describe geometric shapes.

2.4 plan, layout and create sketches.

Competency 3: Utilize the techniques of orthographic projection, multiview, auxiliary, and sectional views to 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 used to select views for part feature representation.

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

3.4 select appropriate views and complete multiview sketches of objects.

3.5 define terms associated with projection of views.

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 sketches and interpret working drawings to include detailed dimensions, notes, and application of 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 use knowledge associated with the construction of working and detailed sketches to interpret drawings of moderate complexity.

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

5.1 construction and utilization of common graphs to derive information relevant to the solution of practical problems.

5.2 interpret specific graphs plotted for establishing methods of assuring quality control; namely, Pareto, histogram, normal distribution, scatter diagram, 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, 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.

Recommended Course Textbook/Workbook

Basic, Intermediate and Advanced, Blueprint Reading Series
Delmar Publishers

Equipment:

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

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

Basic Manufacturing Processes
Kazanas, H.C. & others
McGraw-Hill, N.Y.

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

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

Statistical Quality Assurance
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
- Irregular (French) Curve Set
- 8-Inch 45° Triangle
- 10-Inch $30^{\circ}/60^{\circ}$ Triangle
- 6-Inch Protractor
- Combination Scale, or Architect's and Engineer's Scales
- Metric Scale
- Pad of Cross-Section Paper, 8-1/2 x 11 inches (1/4" or 1/8" squares)
- Pad of Isometric ruled paper 8 1/2 x 11 inches
- Templates (Circles, Ellipses, Symbols: Welding, Piping, etc.)

Course Competencies For:

1. Title: Manufacturing Processes I GET 121 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, identify types of costs and break-even analyses, 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.

Recommended 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: Introduction to Automated Systems/Robotics - ASR 101

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.

Recommended 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.

Course Competencies For:

1. <u>Programmable Controllers</u> ASR 203 3 Credits
Two Hours Lecture
Two Hours Laboratory

2. Course Description: This course is designed to provide the student with knowledge and hands-on experience with programmable logic controllers. To round out the student's educational experiences, drum sequence controllers, programmable logic controllers as well as an introduction to programmable industrial computers (PIC's) will be covered. Topics of coverage will include coding of information, decision-making concepts, hardware, software, installation-start-up-maintenance, data highways and selection of programmable logic controllers (PLC's).

3. Course Competencies/Behavioral Objectives

Competency 1: Demonstrate an awareness of the history of programmable sequences/controllers/industrial computers as well as definitions and basic terms associated with same.

1.1 Cite the historical relationships between electromechanical relays, drum switches, mechanical timers/counters, sequences, PLC's and PIC's.

1.2 Describe why modern automation systems require specific technological integration in the form of sequences, PLC's and PIC's.

1.3 Explain the function of a cathode-ray-tube (CRT), a central processing unit (CPU), input/output (I/O) devices, memory, and a power unit.

1.4 Discuss the differences and similarities between sequencers, PLC's and PIC's.

1.5 Define and discuss the terms "relay ladder logic", "digital logic", hexadecimal, binary, Basic, PROM, EPROM, EAROM, EEPROM.

1.6 List areas within various industries where there are applications for programmable controllers.

1.7 Elaborate on the features/benefits and limitations typically associated with programmable controllers.

Competency 2: Describe the numerical coding, and logic systems, as well as transmission standards and data highways associated with sequencers, PLC's and PIC's, and describe how PLC's, PIC's communicate with each other.

2.1 Discuss the method of coding information for processing, and describe how information is processed during sequencer operation.

2.2 Elaborate on the several numbering systems used by PLC manufacturers to convert decimal numeric information. And, work problems involving these number systems; namely, binary, binary coded decimal (BCD), hexadecimal, octal and octal coded decimal (OCD), gray code, and image tables.

2.3 Explain how the American Standard Code for Information Interchange (ASCII), the International Standards Organization (ISO), and the Electronic Industries Association (EIA) bit codes are set-up and how they are used to effect "parity", "protocol", and "handshaking" functions.

2.4 Define terms such as asynchronous/synchronous transmission, full/half duplex transmission mode, baud rate, data format, parity, stop bits, handshaking, signal and control lines; and describe their use in regard to ASCII/ISO, EIA communication standards.

2.5 Summarize the standard specifications commonly used to interface peripherals, PLC's, PIC's, and I/O's; specifically, physical, electrical, and communication characteristics of the EIA RS-232C, EIA RS-422 and the 20 mA current loop.

2.6 Discuss terms such as repeaters/boosters, gateways, direct numerical control (DNC), distributed numerical control (DNC), Manufacturing Automation Protocol (MAP), local area network (LAN), wide area network, and telecommunication.

2.7 Compare and contrast topologies, and access methods used to establish communication links with PLC's and PIC's; namely, star, common bus, ring -- polling, collision detection, and token passing.

Competency 3: Provide a thorough explanation of the various hardware components and peripheral devices associated with PLC's and PIC's to include usage characteristics.

3.1 Explain, in general terms, the central processing unit (CPU), the power supply, the input/output system, and peripheral devices and the role each has in the control system.

3.2 Discuss, in detail, the processor unit's purpose, function, and operation, to include modules, coordination, and control of the entire PLC's system.

3.3 Elaborate on the various areas and organization within the memory system of a PLC; namely, the execution, temporary storage, application/user and data table, and explain the various memory types available.

3.4 Describe, in detail, the purpose, function, and operation of the I/O system to include types of I/O's available, standard ratings, isolation and grounding devices, interface descriptions, special I/O modules (with an emphasis on CPU requirements as well as I/O devices and the module itself), and remote I/O subsystems.

3.5 Interpret PLC system, subsystem, device and peripheral interface specification requirements.

3.6 Discuss the peripheral devices available to PLC's to include programming devices, displays, documentation and reporting devices, control devices and data entry devices.

3.7 Identify the special requirements that exist for directly interfacing a PIC with I/O devices.

Competency 4: Discuss information relevant to programming sequencers, PLC's, PIC's.

4.1 Describe how to define a strategy, and develop a systematic approach, to programming a sequencer, PLC, and PIC.

4.2 Identify the internal features commonly available on most PLC's and the common logic network circuits that can be developed to assist the programmer.

4.3 Elaborate on techniques a programmer can utilize to define an orderly collection of information relevant to a program.

4.4 Define terms associated with, and construct basic programs using Boolean/digital logic, relay ladder logic, functional block and English language logic statement instruction sets.

4.5 Explain the contents of a system documentation package; namely, the system abstract, system configuration diagram, I/O wiring connection diagram, I/O address assignments, internal I/O assignments, register assignments, and the program coding printout.

4.6 Discuss the system documentation features available on various software program documentation packages and describe their benefits.

4.7 Utilize various logic programs with related documentation, to troubleshoot moderately complex programs.

Competency 5: Specify information, and perform tasks relevant to sequencer, PLC, PIC selection/application, installation, start-up, maintenance, and troubleshooting.

5.1 Cite the general product ranges for PLC's; namely, small, medium, large, and very large, listing the basic features/capabilities of each range.

5.2 Describe relative power supply, control, I/O system, memory, software, peripheral, I/O device and communication medium requirements for a particular system.

5.3 Summarize the major considerations involving reprogrammable controller selection.

5.4 Select a programmable controller system to meet pre-defined criteria, with respect to standards, communication system, devices, and peripherals.

5.5 Explain the considerations that should be taken into account when performing a system layout, to include economics, environmental considerations, equipment locations, enclosures, duct and wiring considerations, power, safety, and special conditions.

5.6 Identify accident prevention, as well as other specific criteria, and procedures, important to the tasks involved in the physical installation of enclosures, ducts and wire ways, power supplies, processors, memory modules, I/O modules/remote modules, I/O devices, and wiring.

5.7 Prepare/apply a checklist of activities and procedures for installation, start-up, maintenance, and troubleshooting of programmable controller systems.

Suggested Course Textbook:

Programmable Controllers - Concepts and Applications, Jones, C.T. and Bryan, L.A., International Programmable Controls, Inc., Atlanta, Georgia, ISBN 0-915425-00-9

Programmable Controllers - Practices and Concepts, Gilbert, R.A. and Llewellyn, J.A., Industrial Training Corporation, Rockville, Maryland (800) 638-3757.

Other:

Technician's Guide to Programmable Controllers, Cox, Richard A., Delmar. Albany, NY ISBN 0-8273-2420-0

Recommended Instructor's Reference Textbook

RS-232 Made Easy, Seyer, Martin D., Prentice Hall

and, various product manufacturer's guides, technical publications

Methods of Instruction

Lecture and discussion, assignments, demonstrations and laboratory sessions.

Methods of Evaluation

Quizzes, written assignments, class discussion, laboratory project completion.

Equipment

Various educational vendors.

Course Competencies For:

1. <u>Electromechanical Devices</u> ASR 205

3 Credits
Two Hours Lecture
Two Hours Laboratory

2. Course Description: This course is designed to provide the student with an overview of theoretical concepts, as well as an investigative approach to participating in practical experiences dealing with the mechanical, electrical, and electronic devices and components comprising robotic and automated systems. Topics of coverage include: industrial wiring for supply and control, electromechanical control devices, transducer/sensor interfacing, timers and counters, electric motors and mechanical drives, open loop, closed loop/servo systems -- with an introduction to solid state control and reprogrammable devices.

Corequisites: PHY 124, Technical Physics II
IEL 205, Digital Circuits

3. Course Competencies/Behavioral Objectives

Competency 1: Describe the basic components, sizing requirements and selection criteria relevant to installing, upgrading, maintaining, and troubleshooting factory floor electrical supply, distribution, control, communication, and computing systems.

1.1 Demonstrate the ability to interpret drawings/diagrams and bills of material to identify material specifications, order requirements for equipment, and prepare cost estimates for installation/upgrading of industrial electrical supply, distribution, control, and communication systems.

1.2 Describe the factors relevant to selection, application, and installation of distribution panels, transformers, fuses, disconnects, switches, receptacles, motors, starters, solenoids, relays, timers, transducers, wire coverings, connectors, etc.

1.3 Explain the techniques and equipment used during electrical troubleshooting activities on starters, contactors, motors, electro-pneumatic/hydraulic/transducer/sensor/timing, servo, and other devices, as well as PC boards and other computer circuits.

1.4 Discuss the procedures and practices commonly employed to maintain and service electrical distribution, control, communication and computing equipment.

1.5 Demonstrate the ability to use accident prevention practices and procedures, drawings/diagrams, manufacturer's manuals, materials, tools, and instruments to install electrical wiring/equipment/components.

Competency 2: Describe the design, operational characteristics, and applications of electrical/electronic/mechanical components found in automated systems.

2.1 Discuss the distribution and control functions that electromechanical components provide within automated systems.

2.2 Identify the construction, ratings, types of operators, schematic symbols, mounting techniques, and circuit applications for various switches.

2.3 Explain the design, drawing symbol designation, rating specification scheme, construction, functional operation, and application of solenoids.

2.4 Describe the construction, mechanical operation, ratings, contact types, enclosure types, various schematic symbol representations, and methods of mounting mechanical and solid state relays.

2.5 Discuss various factors involved with mechanical relay operation to include contact bounce, overlapping of contacts, contact wipe, and split or bifurcated contacts.

2.6 Describe interlock circuit construction and the function of latching or holding relays, and explain the difference between in-rush and holding current in a relay coil.

2.7 List the basic uses, sizing requirements, and installation procedures associated with contactors.

2.8 Compare and contrast, control relays, time-delay relays and contactors.

2.9 Construct, test and troubleshoot circuits utilizing various types of switches, solenoids, relays and contactors

Competency 3: Differentiate limit switches, linear and rotary position-displacement transducers, pressure and temperature transducers and switches, as well as photo electric sensors -- and explain the function of each in an automated system.

3.1 List the basic classes of limit switches and describe various applications for each.

3.2 Explain terms relevant to mechanically operated limit switches such as operating force, release force, pre- or trip travel, over-travel, differential travel, etc.

3.3 Discuss the various types of proximity transducer switches, their general operational characteristics, rating designations, system placement, and application uses.

3.4 Define and discuss terms associated with pressure and temperature switches and transducers; and explain how pressure and temperature transducers and switches are designed, their function in a control environment, their specification ratings, operational characteristics and applications.

3.5 Describe the design and function of temperature controllers and identify the factors to consider when selecting same.

3.6 Explain terms such as controller sensitivity, operating differential, time proportioning, band width, automatic reset, rate control, etc., as they relate to transducers and controllers.

3.7 Identify diagrammatic symbols representing switches, transducers, photosensors and controllers while constructing circuits in accordance with drawings.

3.8 Describe the types of photoelectric sensors commonly available, their operating parameters, along with their selection and application specifications.

3.9 Apply troubleshooting theory and practices associated with particular switches, transducers, photosensors, controllers, etc., to ascertain and alleviate control circuitry problems.

Competency 4: Compare and contrast timers and counters, citing design, function, specification rating, construction, mounting, operational and application differences/similarities.

4.1 Identify the major types of timers, explain the difference between a timer and a time-delay relay, and cite their applications.

4.2 Explain the function/operation of a time-on and a time-off timer.

4.3 Describe how multiple interval timers and repeat-cycle timers differ.

4.4 Explain how dashpot-type pneumatic timers operate and describe some of the design features of solid state timers.

4.5 List the differences between solid state and electromechanical reset-type timers and reset-type counters.

4.6 Discuss timer and counter circuits, in regard to component identification, operation, and application.

4.7 Cite and perform basic procedures and practices used to install and conduct fault analysis on timer and counter circuits.

Competency 5: Explain the basic theory and technology associated with transformers, contactors, motor starters, generators, motors, and the purpose of their use.

5.1 Discuss the principles of transformer operation, and the construction details of several transformer types, as well as their function, and the circuitry within which each would be found.

5.2 Describe how to install and troubleshoot circuits containing three and single phase transformers.

5.3 Elaborate on the difference between a contactor and a motor starter, to include design, construction, function, and operation.

5.4 Explain why overload relays and heaters are used in motor starter control circuits and how ambient-compensated overload relays operate.

5.5 Determine why both mechanical and electrical interlocks are used on a reversing starter and describe the relationship between applied voltage and the resulting torque in motors.

5.6 Explain why a reduced-voltage motor starter should be used in some cases, rather than a full-voltage starter, and give usage examples for each.

5.7 Discuss the principles of design, output, characteristics, and operation for A.C. and D.C. motors.

5.8 Describe the basic types of A.C. and D.C. motors, and compare/contract their design features, operation, and applications.

5.9 Differentiate between the operational principles of a motor and a generator.

5.10 Elaborate on the use of the synchro transmitter (generator) to convert mechanical input energy into electrical output energy and discuss its use in electromechanical systems.

5.11 Utilize circuit diagrams to perform basic troubleshooting of transformers, contactors, starters, motors and synchros.

Competency 6: Identify the operational characteristics of mechanical drives and drive mechanisms associated with the conversion of electrical energy to a resultant motion output.

6.1 Discuss the design, selection, installation, use, maintenance (including troubleshooting procedures) and operation of belts as a medium for power transmission -- to include "V", synchronous, flat, cog and notch, and round belts.

6.2 Explain pulley design requirements, arrangements, and operational mechanisms associated with power transmission/timing via belts.

6.3 Describe design, selection, installation, maintenance (including troubleshooting procedures) and operational characteristics of chains and sprockets as power transmission and timing devices.

6.4 Identify the design, selection, installation, maintenance (including troubleshooting procedures) and operation criteria for gears, to include--parallel axes, nonintersecting, nonparallel-axes, intersecting axes, moving axes and gear trains.

6.5 Elaborate on the design, installation, maintenance, (including troubleshooting procedures) and operation of ball screws and harmonic drives.

6.6 Provide a basic explanation, in regard to design, function, installation, and maintenance (including troubleshooting procedures) of couplings, shafts, keys, key seats, pins, bearings and clutches.

6.7 Discuss the design, operation, maintenance (including troubleshooting procedures) and applications of linkages and cams (associated with modern automation).

Competency 7: Elaborate on the use of control circuits to input information, decision-make, and output work instructions; as well as to perform system analysis during installation, maintenance, and troubleshooting.

7.1 Explain the three basic functions of control circuits; namely, information input, execute decision or logic, and supply output or work.

7.2 Demonstrate the use of an electrical control circuit diagram to gather information about a machine or system.

7.3 Use an electrical control diagram to describe how electrical components are used in a circuit to gather information for decision-making.

7.4 Refer to an electrical control diagram and troubleshoot the outputs of a machine, or system, to isolate an electrical or mechanical problem.

7.5 Utilize sequence bar charts, travel step diagrams, sequence-time, flow charts, narrative event charts, relay ladder logic, and digital logic symbols to perform circuit analyses.

Competency 8: Discuss open and closed loop systems to include electrical devices/stepper motors and servo devices/motors and feedback components.

8.1 Provide a working definition of terms associated with open and closed loop systems, to include components, devices and signals.

8.2 Explain, in basic terms, how a stepper motor and servo motor/system operates.

8.3 Describe how a servo valve functions and how to perform basic troubleshooting procedures on same.

8.4 Describe the basic mechanical procedures for removal and installation of stepper and servo motors.

Competency 9: Identify reasons for the establishment, application, enforcement of, and list sources of electrical codes and standards.

9.1 Provide a list of agencies responsible for the development, promulgation, and enforcement of electrical codes -- national, state, local, other.

9.2 Discuss the major goals of standards and codes.

9.3 Describe the types of equipment and materials that are covered in current codes and standards.

9.4 Elaborate on the term "Good Workmanship" as it relates to compliance with codes and regulations.

9.5 Explain the role that diagrams, markings, nameplates and warning signs play in electrical/personnel safety.

Recommended Course Textbooks:

Suggested selective listing - course professor's prerogative for method of conducting course lectures/laboratories.

> Electrical Control For Machines, Rexford, Kenneth B.
> Delmar Publishers, Inc., 1987

> Robotics and Automated Systems, Hoekstra, Robert I.
> South-Western Pub. Co., Cincinnati, Ohio

> Robotics, An Introduction, Malcolm, Douglas R., Jr.
> Breton Publishers, Boston, Massachusetts, 1985

> Other -- laboratory manual

Methods of Instruction:

> Lecture and discussion, assignments, demonstrations and laboratory sessions.

Methods of Evaluation:

> Quizzes, written assignments, class discussion, laboratory project completion.

Equipment:

> Standard classroom/media projection equipment, appropriate laboratory equipment.

Course Competencies For:

1. <u>Industrial Safety</u> GET 112 1 credit
One Hour Lecture

2. Course Description: This course is designed to provide instruction in industrial safety and accident prevention for employees and managers. Occupational Safety and Health Act (OSHA) of 1970 requirements are stressed. Administrative aspects of record keeping, rights and responsibilities, standards, safety program development and implementation are also covered. The student will receive basic instruction on the identification of accident causes and become aware of the steps required to prevent industrial accidents. Upon successful completion of this course, the student should be able to:

3. Course Competencies/Behavioral Objectives

Competency 1: Demonstrate an awareness of definitions and a basic understanding of safety and accident prevention practices and procedures, including:

1.1 provide basic definitions associated with accident prevention.

1.2 describe how accident and injury rates are determined.

1.3 explain how accidents occur and how they can be avoided/prevented.

1.4 list environmental and human factors contributing to accidents.

1.5 identify job/work factors involved in accidents.

Competency 2: Demonstrate an understanding of voluntary compliance program legislation including:

2.1 policies affecting the legal and moral considerations associated with accidents to include--responsibility, liability and accountability.

2.2 explain the reasons why management and employees should assume responsibility for accident prevention.

2.3 identify the various levels at which laws-ordinances-regulations-codes-standards have been adopted to protect individuals.

2.4 describe relevant national legislation and regulations affecting occupational safety and health.

Competency 3: Demonstrate an understanding for the provisions and implications of a voluntary compliance accident prevention program, including:

3.1 describe the elements of a viable program.

3.2 explain how to establish an administrative scheme for assignment of levels of responsibility.

3.3 develop a scheme for planning a program.

3.4 develop a scheme for implementing a program.

3.5 develop a plan for reviewing, auditing and enhancing an accident prevention program.

3.6 list sources of assistance for guidance, problem-solving, administration, and implementation of a local program.

Competency 4: Identify the important aspects of administering a voluntary compliance accident prevention program under the Occupational Safety and Health Act.

4.1 describe how and where to obtain current information regarding standards adopted under the Act.

4.2 identify guidelines and procedures for developing and maintaining record keeping forms.

4.3 cite the specific rights and responsibilities of employers and employees under the Act.

4.4 develop various policy statements and forms for implementing a program in accordance with the OSHA Act.

Recommended course textbook:

Supervisors Safety Manual
National Safety Council, 444 N. Michigan Avenue, Chicago, IL 60611 (312) 527-4800

Recommended course reference text materials:

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) Safety & Health Regulations for Construction, 29CFR 1926
Department of Labor, Occupational Safety and Health Administration
(available at no cost from local OSHA office)

Recommended instructor references:

Note: It is recommended that the following be acquired, kept on file, and issued to course instructor:

**OSHA Safety & Health Training Guidelines for General Industry (PB-239 310/AS)

**OSHA Safety & Health Training Guidelines for Construction (PB-239312A/S)

**Available from the National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22151

One FREE copy of the following can be obtained from the local OSHA area or regional office:

OSHA Handbook for Small Businesses OSHA 2209
Construction Industry, OSHA 2202
General Industry, OSHA 2206
Organizing a Safety Committee, OSHA 2231
OSHA Inspections, OSHA 2098
Essentials of Machine Guarding, OSHA 2227
Excavation and Trenching Operations, OSHA 2226
OSHA Your Workplace Rights in Action, OSHA 3032
Noise, OSHA 2067
Recordkeeping Requirements Under the OSHA of 1970
What Every Employer Needs to Know About OSHA Recordkeeping, OSHA 412-
Job Safety and Health Protection, OSHA 2203 (Poster)
All About OSHA, OSHA 2056
Publications on Toxic Substances, A Descriptive Listing: Published by Interagency Regulatory Liaison Group (Available through OSHA or EPA)

Recommended Agencies for Other Instructional Materials:

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)
6500 Glenway Ave., Bldg. D-5, Cincinnati, OH 45211

AMERICAN INDUSTRIAL HYGIENE ASSOCIATION (AIHA)
475 Wolf Ledges Parkway, Akron, OH 44311

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)
1430 Broadway, New York, NY

AMERICAN SOCIETY OF SAFETY ENGINEERS (ASSE)
850 Busse Road, Park Ridge, IL

AMERICAN WELDING SOCIETY (AWS)
2501 N.W. 2nd Street, Miami, FL 33125

BEST, A.M. & CO. (Best's Loss Control)
Amherst Road, Olkwick, NJ 08850

BUREAU OF NATIONAL AFFAIRS (BNA)
1231 25th Street, N.W., Washington, DC 20037

CHEMTREC HOT LINE for emergency spills of combustible and flammable liquids and caustic acids

CODE OF FEDERAL REGULATIONS (CFR)
Superintendent of Documents, U.S. Government Printing Office
Washington, DC 20402

COMMERCE CLEARING HOUSE (CCH)
4025 W. Peterson Ave., Chicago, IL 60646

COMPRESSED GAS ASSOCIATION, INC.
1235 Jefferson Davis Highway, Arlington, VA 22202

DEPARTMENT OF TRANSPORTATION (DOT), Materials Transportation Bureau Information Services Division, Washington, DC 20590

FACTORY MUTUAL ENGINEERING (Factory Mutual System)
1151 Boston-Providence Turnpike, Norwood, MA 02062

FEDERAL REGISTER
Superintendent of Documents, U.S. Government Printing Office
Washington, DC 20402

NATIONAL AUDIOVISUAL CENTER (GSA), Information Services,
8700 Edgeworth Drive, Capital Heights, MD 20743

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)
Batterymark Park, Quincy, MA 02269

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH - (NIOSH)
4676 Columbia Parkway, Cincinnati, OH 45226

NATIONAL SAFETY COUNCIL (NSC)
425 N. Michigan Ave., Chicago, IL 60611

NATIONAL TECHNICAL INFORMATION SERVICE (NTIS)
5285 Port Royal Road, Springfield, VA 22161

SUPERINTENDENT OF DOCUMENTS U.S. GOVERNMENT PRINTING OFFICE
Washington, DC 20402

TECHNICAL DATA CENTER (TDC)
U.S. Dept. of Labor OSHA, TDC Room 2439, rear
200 Constitution Ave., NW, Washington, DC 20210

FOR RENTAL AND/OR PURCHASING OF VISUAL AIDS, CATALOGS SENT ON REQUEST.

THE GREATER CHICAGO SAFETY COUNCIL, INC. (Rental Only)
One North La Salle St., Chicago, IL 60602

NATIONAL ARCHIVES & RECORD SERVICE National Audiovisual Center, GSA Reference Section, Washington, DC 20409

Course Competencies For:

1. <u>Automated Systems/Robotics Applications</u> - ASR 201

4 Credits
Two Hours Lecture
Four Hours Laboratory

2. Course Description: This course is designed in a manner conducive to providing the student with theoretical and practical experiences associated with the integration of various disciplines within the field of robotics. The student will complete exercises involved with installation, programming, operation, maintenance, and repair of robotic and automated manufacturing systems.

Prerequisites: ASR 101, Introduction to Robotics
ASR 205, Electromechanical Devices
*GET 234, Introduction to Computer Programming

3. Course Competencies/Behavioral Objectives:

Competency 1: Perform robotic systems installation, set-up and acceptance procedures.

1.1 Apply accident prevention practices and procedures during robot cell installation and development.

1.2 Install and set-up, pneumatic, hydraulic, and electric robots.

1.3 Install a robot controller.

1.4 Install communication and power cabling.

1.5 Evaluate (initial start-up of) an installed robot system.

1.6 Calibrate a robot.

1.7 Verify manufacturer's operational specifications.

1.8 Install electric end of arm tools.

1.9 Install pneumatic end of arm tools

1.10 Hook-up, align, and test-out cell sensors and peripheral equipment such as conveyors, rotary tables, parts feeders, etc.

1.11 Verify safety system interlocks.

1.12 Interface a robot controller with video sensors.

1.13 Perform an in-plant robotic system acceptance inspection.

1.14 Optimize existing system performance.

Competency 2: Program robots.

2.1 Apply accident prevention practices and procedures while programming robots.

2.2 List the stages involved in writing, teaching, and running a program.

2.3 Develop logical flow-chart and narrative statements defining start point, variables, functions, sequence of events, branches, subroutines, etc.

2.4 Interface and integrate the robot with the cell environment via software.

2.5 Access and prepare a robot controller for teaching/programming.

2.6 Interpret error messages.

2.7 Operate conveyors, rotary tables, lathes, mills, etc. via software control.

2.8 Program a robot via teach pendant.

2.9 Prepare programs with wait, conditional and unconditional jump routines.

2.10 Program a cell controller and a robot off-line.

2.11 Load programs into the robot/cell controller.

2.12 Test programs in step-by-step and continuous operation.

2.13 Record, list, edit, and delete program steps to include poin*s, speeds, etc.

2.14 Execute continuous mode operations of a robotic work cell.

2.15 Integrate a robot program with a vison system software program.

Competency 3: Operate a robotic/automated manufacturing work cell.

3.1 Use operation manuals to determine the operational criteria for an automated system.

3.2 Perform system start-up, operation, and shut-down procedures.

3.3 Coordinate the operation of several pieces of automated equipment.

3.4 Adjust equipment/machines and workholding/positioning devices to assume accuracy and repeatability.

3.5 Assist in analyzing and selecting end effectors and end-of-arm tooling, as well as sensing requirements for system optimization.

3.6 Analyze operating difficulties, and modify parameters to ensure system integrity and operational specifications.

3.7 Develop specific safety procedures for personnel in the work cell, to include programmers, operators, and maintenance personnel.

3.8 Utilize data acquisition/retrieval equipment to update system integration information.

3.9 Interact with robotic and automated manufacturing systems.

3.10 Set-up and operate a machine vision system.

Competency 4: Perform accident prevention practices and procedures while maintaining and repairing robots and automated systems.

4.1 Conduct lock-out and tagging procedures during installation, maintenance and repair activities.

4.2 Perform scheduled maintenance activities such as replacing filters, checking fluid levels, adjusting belts and regulators, repairing leaks, applying lubricants, coatings, and preservatives, etc.

4.3 Dismantle and assemble robots and peripheral equipment for inspection, service, and repair.

4.4 Follow manufacturer's procedures described in manuals to inspect, lubricate, adjust and repair drive mechanisms, to include clutches, brakes, gears, linkages, motors, etc.

4.5 Install and troubleshoot lubrication systems, way/slide and ball protection devices.

4.6 Check-out and repair/replace pressure and vacuum system components.

4.7 Troubleshoot end effectors, and repair/replace defective mechanisms.

4.8 Run diagnostic software and interpret error messages.

4.9 Utilize basic electrical meters to analyze/verify electrical characteristics described in maintenance/troubleshooting/repair manuals.

4.10 Analyze and rectify problems with sensors, coils, relays, heaters, starters, contactors, fuses, circuit breakers.

4.11 Adjust hydraulic servo valves and verify electrical sensor operation as well as other electrical devices.

4.12 Verify servo amplifier, servo motor control, and motor operation.

4.13 Troubleshoot robot controller in accordance with manufacturer's recommended procedures and specifications.

4.14 Troubleshoot communication links.

4.15 Carry-out acceptance tests (inspect and test robot/system/component operation following manufacturer's repairs.

Recommended Course Text Materials:

System specific manuals, drawing, documentation, laboratory exercises.

Other: Instructor developed information, instruction, and laboratory exercises.

Methods of Instruction:

Lecture, discussion, demonstration, assignments, and laboratories.

Methods of Evaluation:

Quizzes, written assignments, performance tests, laboratories, final examination.

Equipment:

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

Recommended Agency for Instructional Equipment:

Allegheny Educational Systems, Inc.
113 North Oakhill Road
Pittsburgh, PA 15238

Course Competencies For:

1. <u>Fluid Power Applications</u> ASR 207

3 Credits
Two Hours Lecture
Two Hours Laboratory

2. Course Description: This course is designed to provide an introduction to basic theories and principles associated with hydraulic and pneumatic systems. An emphasis on understanding system function, operation, application, maintenance, as well as an overview of troubleshooting techniques will be stressed. Students will actively engage in the construction of circuits and systems and will analyze system performance. Topics of coverage will include force transmission through a fluid, prime movers, energy creators, devices for controlling fluid energy, fluid conditioning, fluid conductors, and output devices.

Prerequisite: PHY 123, Technical Physics I

3. Course Competencies/Behavioral Objectives

Competency 1: Define terms and acronyms, units of measurement, and schematic symbols, associated with fluid systems, and cite relative advantages/disadvantages of these systems.

1.1 Describe the meaning of words commonly found in a "glossary of terms" on fluid power and fluid power systems.

1.2 Provide a suitable explanation for acronyms and abbreviations associated with fluid power systems.

1.3 Differentiate between English and preferred metric (SI system) units of measurement and utilize same to perform mathematical solutions to physical problems.

1.4 Identify and elaborate on the differences between various symbols represented on fluid power system schematics.

1.5 Utilize standard schematic symbology to describe the function and operation of a fluid power circuit.

1.6 Layout and construct fluid power circuits/systems utilizing schematic symbology.

1.7 Draw diagrams showing the components within various hydraulic and pneumatic power systems.

1.8 Utilize fluid power system schematics, diagrams and drawings to perform installations, maintain, and troubleshoot operations.

1.9 Cite the advantages and disadvantages of a fluid versus other power systems.

1.10 Compare and contrast the advantages and disadvantages of hydraulic and pneumatic systems for providing power to mechanized equipment.

Competency 2: Demonstrate the ability to combine the theoretical knowledge and practical experience required to describe physical relationships within fluid power systems.

2.1 Perform basic mathematical calculations and apply principles of physical laws to solve formulae and conversion factors involving practical problems.

2.2 Describe each of the following principles of fluid behavior and explain how it relates to fluid power systems; Pascal's law, the continuity equation, Bernoulli's theorem, Torricelli's Theorem, Boyle's law, Charles' law.

2.3 Solve practical problems involving area, volume, pressure (positive and negative), force, temperature, heat, velocity, torque, levers, work, power, horsepower, efficiency.

2.4 Perform mathematical computations and technical analysis relevant to saving hydraulic/pneumatic pumps, actuators, conductors.

2.5 Interpret information from manufacturers' and engineering manuals graphs, charts, and tables.

2.6 Prepare and read timing and motion graphs describing fluid power component operation.

Competency 3: Discuss the properties and characteristics of fluids with regard to power systems.

3.1 Explain the relevance and application/association of such terms as specific gravity, viscosity, viscosity index, lubricity, oxidation resistance, fire resistance, additives, etc.

3.2 Identify the properties of hydraulic fluids.

3.3 Define the purposes of a hydraulic fluid and cite the quality requirements of same. Cite types and selection criteria for a specific application of the most commonly used hydraulic fluids.

3.4 Describe the effects of pressure, temperature, and humidity on fluids and resultant system performance.

Competency 4: Elaborate on the various aspects of fluid storage and conditioning.

4.1 Identify the various types and explain the purpose of fluid reservoirs/tanks and receivers.

4.2 Describe how receivers and reservoirs are sized and which design considerations are important for system selection.

4.3 Discuss the types of fluid strainers, filtering, cleaning, and drying (pneumatic), silencing (pneumatic), system placement devices, and their ratings.

4.4 Elaborate on the purpose, design, considerations, system placement, and types of heat exchangers/coolers, and heaters for fluid power systems.

4.5 Explain the purpose, function, operation, and how to set-up an air line filter-regulator-lubricator unit.

4.6 Explain the conditions under which conditioning agents such as inhibitors and additives should be specified for a particular hydraulic fluid application.

Competency 5: Describe the basic types, construction, characteristics and installation, maintenance of hydraulic pumps, air compressors, and vacuum generators.

5.1 Explain the purpose of pumps, generators, and compressors and describe the basic types that are available.

5.2 Elaborate on the construction, operating principles, and characteristics of various types of pumps, generators, and air compressors.

5.3 Cite the advantages of various types of pumps, generators, and air compressors, and discuss the factors relevant to making a selection.

5.4 Discuss topics such as heat and energy in pump systems and factors determining suction and discharge heads in a closed hydraulic system.

5.5 Determine pump displacement, volumetric efficiency and the effect that pump operating pressure has on volumetric efficiency.

5.6 Explain the most common types of damage to air compressors and hydraulic pumps and the most important factors in both pump and compressor maintenance.

5.7 Describe how to install, maintain, and prepare to repair pumps, compressors, vacuum generators, and other major components within fluid power systems.

Competency 6: Discuss the design, construction, and operating features of power converters (linear, rotary actuators, and accumulators).

6.1 Explain the purpose of power converters in a fluid systems.

6.2 Determine the design and operating characteristics of various accumulators and actuators, to include options and special construction, as well as mounting styles and classifications.

6.3 Explain the factors that affect actuator speed and output force.

6.4 Identify how hydraulic motors are rated and understand the factors affecting motor speed and torque.

6.5 Compare and contrast the design, construction, and rating factors of hydraulic pumps, motors, and cyclinders.

6.6 Describe, compare, and contrast the construction and operating characteristics of hydraulic and pneumatic motors.

6.7 Discuss the application, and determine the mounting and sizing criteria relevant to specifying a particular accumulator or actuator.

6.8 Describe applications and operation of fluid power intensifiers, booster and air-over-hydraulic systems.

Competency 7: Discuss the design and operation, as well as the mounting and plumbing of fluid conveying, conditioning, controlling and actuating devices.

7.1 Explain the purpose of mechanical linkages, mounting devices, and fluid conveying devices.

7.2 Describe basic criteria relevant to selecting and specifying gasket material, pipe, tubing, hose, fittings, adapters, swivel joints, couplings and accessories, and manifolds for fluid power systems.

7.3 Describe the function, design, application, and operational characteristics of accumulators, intensifiers, check valves, control valves (various), fluidic control valves, servo valves, and filter-regulator-lubricators.

7.4 Discuss the criteria relevant to mounting fluid devices and associated hardware to include mechanical linkages and brackets/braces.

7.5 Identify, prepare, assemble, and install common hydraulic and pneumatic conductors and connectors.

7.6 Identify and cite specific information required to replace actuation, pumps, air compressors, heaters, heat exchangers, coolers, seals, control valves, (counterbalance, check, pressure-reducing-relief/safety-unloading, flow, directional), accumulators, receivers, filters, regulators, lubricators, manifolds, hydraulic fuses and pressure switches.

7.7 Cite the attributes of a fluid power plumbing system which ensure adequate performance.

Competency 8: Discuss the basic design (to include safety requirements) and operational features of contract circuits in pneumatic and hydraulic systems.

8.1 Describe the factors (associated with control devices) that limit speed and force output of actuators.

8.2 Identify the function of various components in basic fluid power circuits and the controlling factor each has on the system performance and operation.

8.3 Explain the operational characteristics and requirements of clamping and sequencing, and motion synchronization circuits.

8.4 Explain the operational characteristics and requirements of a rapid traverse, feed, braking, and counterbalance circuits.

8.5 Explain the operational characteristics and requirements of unloading, venting, reciprocating, and regenetive circuits.

8.6 Explain the operational characteristics and requirements of safety circuits.

8.7 Discuss the operational characteristics of pilot operated devices and circuits and remote control circuits.

8.8 Explain the operational characteristics and requirements of basic automation and servo circuits.

Competency 9: Install, maintain, troubleshoot and repair basic pneumatic and hydraulic systems.

9.1 Discuss the design, selection, and safe use of portable power, and hand tools, as well as test equipment commonly used to perform installation, maintenance and troubleshooting procedures on fluid power systems.

9.2 Perform accident prevention practices and procedures relevant to job planning, installation, maintenance, and troubleshooting activities associated with fluid power systems.

9.3 Work independently, as well as with others, while applying troubleshooting aids and techniques to diagnose, specify, and complete remedial action on troublesome basis and hybrid pneumatic and hydraulic systems.

9.4 Troubleshoot cylinders to overcome problems with drift, failure to move the load, erratic or chatter operation, seal wear/leakage.

9.5 Troubleshoot pumps, compressors, motors, and accumulators to overcome problems related to excessive noise, failure to deliver fluid, expected output, leakage, worn/failed parts.

9.6 Troubleshoot problems associated with hose, pipe, tubing and related fittings, fluids/reservoirs, and circuits.

Recommended Course Textbook

Course professor's preference to be applied in making a selection of course theory text(s) and reference materials - laboratory manuals will be selected in regard to equipment supplier's curriculum materials.

List of Recommended Theory Textbook(s) Required/Reference

Handbooks

Fluid Power Data Book: Hedland, Div. of Racine Federated, Inc., 2200 South Street, Racine, Wisconsin 53404, Tel. No. (414) 639-6770

Hose & Reusable Fittings: Cat. No. 261B and others, Aeroquip, Industrial Division, 1225 West Main Street, Van Wert, Ohio 45891, Tel. No. (419) 238-1190

Design Engineer's Handbook Bulletin 0224-B1 and others, Parker Hannifin Corporation, 17325 Euclid Avenue, Cleveland, Ohio 44112, Tel. No. (216) 531-3000

Other: Various suppliers of hydraulic/pneumatic devices.

Textbooks

Fluid Power, Stewart, Harry L., and Stover, John, M. Howard W. Sams & Co., Inc., Indianapolis, Indiana 46206

Industrial Hydraulics, Pippenger, John & Hicks, Tyler, Greg Div. of McGraw

Industrial Hydraulics Manual, Sperry/Vickers Corporation, Troy, Michigan 48084

Various Titles - Parker Hannifin Corp. - same as above
- Womack Educational Publications
2010 Shea Road, Dallas, Texas 75235

Other: System specific operator's manuals and laboratory manuals

Methods of Instruction

Lecture and discussion, assignments, demonstrations and laboratory sessions.

Methods of Evaluation

Quizzes, written assignments, class discussion, laboratory project completion.

Equipment

Standard classroom/media projection equipment, appropriate laboratory equipment.

MEMORANDUM

TO: CIM and Automated Systems/Robotics Task Force

RE: Recommendations for Equipment/Software Selection for Individual Program Areas

Make an effort to select equipment and software (CAD/CAM/CNC/Robotic/CIM which will serve both programs jointly; and which will be supported with student laboratory/exercise materials wherever possible. In this regard, hardware and software networking interface and integration capabilities should be considered from the outset. For example, CAM software should link with CAD software, and CAM software should include generalized post-processing capabilities and be compatible with CNC and robotic/automation equipment. Likewise, individual software packages should be integratable to achieve a CIM environment. This is particularly important to the instruction provided in the CIM course.[1] To effect in-house software integration can be quite frustrating and expensive and will require close scrutiny of system specifications, and will probably involve hiring of an individual with considerable programming background.

In essence, contract with consultants/vendors to provide fully interfaced and integratable hardware/software if monies are available, thus avoiding in-house problems of having to accomplish same.

[1]Note: A suggested product to review for compatibility and cost comparison purposes, and one which includes curriculum materials, interface and integration capabilities, would be the AML System (or one similar thereto) produced by Educational Technologies, Inc., Trenton, NJ.

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 most 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,
* Industrial Safety, and
* Manufaturing Processes.

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.

S E C T I O N IV:

A T T A C H M E N T S

A T T A C H M E N T S

1. Curriculum Development Task Force
2. Task Force Data/Recommendations
3. Advanced Technology Center Brochure
4. Program Brochure
5. Equipment Specifications

CURRICULUM DEVELOPMENT TASK FORCE

1987 - 88

1. George Butwin
   Meyers High School

2. Joseph DeSanto
   Luzerne County
   Community College

3. Stanley Fraind
   Crestwood High School

4. Albin Grabowski
   Wilkes Barre AVTS

5. James Haggerty
   Wilkes Barre AVTS

6. Kathleen Heltzel
   West Side AVTS

7. James Kane
   West Side AVTS

8. Joseph Kasztejna
   Monroe Country AVTS

9. Edward Kuehner
   Luzerne County
   Community College

10. Kenneth Lewis
    Luzerne County
    Community College

11. Ormond Long
    Wilkes Barre AVTS

12. David Lyons
    West Side AVTS

13. Robert Mattern
    GAR High School

14. James Newell
    Wilkes Barre AVTS

15. Arthur Parsons
    Wyoming Valley West
    Sr. High School

16. Ben Rondomanski
    Lackawanna County AVTS

17. Walter Rounds
    Lackawanna County AVTS

18. Leonard Tarapchak
    Hazleton AVTS

19. Nathan Williams
    Wilkes Barre AVTS

ATTACHMENT #2

Task Force Data/Recommendations

MANUFACTURING PROCESSES I & II (GET 121 & 122)

ATTACHMENT #2

Book Review

1. Basic Manufacturing Processes
   Kazanas, Baker, Gregor
   Dave Lyons - Text adequate in coverage of manufacturing areas
   Robotics not mentioned
   Format and photographs reveal that the book is dated
   Recommend use of a more modern text
   Lenny Tarapchak - Not very up to date
   Material covered is somewhat insignificant
   I do not recommend this book
   Joe Kasztejna - Recommend this text for GET 121
   Contains all needed information to meet competency requirements
   Information in the text is up to date and well written
   Illustrations are also very good
   Jim Newell/Nate Williams - Out of date
   Recommend look for a different text

2. Principles of Machining
   American Society for Metals
   Joe Kasztejna - Text collection of technical writings in module form
   Each module can be used as a separate lesson with many of the competency requirements matching the lessons
   Recommend that the text be be used as separate lessons with the order revised to meet course competency requirements
   Lenny Tarapchak - Well defined processes as well as good back-up materials
   Recommend this book

Advanced Placement

Lenny Tarapchak recommends a written and a practical test. The time limit for both sections of the test is approximately 6 hours. Sample test attached.
Joe Kasztejna recommends a written and a practical test for Manufacturing Processes II. The practical test should emphasize competencies 3, 4, and 5. Manufacturing Processes I has a heavy emphasis on theory and therefore only requires a written test. Comments attached.

Additional Comments

SKETCHING AND PRINT INTERPRETATION (GET 108)

Book Review

1. Blueprint Reading for Industry
   Walter Brown
   Ben Rondomanski - Recommends use of this text with additional handouts to cover competency requirements not included
   May require use of second text

   John Witko - Material in the text is well written and easy to understand
   Instructor should present the material in a different order than the book
   Meets the competency requirements of the course
   The text can be used by a beginner or by someone with some experience
   The advanced section uses a variety of blueprints with different styles

Advanced Placement

Ben Rondomanski provided the attached test for advanced placement. John Witko feels the test is a good starting point for advanced placement criteria. Portfolios, interviews, etc. still must be examined.

Additional Comments

John Witko feels that actual industry blueprints should be used whenever appropriate. He is currently working on prints and parts for various sections of the course.

INTRODUCTION TO COMPUTER PROGRAMMING (GET 234)

Book Review

not applicable - current course

Advanced Placement

Kathy Heltzel recommends a one (1) hour written test and a one (1) hour practical test. The written test should include the following:

Know the difference between micros and mainframe computers

Know the function of and understand the differences between hardware, software, electronic spreadsheets, peripheral devices, etc.

Know and explain the following terms and acronyms: Input, output, peripheral, CPU, graphics, bit, PC, LAN, mouse, hard copy, boot, execute, storage device, RAM, ROM, disk storage, CRT, byte, modem, ASCII, light pen, hard disk, files, debug, database, floppy disk, format, initialize, DOS, BASIC, microprocessor, host computer, remote terminal, monitor, menu, mode, backup, program

Know and understand the following commands - the exact command may differ depending on the computer used. But whatever computer is used, one must learn the commands. directory, erase, kill, BASICA - command to get in BASIC mode, system - to get back to system mode, rename

Know and understand the following BASIC commands - the above statement is still true regarding the computer used. SAVE, LIST, LOAD, PRINT, AUTO, LET, SUBR, FOR/NEXT, RUN, SYSTEM, EDIT, ERASE, DELETE, GOTO, IF THEN, READ DATA, INSERT

Know how to boot up the system - both ways

Know how to format a floppy disk to prepare it for use. Understand why we must prepare a disk.

Understand all the words listed previously and know what the acronyms mean in terms of the function they perform.

Know how to key in a program, execute it, debug it, and test it after corrections have been made.

Know how to call up files, check what is on your disk.

Know and understand all components of a PC, how they interface.

Know and understand where the PC field is going technologically.

Know and understand databases - internal and external.

Know and understand the additional equipment needed to access an external database.

Know and understand the difference between packaged software and user written programs.

Have an introductory knowledge of spreadsheets.

Additional Comments

D.C. AND A.C. ELECTRICITY (IEL 131 & 132)

Book Review

not applicable - current course

Advanced Placement

D.C. Electricity - May 10, 1988 discussion (attached)

Additional Comments

FLUID POWER (ASR 207)

Book Review

1. Industrial Hydraulics

Pippenger and Hicks

Jim Newell/Nate Williams - Book is outdated

The text looks at fluids from a plumber's point of view

Need robotic point of view for this program

Walter Rounds - Book covers competencies as specified

It is not easy to read

I do not recommend this text

Advanced Placement

Not appropriate at this time.

Additional Comments

Walter Rounds suggests we review the following books for this course:

1. Mobile Hydraulics Manual
   Technical Training Center
   VICKERS, Inc.
   1401 Crooks Road
   Troy, Michigan 48084
2. Industrial Hydraulic Technology
   Bulletin 0221-B1
   Power and Controls Group
   Parker-Hannifin Corp.
   17325 Euclid Avenue
   Cleveland, Ohio 44112

CIM 101/103/104

Book Review

1. Basic CNC Programming
   Laviana and Cormier
   Lenny Tarapchak - More an example of a ready reference book than an actual theoretical book

2. Principles of Numerical Control
   Childs
   Al Grabowski - Book is obsolete - used a book like this in 1961

DIGITAL ELECTRONICS (IEL 205)

Book Review

not applicable - current course

Advanced Placement

Art Parsons recommends a written and practical test. The test(s) should be designed so that the same test can be given in various forms. This would prevent students from passing the test information on to other students. A sample test is attached.

Additional Comments

MANUFACTURING PROCESSES

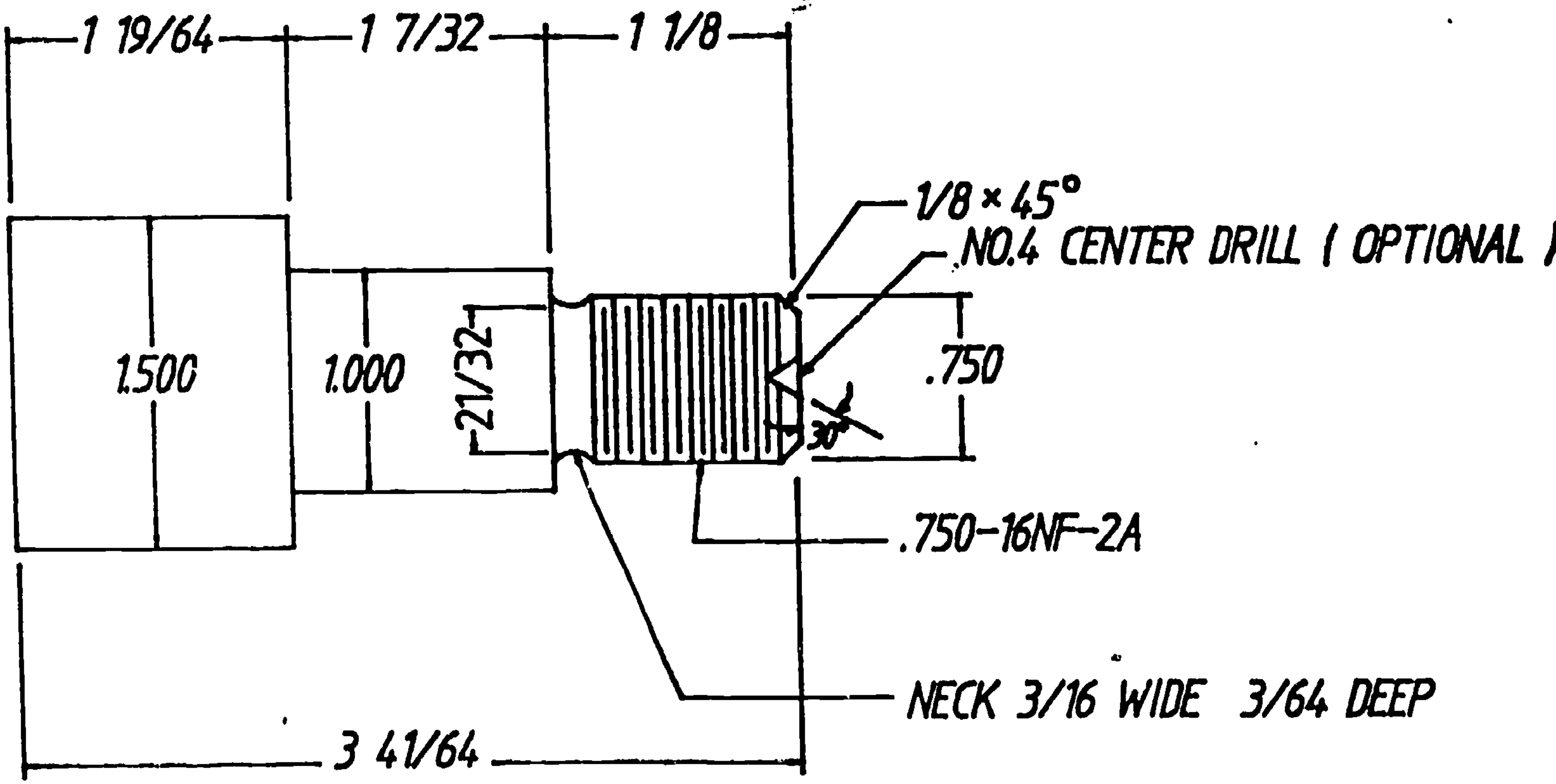
LAB ADVANCED

PLACEMENT

Job/Task: ENGINE LATHE

PERFORMANCE OBJECTIVE:

The student given the necessary print and materials, will have two (2) hours to turn, neck, angle, and thread the lathe project. The student will be evaluated according to the operations of an engine lathe, General safety specifications, and tolerances on the Blueprint.



UNLESS OTHERWISE SPECIFIED:

LIMITS ON DECIMAL DIMENTIONS WITHIN ±.001"

LIMITS ON FRACTIONAL DIMENSIONS WITHIN ±1/64"

INSPECTION SHEET

Student______________________ Instructor________________

PROJECT: TURNING EXERCISE.

Length, overall 3 41/64 _______

Diameters, O.D.

1.500 x 1 19/64	_______	x	______
1.000 x 1 7/32	_______	x	______
.750 x 1 1/8	_______	x	______
1/8 x 45 Chamfer	_______	x	______
3/16 x 21/32 Neck	_______	x	______
.750-16 T.P.I.	_______	x	______
Class 2A			

WORKMANSHIP _________________

GRADE _________________

MANUFACTURING PROCESSES

LAB ADVANCED

PLACEMENT

Job/Task: MILLING MACHINE

PERFORMANCE OBJECTIVE:

The student given the necessary print and materials, will have 1 hour to mill, drill, ream the project. The student will be evaluated according to milling, drilling and reaming safely, general safety specifications and tolerances on print.

MANUFACTURING PROCESSES

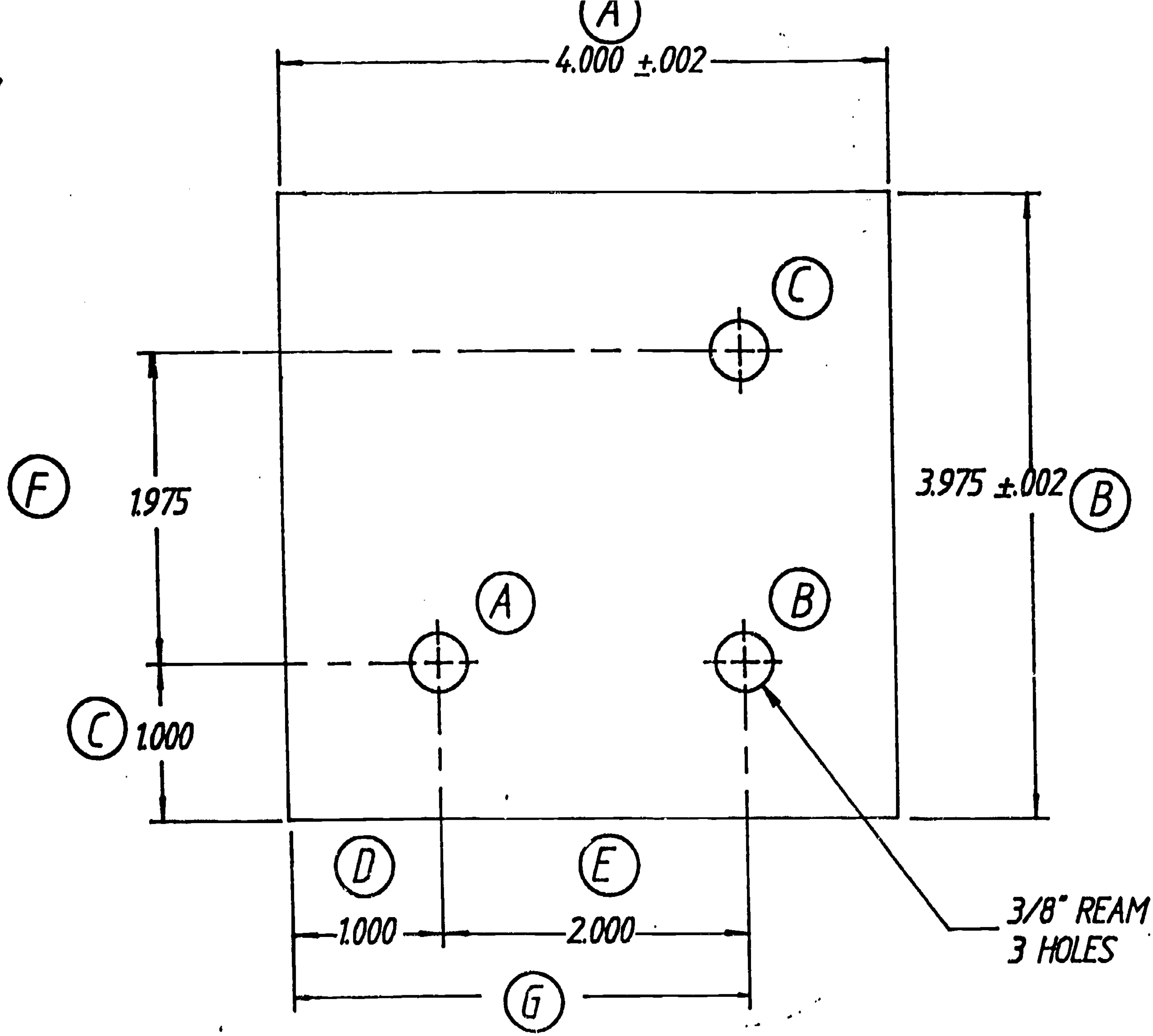
LAB ADVANCED

PLACEMENT

Job/Task: LAYOUT WORK

PERFORMANCE OBJECTIVE:

The student given the necessary print and materials will layout work piece that will be milled, drilled and reamed. The student will be evaluated according to the specifications of print and tolerances and general safety.



UNLESS OTHERWISE SPECIFIED:

LIMITS ON DECIMAL DIMENSIONS WITHIN ±.001"

INSPECTION SHEET

STUDENT________________________ Instructor__________________

PROJECT --- VERTICAL MILLING, DRILLING, REAMING EXERCISE.

Length A 4.000 ± .002 ______________________________

Length B 3.975 ± .002 ______________________________

Location of Hole A - 1.000 × 1.000 ± .001 _______________

Location of Hole B - 1.000 × 2.000 ± .001 _______________

Location of Hole C - 3.000 × 2.975 ± .002 _______________

Location of C - 1.00 ± .001 ______________________________

Location of D - 1.00 ± .001 ______________________________

Location of E - 2.00 ± .001 ______________________________

Location of F - 1.975 ± .001 ______________________________

Location of G - 3.000 ± .002 ______________________________

3 Holes Ream to 3/8" Dia. ± .001 ______________________

WORKMANSHIP ______________________________

GRADE ______________________________

MANUFACTURING PROCESSES

LAB ADVANCED

PLACEMENT

Job/Task: SURFACE GRINDING

PERFORMANCE OBJECTIVE:

The student given the necessary print and materials will have 45 minutes to dress grinding wheel, to achieve size and finish the project.

The student will be evaluated according to the operations of a surface grinder, safety, general safety, specifications and tolerances on print.

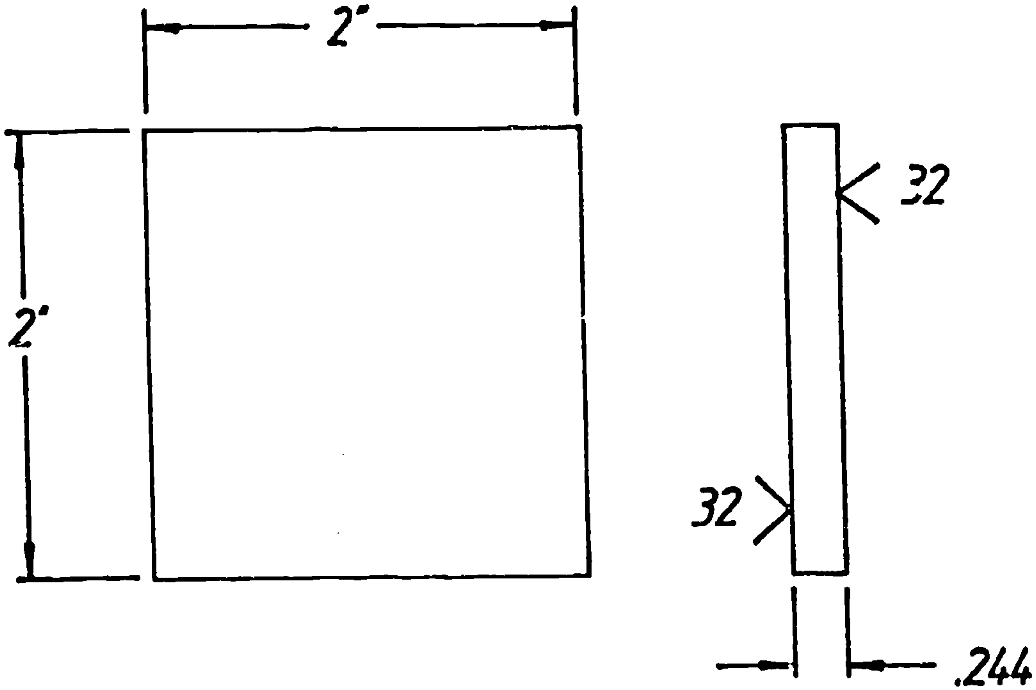


PLATE:
C.R.S.
BREAK ALL SHARP EDGES
LIMITS ON DECIMALS +.0005 −.0000
LIMITS ON FRACTIONS ±1/64"

INSPECTION SHEET

Student ________________ Instructor________________________

	32	
Grind Finish	.244	
	+.0005	
2 surfaces	- 0000	__________________________________

MANUFACTURING PROCESSES

LAB ADVANCED

PLACEMENT

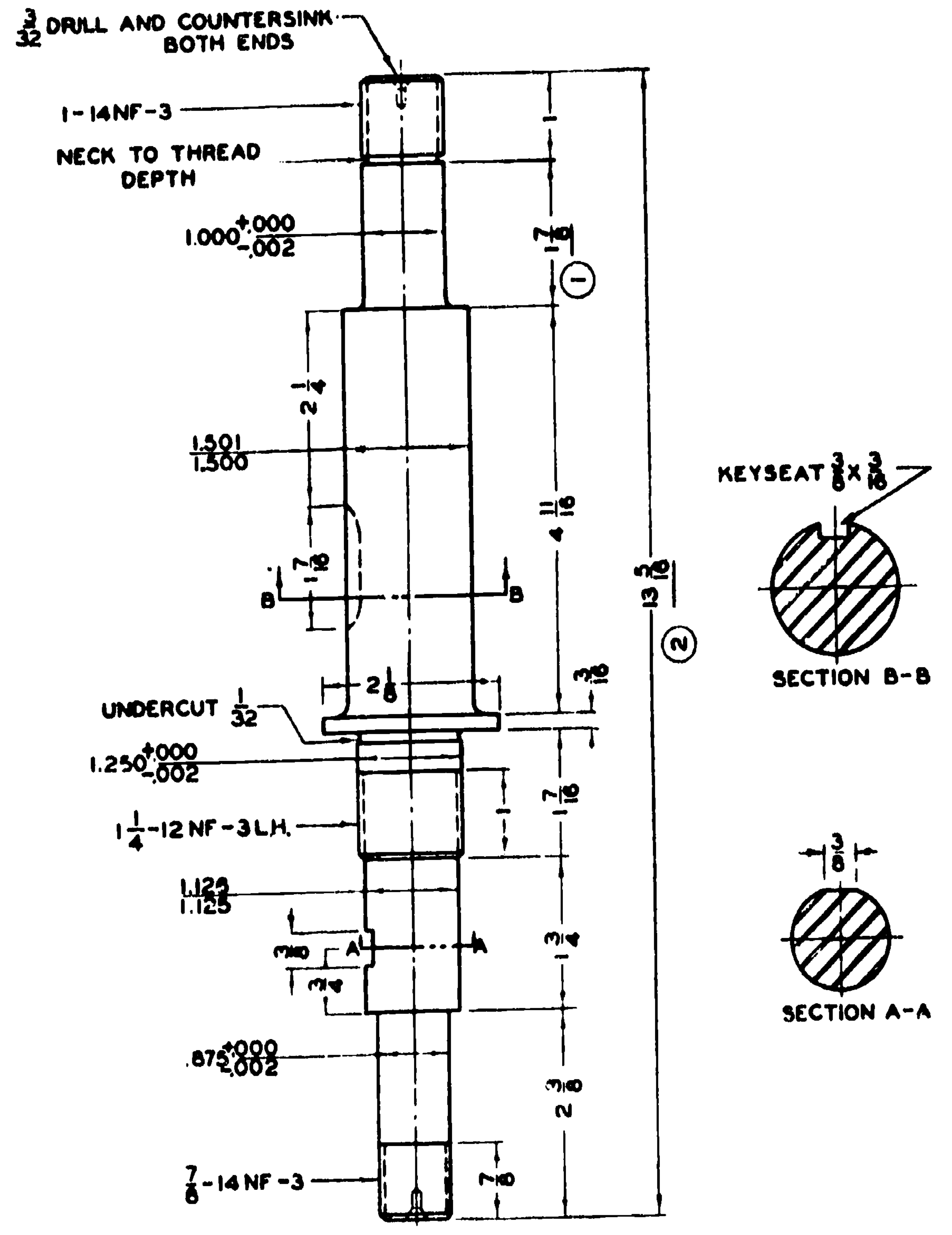
Job/Task: BLUEPRINT READING

PERFORMANCE OBJECTIVE:

The student given the necessary Blueprint will have 45 minutes to interpret this drawing.

The student will be evaluated according to the number of questions answered correctly of given Blueprint.

A minimum of 85 percent accuracy is required.



NOTE: ALL FILLETS 1/8 R

CHAMFER STARTING END OF ALL THREADS 30° TO THREAD DEPTH

NO.	CHANGE	DATE	BY
②	WAS 13 1/16	9/22/40	R.C.L.
①	WAS 1 5/8	9/22/40	R.C.L.

QTY.	ORDER NO.	DATE	DWG. BY	CK. BY	APP. BY
42	16-172	[redacted]	J.J.A.	Elkin	W.W.R.
			SCALE 6=12	MAT. S.A.E. 3135	H.T.

UNLESS OTHERWISE SPECIFIED:

LIMITS ON DECIMAL DIMENSIONS WITHIN ± .005"

LIMITS ON FRACTIONAL DIMENSIONS WITHIN ± 1/64"

LIMITS ON ANGULAR DIMENSIONS WITHIN ± 1/2°

SPINDLE SHAFT

FINISH: BREAK ALL SHARP EDGES

D-20

SPINDLE SHAFT

1. What is the name of the part? ____________

2. What is the blue print number? ____________

3. What is the material used? ____________

4. What is the largest diameter on the shaft? ____________

5. What is the overall length on the shaft? ____________

6. Starting at the bottom end of the shaft, what are the successive diameters up to the 2-1/8" diameter? ____________

7. Starting at the top end of the shaft, what are the successive diameters down to the 2-1/8" diameter? ____________

8. At how many places are threads being cut? ____________

9. Starting at the bottom, what are the thread diameters along the shaft? ____________

10. Specify, for any <u>left-hand thread</u> on the job, the thread diameter and number of threads per inch. ____________

11. How many threads per inch are being cut on the 7/8", 1¼", and 1" diameters? ____________

12. What class of fit is required on the threads? ____________

13. Is this a close fit or a loose fit? ____________

SPINDLE SHAFT

14. What is the length of that portion of the shaft which has the 7/8"-14 thread? ____________

15. What is the length of the thread cut along this diameter? ____________

16. How much clearance is allowed between the last thread and the shoulder on the 7/8" diameter? ____________

17. What is the length of the 1.125" diameter? ____________

18. What is the upper limit of size of the 1-1/8" diameter? ____________

19. What is the lower limit of size of the 1-1/8" diameter? ____________

20. How long is that portion of the shaft which has the 1¼"-12 thread? ____________

21. What is the length of the 1¼"-12 thread? ____________

22. What is the distance from the thread (1¼"-12) to the 2-1/8" diameter shoulder? ____________

23. What is the largest size to which the 1.250" portion of the shaft can be turned? ____________

24. What is the smallest size to which this can be turned? ____________

25. How far is it from the bottom end of the shaft to the shoulder of the 2-1/8" diameter? ____________

26. How far is it from the shoulder made by the 7/8" and 1.125" diameters to the center of the flat? ____________

SPINDLE SHAFT

27. In section A-A is shown the cut across the shaft at the point the flat is milled. How wide is the flat cut? ____________

28. What width of cutter is used in milling the flat? ____________

29. How far is it from the bottom end of the shaft to the shoulder formed by the 1.125" and 1.250" diameters? ____________

30. What is the thickness of the 2-1/8" collar? ____________

31. How far from the top end of the shaft is the 2-1/8" shoulder? ____________

32. How long is the 1.500" diameter? ____________

33. How long is the 1" diameter? ____________

34. What is the length of thread cut on the 1" diameter? ____________

35. For what purpose is the 3/16" x 3/8" cut in section B-B used? ____________

36. What is the length of this cut? ____________

37. How far is this cut from the shoulder of the 1" diameter? ____________

38. What is the largest diameter to which the 1.500" shaft can be turned? ____________

39. What is the amount of chamfer on each end of the piece? ____________

40. What operation cuts below the 1¼" diameter near the collar? ____________

TO: Wesley E. Franklin
FROM: Joseph P. Kasztejna
SUBJECT: Criteria for Advanced Placement
RE: April 22, 1988

****

AREA: MANUFACTURING PROCESSES LAB I

All course competencies and objectives for Manufacturing Processes Lab I are designed to require the student to absorb theoretical information. Because of the emphasis on theory, I would recommend a comprehensive written test to obtain advanced placement status for this course or study. The questions on this test must be based on the seven course competencies and their objective.

AREA: MANUFACTURING PROCESS LAB II

Competencies and objectives for Manufacturing Processes Lab II are both theoretical and practical. I recommend both a comprehensive written test and a practical shop test. The written test should measure the student's ability to identify various machines, machining operations, cutters, holding devices, and measuring instruments use in the machine field. The test should also include blueprint reading, mathematics and safety practices used in the setup and operation of basic machine tools.

The practical test for LAB II should require the student to demonstrate his/her ability to use precision measuring instruments and perform both precision and semi precision layout. The actual machine tool operation part of the practical test should require the student to complete one or two projects that would test his/her ability to setup and operate the following machine tools.

COMPETENCY	MACHINE TOOL	OPERATION TESTED
No. - 3	Lathe	Straight turning, shoulder turning, drilling, angle turning, threading, select tooling, measuring, tool sharpening
No. - 4	Verticl Milling	Align fixtures, attachments and cutting tools; slot cutting; mill to length; mill sides square; drilling with a milling machine.
No. - 5	Grinding Surface	Dress grinding wheel, secure workpiece, perform parallel grinding, setup and grind 90° to parallel surface

As part of the practical test the student should be observed selecting the proper tools and cutters, using proper procedures when setting up machine tools, setting proper cutting speeds and feed rate, and working in a safe and careful manner. The practical test should have an area in its criteria for safety and work habits observed as the student performs the test.

G.E.T. 108 SKETCHING & PRINT INTERPRETATION

PART I - GENERAL INFORMATION

Below are two columns of information, Column A gives terms associated with print reading and Column B provides definitions. On the answer sheet give the letter of the definition that matches the term in Column A.

PART II - MACHINE DRAWINGS

On your answer sheet answer all questions noted.

PART III - WELDING DRAWINGS

On your answer sheet answer all questions noted.

NAME: ______________________ S.S.# ______________

ANSWER SHEET

PART I

1. ______
2. ______
3. ______
4. ______
5. ______
6. ______
7. ______
8. ______
9. ______
10. ______
11. ______
12. ______
13. ______
14. ______
15. ______
16. ______
17. ______
18. ______
19. ______
20. ______

PART II

Section View I ______
Section View II ______
Section View III ______

1. ______
2. ______
3. ______
4. ______
   ______
   ______
   ______
5. ______
6. ______
7. ______
8. ______
9. ______
10. ______

PART III

1. ______
2. ______
3. ______
4. a ______
   b ______
5. ______
6. ______
7. Dia ______
   Lgth ______
8. Size ______
   Qty ______
9. f ______
   h ______
10. Inches ______
    Type ______
11. ______
12. ______
13. ______
14. ______
15. ______
16. ______
17. a ______
    e ______
18. ______
19. ______
20. ______

COLUMN A

PART 1

1. Orthographic Views
2. Dimensions
3. Notes
4. Object Line
5. Hidden Line
6. Threads
7. Extension Line
8. Dimension Line
9. Leader Line
10. Cutting Plane Line
11. Cross Sectioning
12. Assembly Drawings
13. Detail Drawings
14. Auxiliary View
15. Sectional View
16. Tolerance
17. Isometric View
18. Developed Drawing
19. Graphs
20. Single Line Schematic

COLUMN B

PART 1

A. A geometric shape associated with various types of fasteners

B. Values indicating size

C. Contains value and dimensioning distance

D. Bringing a line beyond the object to provide for clear dimensioning and show dimensioning points

E. Positions of an object that are perpendicular to the plane of projection

F. Shows a single unit with contour and size

G. A piping drawing that have all lines in a single plane

H. A technique used to show internal structure of a part

I. Shows the visible shape of an object

J. Represents material being cut by a cutting plane line

K. A drawing providing information of an electrical circuit

L. Points directly to a point of surface to apply a dimension or note

M. The upper and lower limits of a dimension

N. Written information on a drawing applying to an entire drawing or a specific location

O. A drawing that shows relationship between parts

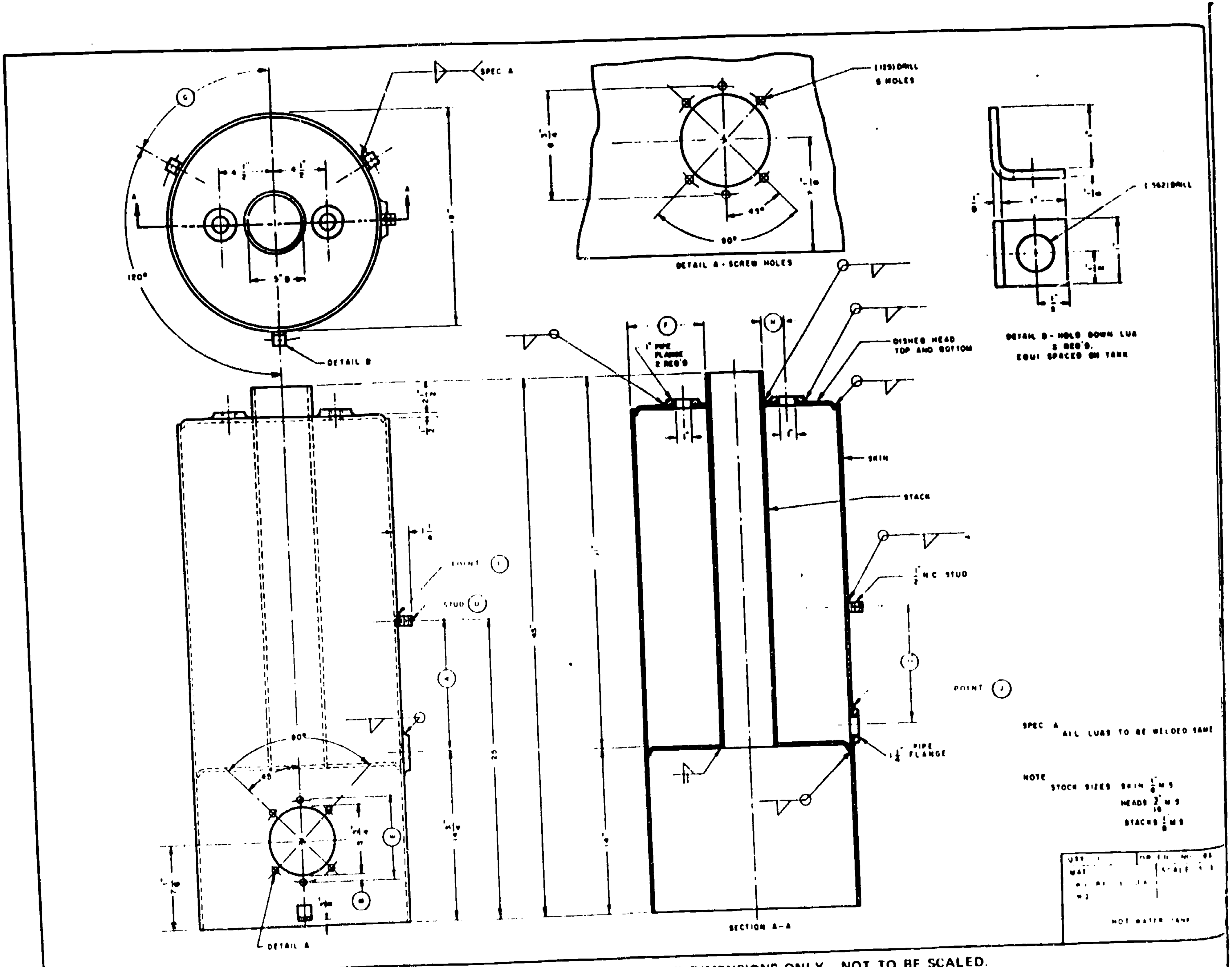
P. A technique used to show description of an inclined or oblique plane

Q. Shows edges and outlines not visible

R. A pictorial type drawing that uses an ordinary scale value

S. Indicates position of view in sectioning

T. A drawing used to represent engineering facts, statistics and/or laws of phenomea



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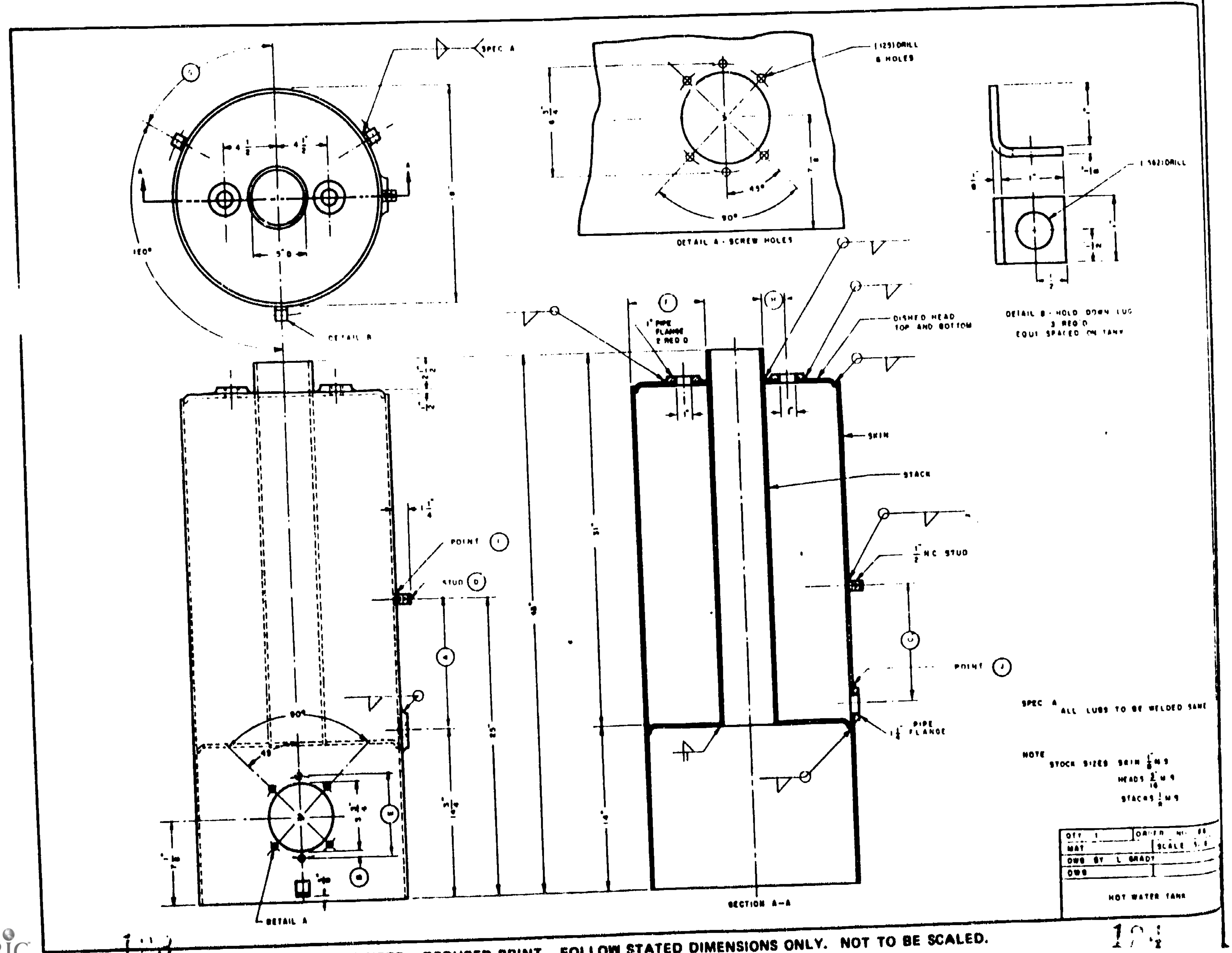
SUMMARY REVIEW NO. 2

A. Refer to the drawing, Hot Water Tank, page 94.

1. How thick is the bottom head? ____________
2. How thick is the material used in the stack? ____________
3. How thick is the skin of the tank? ____________
4. Give the dimensions of the sheet required for the
   a. skin of the tank ______ b. the stack ______
5. What type of threaded fittings are used? ____________
6. Give the sizes and number of fittings used. ____________
7. What is the diameter and length of stud D ?
   ____
8. What size and how many screw holes are used around the large hole? ____________
9. What is the size of distance F ? ______ of H ? ______
10. How many inches and what type of weld is required to join the stack to the head at the top of the tank?
    ____
11. What type of weld is required at point J ? ______
12. What type of weld is used to join the hold-down lug to the tank? ____________
13. How many hold-down lugs are there? ____________
14. a. Do all these lugs require the same type of weld?
    ____
15. What is the angle of G ? ____________
16. What is the distance from the top of the top head to the bottom of the bottom head? ____________
17. What is the dimension of A ? ______ of E ? ______
18. What is the distance from the water-holding bottom of the tank to the bottom of the hold-down lugs?
    ____
19. How many degrees apart are the hold-down lugs?
    ____
20. What types of welds are required to join the stack to the bottom of the tank? ____________



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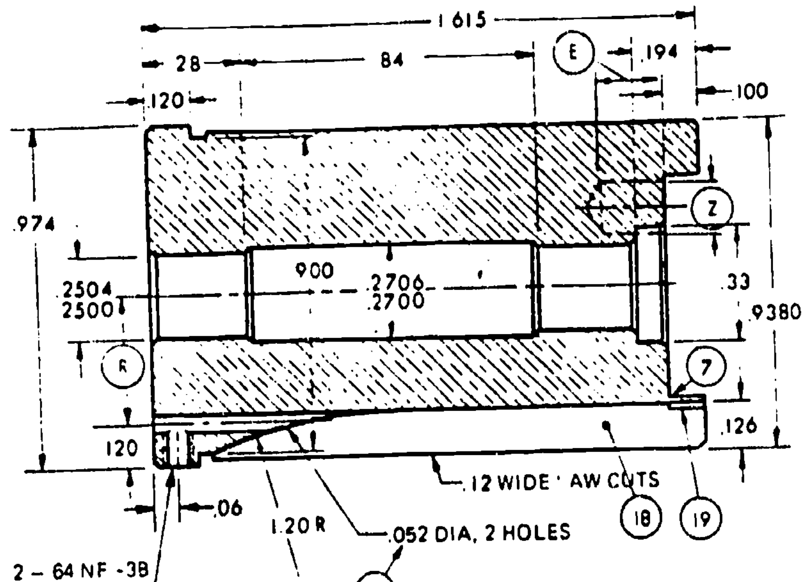
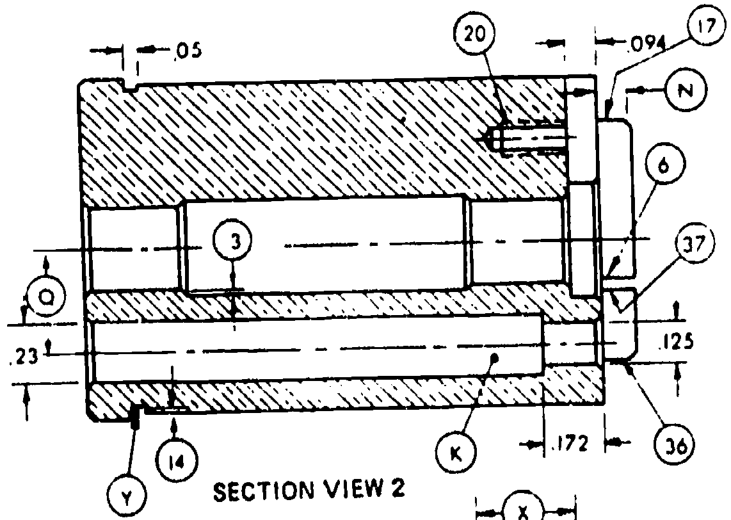
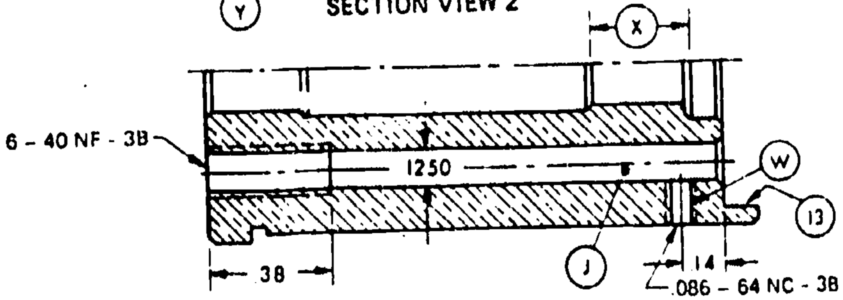


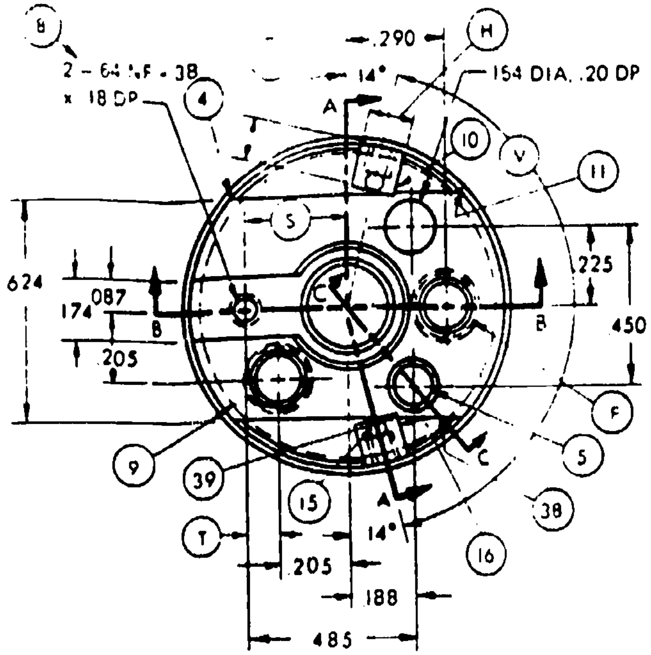
SECTION VIEW 1



SECTION VIEW 2



SECTION VIEW 3



ANSWERS

1 ____
2 ____
3 ____
4 (11) ____
(19) ____
(37) ____
(38) ____
5 ____
6 ____
7 ____
8 ____
9 ____
10 (E) ____

ASSIGNMENT

Label each of the section views with the appropriate titles with reference to the cutting plane lines on the end view.

QUESTIONS

1. What is the diameter of hole (F) ?
2. What is the diameter of hole (Z) ?
3. Identify hole (8) in another view.
4. Locate lines (11) (19) (37) (38) in another view.
5. Determine angle (V) .
6. Locate line (Y) in another view.
7. Determine depth of slot at (14)
8. Determine maximum depth of recess at (3)
9. Locate hole (M) in another view
10. Determine distances (E)

QTY	6
MATERIAL	BRASS
SCALE	2.5/1
DRAWN	DATE
SPINDLE BEARING	A-51

CURRICULUM PLANNING TASK FORCE MEETING
MAY 10, 1988

Discussion of advanced placement criteria resulted in formulation of the following tentative plans and opinions.

D.C. ELECTRICITY

This course had been selected originally as one in which advanced placement might be possible. There seemed to be general agreement that the mathematics background of students from vocational schools and from comprehensive high schools where electronics courses are offered is inadequate to warrant advanced placement in this course. High school instructors stated that their electronics students have a good laboratory background, but the theory and math involved in the D.C. electricity course is such that a student would rarely benefit by exclusion from the course.

There are students, however, who have the lab experience that might be sufficient to exempt them from either <u>all</u> or <u>part</u> of the D.C. experiments.

DIGITAL ELECTRONICS

All participants agreed that this course might be one in which both vocational high school and comprehensive high school students with electronics backgrounds might earn advanced placement.

TECHNICAL PHYSICS

Advanced placement in the technical physics course would be based upon the following criteria:

Successful completion, with an A or B grade, of a course in a recognized, advanced placement high school course, along with at least a B grade on its associated standardized exam. Recommendation of a high school instructor is also required.

TECHNICAL MATH 111

Discussion included the possibility of accepting credit only from advanced placement courses in high school.

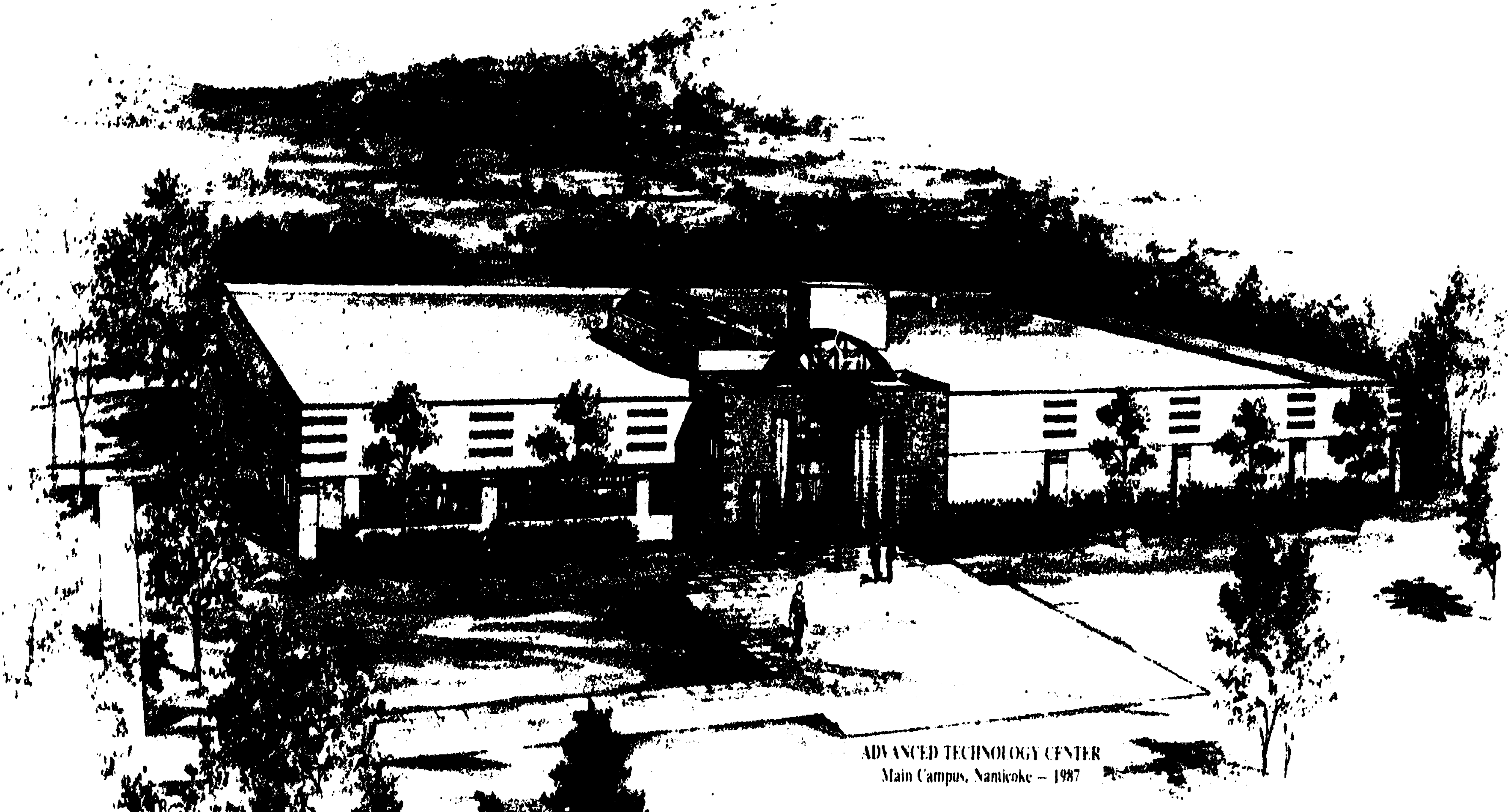
ATTACHMENT #3

Advanced Technology Center Brochure

In the event that a student has not taken advanced placement courses in high, an alternative method of screening for awarding of advanced placement was explored. It would include the following steps:

1. Interview with counselor/college representative during which the student's background is explored with respect to requirements of the course.
2. Recommendation of the appropriate high school instructor.
3. Demonstration of completion of the prerequisite courses in high school. For example, electronics students must have completed algebra I and II, trigonometry, and physics before being considered for advanced placement in math or electronics courses.
4. Documentation of any relevent experience.
5. Formal testing in the course must result in a minimal score of ______.

Community College of Luzerne County



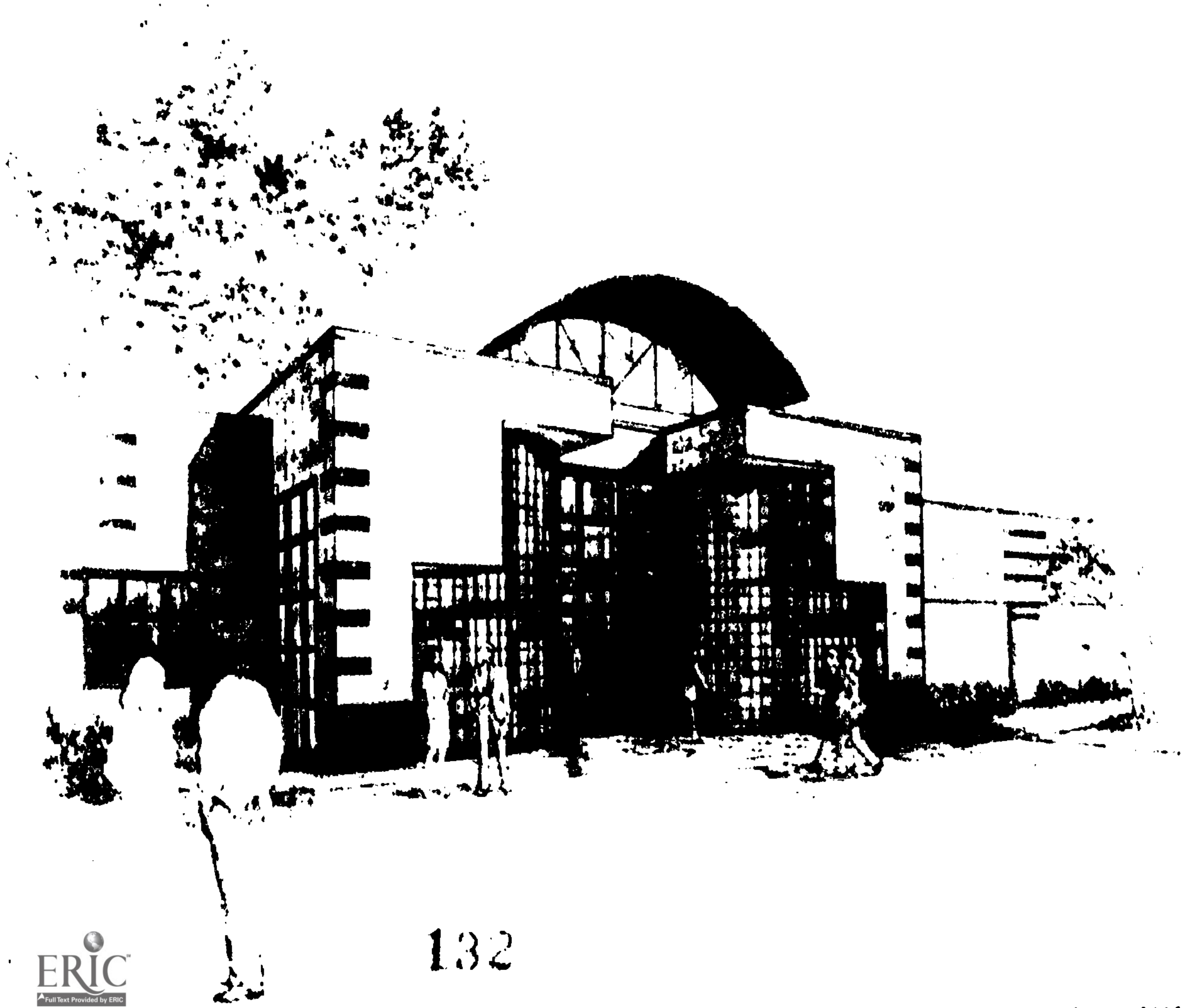
ADVANCED TECHNOLOGY CENTER
Main Campus, Nanticoke – 1987

moving education into the 21st Century

fulfilling our mission . . .

Luzerne County Community College over its two decades of service to the region has developed strong programs in technical-career education and training. Follow-up studies show that the students that have been served by these programs have been well prepared to compete in the region's job market. In a continuing effort to fulfill the College's mission, and to maintain the marketability of our constituents, a major new initiative has been identified. A decision was made in 1986, after an assessment of regional manpower needs and emerging manufacturing process, to expand technical-career offerings into the areas of the advanced technologies to better position the College to support the careers of tomorrow and to foster community and regional economic development.

The intent of this new initiative is to attract new industries and to support existing enterprises which will add to the stability and health of the manufacturing and business communities in Northeastern Pennsylvania.



Fulfillment of this commitment will be accomplished through the development of an Advanced Technology Center (ATC) which will be dedicated to and designed for a wide array of new and upgraded programs that will provide the foundations for careers of tomorrow. ATC programming will be designed to support the identification, selection, and implementation of new technologies. The ATC will play a vital role in economic development by providing companies with a central source for help in applying the new technologies to their operations as well as providing a pool of trained personnel to meet manpower needs. This facility will feature new programs in areas including computer-aided manufacturing, laser-electro optics, computer systems maintenance, computer-assisted design, robotics, computer-aided drafting, automotive technology and broadcast telecommunications.

A strong design feature of the ATC will be built-in structural flexibility to respond to manpower needs as currently identified as well as those that will emerge in the future. The ability to eliminate, modify, add, or customize a specific training program within an extremely short time frame is of utmost priority to the College and to the region.

Finally, development of the ATC has grown out of the belief that continued regional economic growth requires government, business and education cooperation. The need to integrate new technical resources challenges all of us to come to grips with new technology and innovation. This new initiative will foster and encourage new partnerships to work together for a better tomorrow.

more than a building . . .

An Advanced Technology Center (ATC), as we should define it, is more than just a building . . . it's a CONCEPT. Involved with the concept are the following elements:

Credit (certificate/degree) program instruction:

- Telecommunications (Broadcast Communications)
- Automotive Technology
- Architectural Engineering Technology
- Mechanical Engineering Technology
- Electrical/Electronics Technology
- Computer Integrated Manufacturing Technology
- Automated Systems/Robotics Technology*
- Computer Assisted Design Technology*
- Computer Systems Maintenance Technology*
- Laser/Electro-Optics Technology
  Computer Numerical Control Technology
- Nuclear Power Technology

* May develop as **options** of other programs.

In the above-listed programs, the objective will be to produce a well-balanced, technical person capable of assisting architects, engineers, and other technology experts in a variety of support functions, to include, for example, designing and maintaining various design and manufacturing systems.

In the individual/business setting, this person will be somewhere on a level between the design and production stages of the manufacturing processes. This person will be the "trouble-shooter" - the one with the **practical** knowledge of what needs to act with what in what way to produce a product. Yet, this person will also have enough backgrounds (credits) to pursue advanced degrees, beyond the associate level.

These programs will be primarily competency-based, and will be delivered utilizing a variety of instructional approaches, including inter-active video, and computer-assisted instruction. The pool of available students will include recent high school graduates interested in seeking a degree or certificate, and adults interested in upgrading skills and/or changing careers.

Short-Term training

As technology continues to advance and change, especially in the Northeast corridor (regional scope - 20 county area), short-term training (10 to 25 hr. range) will become increasingly important in order for the private sector to keep employees (especially production personnel) current regarding new processes and new equipment. For the most part, this short-term activity will be of a custom-designed nature . . . a blend of standard pedagogical methodology and innovative delivery approaches with **new** content (subject matter).

The ATC will be the setting for a host of initiatives connected with custom-designed, short-term training . . . especially where equipment manufacturers located outside the region will need to provide training to local manufacturers *as a condition of the sale of equipment*. In this regard, the ATC will become the training site and/or location for equipment manufacturers like Cincinnati-Milicron, Allen-Bradley, Bridgeport, General Electric, etc. to do outreach regionally. The College's role in this process will be to provide space, interface with the training activity, and obtain, as a result (consequence), donated equipment. The spin-offs from this activity, in terms of benefits to the College, are impossible to clearly identify at this writing, but it seems logical to think they will be significant.

Contract Training

As technology advances in our region, the private sector will be in need of specific training to up-grade and advance the skills of employees. Remembering that the Northeast has an **older** work force, it seems logical to assume that rather than engage in union-difficult, lay-off strategies, companies in the private sector will be looking for means to "bail them out" of the problem of re-training with reasonable cost.

Contract training, i.e., educational programming and support services specifically geared to the re-training needs of a particular manufacturing process or company should be the answer to many prayers in the private sector. This type of training will be in the 100 hr. to 500 hr. range, delivered in the ATC and/or on site (of the company) in various fashions—and designed and delivered in such manners as to address an immediate training need, while, at the same time, having application in some manner to existing (degree) programs.

Technology Exchange

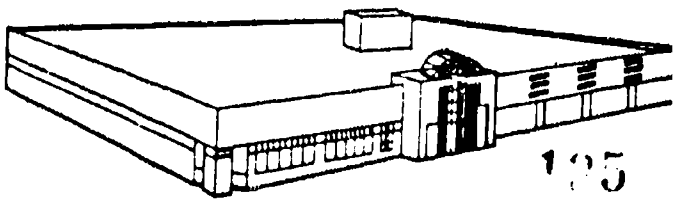
While definitely connected to short-term training, this ATC element can be of great significance in providing the setting for existing, regional companies (and local ones) to view and examine new technological advances—the actual equipment, not just pictures or catalog cuts. Displays and exhibitions, either as stand-alone activities, or in conjunction with workshops and seminars (5 hr. to 10 hr. duration) will be important to the development of the ATC as a highly visible community/private sector resource, and important to the educational conference center as a focus for private sector thrusts (fund-raising).

Other Considerations

The Institute has already conducted a very successful "Incubator Without Walls" project under a grant from Sears PDF/KAW-AACJC. The Sears project, as it is affectionately known, has garnered many plaudits and acknowledgements as a unique, effective approach to assisting new, fledgling companies. We need to do more of the same, and this kind of activity can be continued through the application of the ATC concept.

The private sector in our region has many needs . . . and needs to be supported and assisted, especially existing small and moderately sized businesses/companies.

The ATC is more than just a building; it is a jumping-off point for a venture into the future that should be on-going well into the next century. Because of what the ATC is and will do, the very foundation upon which the College was founded—to address the changing needs of the community (with the emphasis on "changing")—this foundation should be bolstered tremendously.



Committed to the introduction of new technology into the workplace, the ATC is both market driven and business responsive. In building and expanding its role as a technology resource, the ATC will carefully focus on an agenda tailored to increasing productivity, improving product quality, enhancing employee skills, and helping Northeastern Pennsylvania companies gain and maintain a competitive status.

The 85,000 sq. ft. Center will offer:

- Comprehensive teleconference facilities.
- Exhibition space for technology systems and demonstrations supported by furnished office and reception suites for customer meetings and business transactions.
- Many individual computer workstations permitting self-paced instruction to support custom-designed training delivery.
- Dedicated computer training labs.
- On-site media support systems.
- Seminar and meeting rooms with audio-visual support.
- Climate controlled manufacturing process lab with 20 stations.
- Fluid Power Lab with 24 stations.
- A robotics lab with three cells featuring the latest automatic machinery.
- Computer Integrated Manufacturing (CIM) lab.
- Computer aided drafting lab.
- Laser lab.
- Six auto-labs.

Here, in one location, businesses can find many of the services needed to integrate modern technology into their operations.

Upper Level

☐ Offices
- Administrative
- Faculty

☐ Technology Training and Demonstration
- Large Group/Demonstration
- Small Group Seminar

☐ Lobby/Display and Exhibition

☐ Broadcast Communications Facility
- FM Radio Station Studio/Control
- Audio Production/Editing
- Video Production/Editing
- TV Production Studio
- TV Production Control

■ Instructional Laboratories
- Electrical Machines
- AC/DC
- Microprocessor
- Mechanical Drafting
- Architectural Drafting

☐ Restrooms, Elevator, Stairways

☐ Classrooms

Lower Level

☐ Offices
- Faculty

☐ Lobby/Display and Exhibition

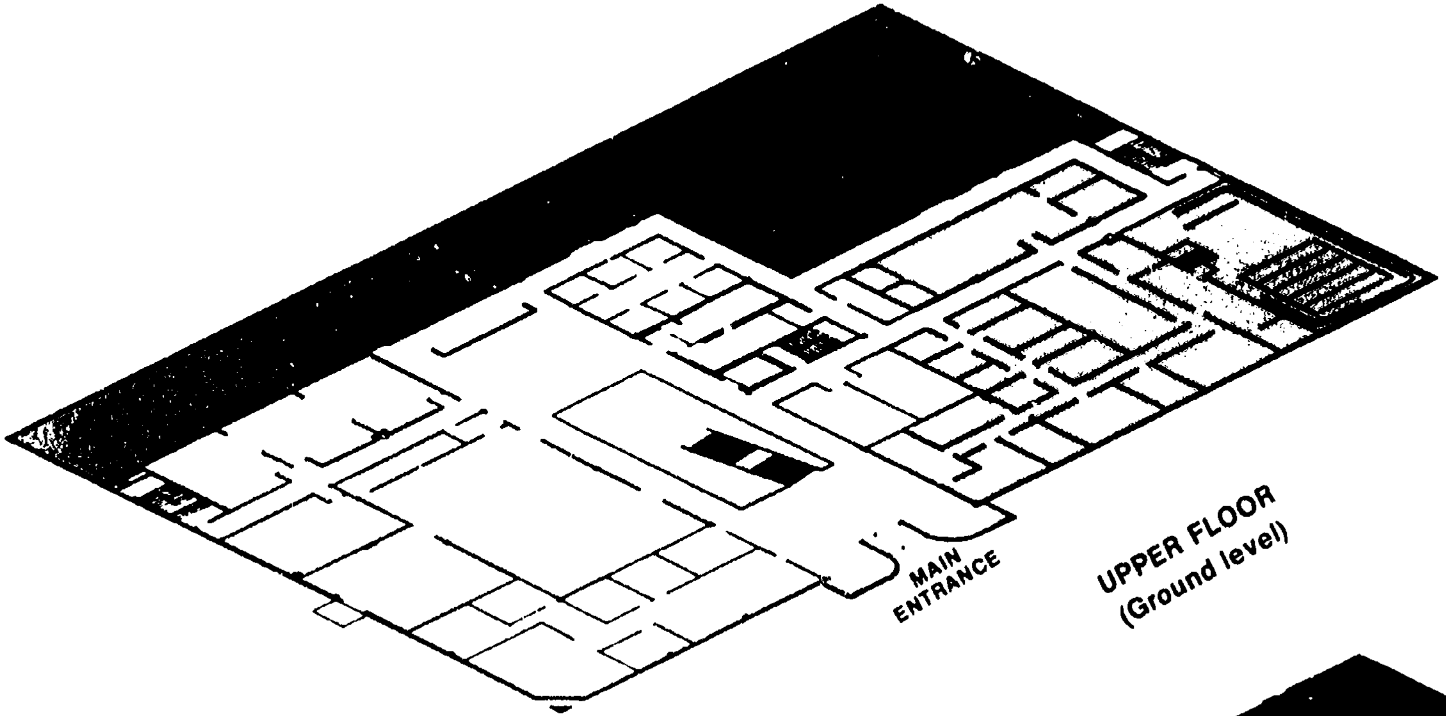
■ Instructional Laboratories
- Laser
- Automotive
- Manufacturing Processes
- Computer Integrated Manufacturing
- Computer Aided Drafting
- Fluid Power
- Robotics
- Technical Equipment Service

☐ Classrooms

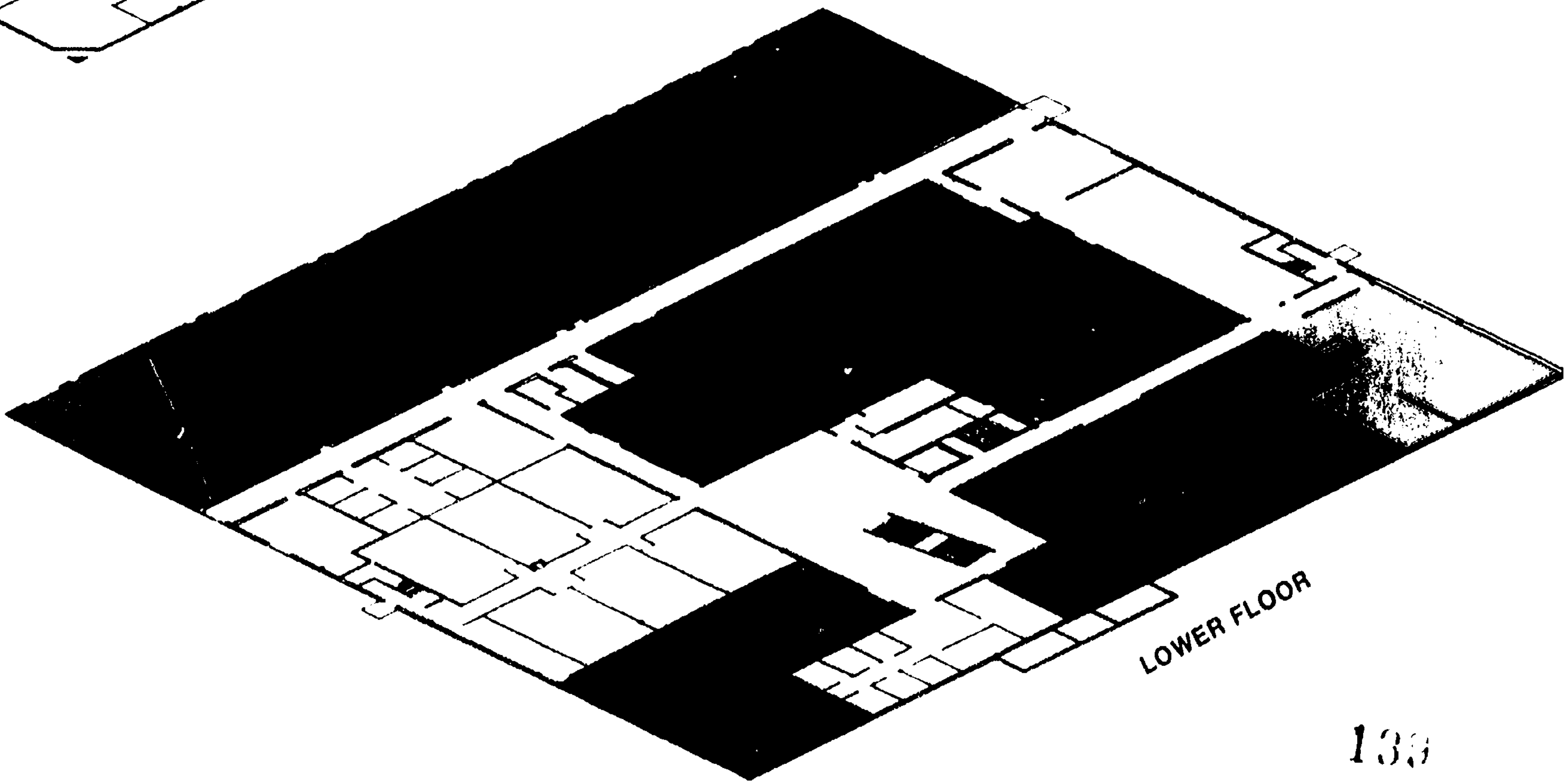
☐ Receiving, Staging, and Exhibition

☐ Restrooms, Elevator, Stairways

☐ Broadcast Communications Facility



UPPER FLOOR
(Ground level)



LOWER FLOOR

opportunities in high technology . . .

BROADCAST COMMUNICATIONS TECHNOLOGY

This two-year associate degree program utilizes a "hands-on" approach, whenever feasible, to provide the student with a comprehensive understanding of the theory and skills vital in the broadcast medium, as well as the private and corporate communications fields. An emphasis is placed on student competency in the operation of advanced technology equipment in audio and video production, and in the latest computer graphics video system.

AUTOMOTIVE TECHNOLOGY

The Automotive Technology program is a two-year associate degree program which offers both theory and practical experience combined. Students enrolled in the program will acquire a comprehensive understanding of the theory and skills necessary to diagnose, service and repair automotive systems and components utilizing varied computer systems/technology.

ARCHITECTURAL ENGINEERING TECHNOLOGY

The College offers both a one-year certificate and a two-year associate degree program in Architectural Engineering which prepares students for employment opportunities as technicians in the field. In addition to positions with architectural firms, the student may also qualify as an engineering aide, architectural draftsman, assistant surveyor, detailer, building materials and equipment salesman or estimator.

MECHANICAL ENGINEERING TECHNOLOGY

This curriculum is offered in both a one-year certificate or two-year associate degree program and is designed to prepare students for work in industry as an engineering technician, and for advancement to group leader or foreman. The program includes the basics in humanities, social sciences, applied math and physics, and appropriate technical courses.

ELECTRICAL/ELECTRONICS TECHNOLOGY

The Electrical/Electronics Technology program is offered in both a one-year certificate program and a two-year associate degree program. The two-year program emphasizes both the theory and the practical applications of electrical/electronics which is in line with the rapid changes in this extremely diversified field which requires competency in a broad range of fundamentals.

The one-year program enables students to develop the specialized skills necessary to design, install, service, and operate electrical/electronic equipment.

COMPUTER INTEGRATED MANUFACTURING TECHNOLOGY

Both a one-year certificate and two-year associate degree program are being developed for this program which will train technicians for employment in modern computerized manufacturing industries. Such technicians produce production parts by using computer-controlled machine tools and similar sophisticated equipment.

Employment in the field of automated manufacturing is expected to increase faster than the average for all occupations through the 1990's.

AUTOMATED SYSTEMS/ROBOTICS TECHNOLOGY

This two-year associate degree program is designed to provide students with the knowledge and practical experience for electromechanical equipment and controls common to both robotic and automated systems.

COMPUTER SYSTEMS MAINTENANCE TECHNOLOGY

This two-year associate degree program is a specialty concentration within the broader scope of the Electronics Engineering Technology program. The complexity and scope of the internal functions of the microcomputer as well as its wide variety of associated peripherals, instruments and systems, requires high academic capacity as well as technological/manipulative skills.

LASER/ELECTRO-OPTICS TECHNOLOGY

This two-year associate degree program will emphasize the theory and applications of Laser/Electro-Optical technology. A broad based knowledge of electronics, optics, and lasers is required for competency in this emerging technology.

NUCLEAR POWER TECHNOLOGY

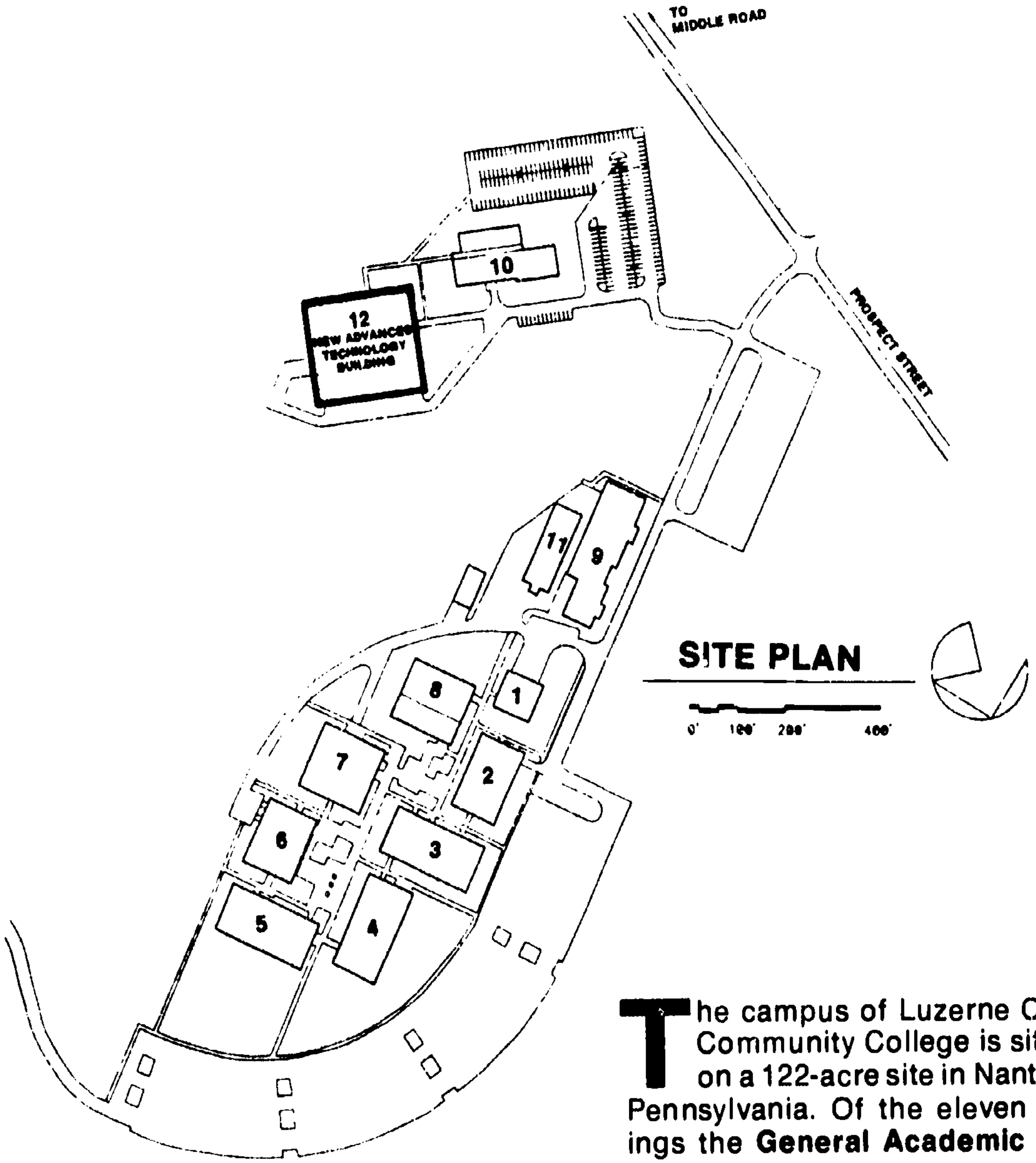
This two-year associate degree program is designed to provide technically trained personnel to support the nuclear power industry. The objective of the program is to provide students with a comprehensive understanding of the theory and skills necessary to function in one of the following areas — reactor operations, instrumentation and control, and health physics.

COMPUTER AIDED DESIGN (CAD) TECHNOLOGY

This two-year associate degree curricuum is designed to provide students with a working knowledge of micro and mainframe CAD systems. It also introduces basic and advanced drafting and design done on computers as well as basic programming and automated systems concepts.

COMPUTER NUMERICAL CONTROL TECHNOLOGY

The Computer Numerical Control (CNC) Technology curriculum, which is a two-year associate degree program of study, emphasizes the use of current computerized numerical control and computer aided manufacturing technologies to program machine tools to perform drilling, milling, and turning operations. Instruction emphasizes hands-on skills as well as related information.



The campus of Luzerne County Community College is situated on a 122-acre site in Nanticoke, Pennsylvania. Of the eleven buildings the **General Academic Building (#4)** and the two **Technical Arts Buildings (#2 and #3)** contain classrooms, laboratories, and faculty offices. Recently completed was the **Medical Arts Complex (#9)**, consisting of a dental arts facility, a nursing arts facility and a multipurpose facility.

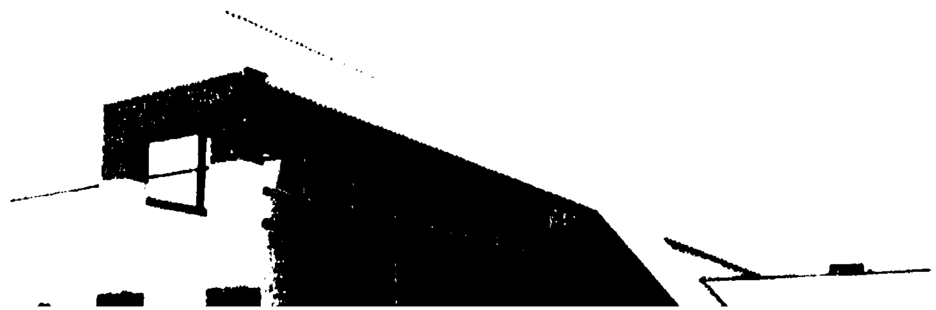
The Student Center Building (#7) houses student lounges, a dining-vending area, the College Bookstore, the College Health Office, and student activity offices.

The **Health and Physical Education Building (#8)** includes a two-station gym-

. . .in a perfect setting

The Educational Conference Center has been designed to meet the needs of outside agencies, businesses and organizations for meetings, seminars and conferences. Seven various size seminar rooms and two auditoriums offer the needed flexibility in preparing for a successful learning experience. The attractive, spacious dining area provides for all day or meal-centered activities. All of the latest electronic and communication equipment, including a satellite receiving station, is available.

A professional coordinator and staff are available to answer your every need. The College is pleased to offer its comprehensive conference planning program to area residents at the most reasonable price possible.



Credits

Robert P. Casey, Governor
Commonwealth of Pennsylvania

Thomas K. Gilhool
State Secretary of Education

Luzerne County Board of Commissioners
- Frank Trinisewski, Chairman
- Jim Phillips
- Frank Crossin

Thomas J. Moran, President

John Hosage, D.D.S.
Chairman, Board of Trustees

John M. Beccaris
Dean of Institutional Development and College Project Officer

Pyros and Sanderson
Architect

Sordoni Construction Company
Construction Manager

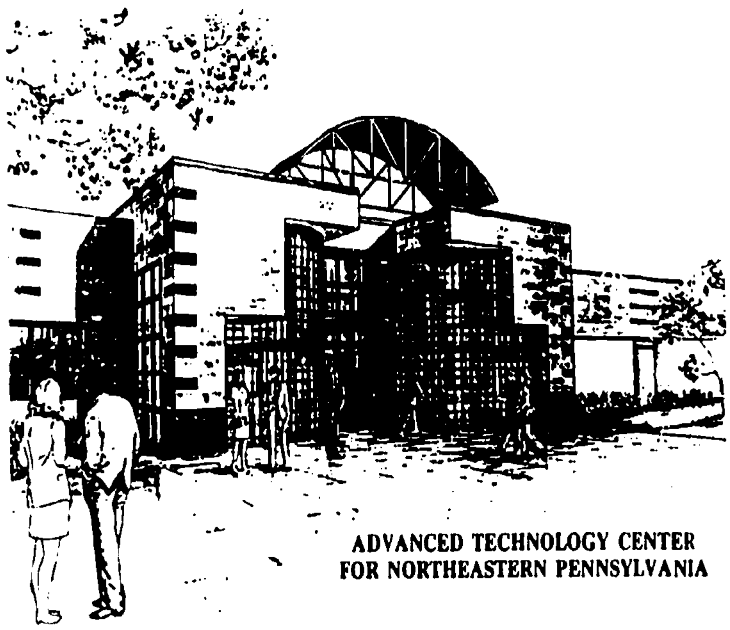
Pauline G. Carmody, Assistant to President/External Affairs

Community College of Luzerne County • Nanticoke, PA • (717) 829-7300

ATTACHMENT #4

Program Brochure

Automated Systems/Robotics Technology



ADVANCED TECHNOLOGY CENTER
FOR NORTHEASTERN PENNSYLVANIA

BEST COPY AVAILABLE

Community College of Luzerne County

. . . moving education into the 21st Century

Automated Systems/ Robotics Technology

Automated Systems/Robotics (ASR) training and education is at the forefront of manufacturing technology training, and there is a strong demand for ASR technicians because of the need for increased competitiveness and productivity in industry, both locally, state-wide, and nationally.

A student in the Automated Systems/Robotics program at LCCC will learn broad-based electro-mechanical skills and become familiar with electronic, mechanical, hydraulic, pneumatic and programmable controller devices. You will be trained to install, set up, troubleshoot, integrate, program, modify, test, operate and repair automated systems and components. An ASR technician may work under the supervision of an engineer, as a member of a team, or as a supervisor of other technicians.

What are your job and salary opportunities as a graduate of LCCC's Automated Systems/ Robotics Technology Program?

Starting salaries range from $16,000 to $19,000 per year in eastern Pennsylvania. Experienced technicians average over $30,000 per year depending upon background and experience.

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Associate Degree Program

First Semester			*Semester Hours*
ENG	101	English Composition I	3
MAT	111	Technical Math I	5
GET	108	Sketching & Print Interpretation	2
GET	121	Manufacturing Process. I	3
IEL	131	D.C. Electricity	4
			17

Second Semester			*Semester Hours*
ASR	101	Intro. to Automated Systems/Robotics	3
MAT	112	Technical Math II	5
PHY	123	Technical Physics I	4
GET	234	Intro. Computer Program.	3
IEL	132	A.C. Electricity	3
			18

Third Semester			*Semester Hours*
ENG	261	Technical Report Writing	3
PHY	124	Technical Physics II	4
IEL	205	Digital Circuits	3
ASR	203	Programmable Logic Controllers	3
IEL	135	Electronic Devices	3
HPE		Health/Physical Education	1
			17

Fourth Semester			*Semester Hours*
ASR	205	Electromech. Devices	3
GET	112	Industrial Saftey	1
ASR	201	Automated Systems/ Robotics Applications	4
ASR	207	Fluid Power Applications	3
SPE	125	Fundamentals of Speech	3
		Social Science Elective	3
			17

Please send me information on each category or area of study checked below:

- ☐ Admissions Procedures
- ☐ Advanced Placement Procedures

Advanced Technology Center Programs

- ☐ Automotive
- ☐ Architectural Engineering
- ☐ Automated Systems/Robotics
- ☐ Broadcast Communications
- ☐ Computer Assisted Design
- ☐ Computer Integrated Manufacturing
- ☐ Computer Numerical Control
- ☐ Computer Systems Maintenance
- ☐ Electrical/Electronics
- ☐ Laser/Electro-Optics
- ☐ Mechanical Engineering
- ☐ Other Training (please specify)

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Here's How To Apply For LCCC's Advanced Technology Programs

1. You may call 829-7343 or visit the Admissions Office to obtain an application, or go to your local high school guidance office. The Admissions Office at the Community College is located in Building 5 (Administration Building).
2. Have your high school transcripts or GED scores and your completed application for admission sent to the college's Admissions Office.
3. The college will contact you regarding your program of study.
4. An interview is not required, but may be scheduled to obtain additional information. Please call 829-7343 or 459-1600 for more information.

You May Qualify For Financial Aid

At LCCC, several types of financial aid may be available to you. You may apply for federal and state grants that do not have to be repaid. A number of scholarships also are available.

Other options you may want to consider are loans and student employment — both on and off campus. LCCC does not turn students away because of financial need. Let us work with you to make college affordable.

Call LCCC's Financial Aid Office for detailed information at 735-8300, 829-7300, or 459-1600 extension 389.

FOR MORE INFORMATION

Wesley E. Franklin, Executive Director
Advanced Technology Center
for Northeastern Pennsylvania
Community College of Luzerne County
Nanticoke, Pennsylvania 18634-3899

AUTOMATED SYSTEMS/ROBOTICS

EQUIPMENT SPECIFICATIONS

1. Programmable Logic Controllers
   a. Allen Bradley PLC 2/02
   b. Allen Bradley PLC 2/17
   c. Allen Bradley PLC 5/15

2. Robotic Work Cell

3. Fluid Power Training System

LUZERNE COUNTY COMMUNITY COLLEGE

PROGRAMMABLE LOGIC CONTROLLER SPECIFICATIONS

QUANTITY: 2   ALLEN-BRADLEY PLC 2/02 OR EQUIVALENT

TABLE OF CONTENTS

1.00 General Specifications

1.01 This specification has been developed to establish minimum requirements for a solid-state programmable controller designed to provide high reliability in industrial applications. The internal wiring of the controller is to be fixed, with the logic functions it must perform in a given application to be programmed into its memory. The controller shall be supplied with the CPU, input/output scanner, input modules, output modules, memory, power supply, and all power and interface cables necessary to function as a complete and operable programmable controller system.

1.02 The objective of the programmable controller will be to improve reliability, maintainability, and efficiency by reducing operating costs and downtime.

1.03 The specification shall be followed in accordance with the contract and all areas of questions or noncompliance shall be submitted to the purchaser for review and approval.

2.00 Services

2.01 The supplier shall provide operating instruction manuals with adequate information pertaining to the following:

(1) Programming procedures

(2) System specifications

(3) Electrical power requirements

(4) Application considerations

(5) Explanation of internal fault diagnostics

(6) Assembly and installation procedures

(7) Troubleshooting procedures

(8) Power up procedures

(9) Shut down procedures

(10) Recommended spare parts list

2.02 In cases where the programming is done by the supplier, the supplier shall provide a copy of all working programs on data cartridge tapes as well as a printed program listing.

2.03 The supplier shall provide a network of field sales and support personnel located in key cities throughout the United States and internationally. The supplier shall also provide a field service department with experienced representatives stationed in major cities with the capability to provide telephone consultation, prompt on-site service, and field replacement stock.

2.04 The supplier shall provide product application assistance by trained and experienced engineers to assist the customer with program and system development through telephone consultation and on-site check-out, debug, and start-up assistance.

2.05 The supplier shall provide a customer training program designed to teach the customer's personnel in the understanding and application of the programmable controller. The training program shall include training manuals and "hands-on" programming experience on a programmable controller of a type similar to that provided by the supplier.

2.06 The supplier shall have the capability to conduct on-site training programs at a location provided by the customer.

2.07 The supplier shall supply videotape training courses directed toward the operation and maintenance of the programmable controllers.

2.08 The supplier shall provide on magnetic tape a software package, written in FORTRAN IV, from which a translation of programmable controller binary files into ladder diagrams, including symbolic name and octal address assignments, can be run on a mini-computer such as the Digital Equipment Corporation PDP-11 or VAX family.

3.00 Assembled Systems

3.01 A supplier shall assume single source responsibility for system assembly. An assembled system may include mounting and wiring of relays, motor starters, transformers, and disconnecting means, or other control devices as specified by customer supplied documentation.

3.02 The supplier shall provide mounting and wiring of the programmable controller system in a NEMA type 12 or other enclosure that may be specified.

3.03 If specified, the enclosure shall be able to accommodate an electrical service of 460 volt, 3 phase, 60 Hz. The enclosure shall have sufficient room for a 460 VAC (primary) to 115 VAC (secondary) control transformer to service the processor, inputs and outputs.

3.04 The supplier shall be able to provide a sealed lexan plastic window in the NEMA 12 enclosure door(s) for observing the processor and I/O status indicating lights.

3.05 The supplier shall have the capability to supply an enclosure with special paint and graphic displays.

3.06 The supplier shall wire all programmable controller inputs and outputs to customer specified terminal blocks.

3.07 The assembled system shall include fuse blocks as sized by the customer's application.

3.08 Within the enclosure all I/O racks, processor racks, and power supplies shall be grounded to meet the manufacturer's specifications.

3.09 The supplier shall be able to provide within the enclosure a master control relay to de-energize each I/O module and inhibit machine motion. The master control relay must be de-energized directly by a hardwired Emergency Stop pushbutton.

3.10 If more than one controller is mounted within an enclosure, the capability must exist to share a single programming panel or line printer.

3.11 All pushbuttons, switches and other operator devices must be UL listed and/or CSA approved, and sufficiently large and durable to provide dependable, long life operation.

3.12 All cables (with associated plugs, connectors and receptacles) requiring user field installation, shall be designed for commercial use to withstand an industrial environment.

3.13 Upon receipt of the purchase order but prior to the start of the manufacturing of the equipment, the supplier shall submit drawings of the complete assembled system for approval by the purchaser or his consultant.

3.14 Drawings which are returned to the supplier for correction or revision shall be resubmitted for approval before starting fabrication of the work in question unless marked "approved as noted".

3.15 All drawings shall include page, sheet, and line numbers.

3.16 The first page of all drawings and schematics shall be a cover sheet consisting of a Bill of Material, purchase order number, manufacturer's job number, user's name, location, application, and shipping address.

3.17 The drawings shall include a mechanical layout detailing the overall external dimensions of the enclosure. Included shall be such pertinent information as location of door handles, windows, lifting lugs, and enclosure mounted items such as tachometer or current meters, cooling fans, etc.

3.18 The supplier shall provide documentation detailing the mounting of the processor, I/O racks, relays, motor starters, disconnect switch, fuse blocks, wireways, etc. All materials shall be labeled to provide easy cross-reference to the Bill of Material listing.

3.19 Electrical prints detailing all hardwiring, done by the supplier, to devices such as relays, motor starters, disconnect switches, fuse blocks, etc. shall be provided with individual wire numbers and relay contact cross-reference designations.

3.20 Sections describing inputs shall designate input modules by name, rack, module, and terminal location.

3.21 Each limit switch, pushbutton or other input device shall be connected to only one individual input point.

3.22 Each output device shall be connected to only one individual output point.

3.23 The last sheet in the set shall be for terminal block designations each containing their individual terminal numbers.

3.24 At the time the equipment is shipped, one (1) reproducible copy of each drawing mentioned above shall be provided with the equipment.

4.00 <u>Design Description</u>

4.01 A major consideration of the programmable controller system shall be its modular, field expandable design allowing the system to be tailored to the customer's machine and/or process control application. The capability shall exist to allow for expansion of the system by the addition of hardware and user software.

4.02 The processor plus input and output circuitry shall be of a modular design with interchangeability provided for all similar modules.

4.03 Modules are defined herein as devices which plug into a chassis and are keyed to allow installation in only one direction. The design must prohibit upside down insertion of the modules as well as safeguard against the insertion of a module into the wrong slot.

4.04 The programmable controller shall have downward compatibility whereby all new module designs can be interchanged with all similar modules in an effort to reduce obsolescence.

4.05 All hardware of the programmable controller shall operate at an ambient temperature of 0° to $60^{\circ}C$ (32° to $140^{\circ}F$), with an ambient temperature rating for storage of -40° to $+85^{\circ}C$ (-40° to $185^{\circ}F$).

4.06 The programmable controller hardware shall function continuously in the relative humidity range of 5% to 95% with no condensation.

4.07 The programmable controller system shall be designed and tested to operate in the high electrical noise environment of an industrial plant.

4.08 The programmable controller shall provide a means for mounting the chassis in a standard cabinet or 19 inch rack.

4.09 Each input and output module shall be a self-contained unit housed within an enclosure.

4.10 The programmable controller shall include the capability of addressing remote input and output modules up to 10,000 cable feet from the processor. The communication link between the CPU and any remote input and output distribution chassis shall be via a 20 AWG tinned copper twinaxial cable with braided and foil shields or via fiber optic cable.

4.11 The communication rate between the CPU and the remote input and output modules shall be user selectable between 57.6 and 115 K bauds. At a distance of 10,000 cable feet between the processor and the input and output modules the transmission rate shall be no less than 57,600 baud. If the distance in cable feet is reduced, then this transmission rate may be increased.

5.00 <u>Processor Hardware</u>

5.01 The operating system shall be mounted on plug-in modules which allow for easy field replacement.

5.02 Each module within the system shall perform internal diagnostic checking and give visual indication to the user by illuminating a "green" indicator when no fault is detected and a "red" indicator when a fault is detected.

5.03 All system modules, main and remote chassis shall be designed to provide for free air flow convection cooling. No internal fans or other means of cooling, except heat sinks, shall be permitted.

5.04 The processor shall include a connector that provides a communication for peripheral support devices.

5.05 When the battery goes low, two events shall occur:

1. A bit shall be set in the processor, which can be used for an alarm.

2. A red LED, located on the front of the processor, shall illuminate.

5.06 The processor front panel shall include a two-color indicator showing either that the processor is in run mode or that a fault is present in the system.

5.07 Memory shall be protectable by a hard-wired switch to prevent inadvertent changes to program, messages or data table values.

5.08 A switch shall be located on the front of the processor to cause transfer of memory from RAM to EEPROM for back-up storage.

5.09 A key switch shall be mounted on the front of the processor to transfer between program, run/program and run modes.

6.00 Power Supplies

6.01 The programmable controller shall operate in compliance with an electrical service of either 120 VAC or 220/240 VAC, single phase, in the frequency range from 47 to 63 Hz.

6.02 The manufacturer shall provide as standard equipment a system power supply capable of converting 120 VAC or 220/240 VAC line power to the DC power required to operate the programmable controller system.

6.03 A choice of either internal or external power supplies shall be available to supply power for CPU operating system, memory and at least 1.75 Amperes of logic power to the inputs/outputs modules in that rack. Power supplies shall be available for additional local and remote inputs/outputs.

6.04 The power supply shall automatically shut down the programmable controller system whenever its output current is detected as exceeding 125% of its rated current.

6.05 The power supply shall monitor the incoming AC line voltage for proper levels. When the power supply is wired to utilize 120 VAC power, the system shall function properly within the range of 97 to 132 VAC. If the voltage level is detected as being out of range for more than one-half line cycle, the power supply shall automatically shut down the system and remain disabled until the proper voltage level returns. In addition, the power supply shall provide surge protection, isolation, and outage carry-over up to 2 cycles of the AC line.

6.06 In cases where the AC line is especially unstable or subject to unusual variations it shall be possible to install a constant voltage transformer having a sinusoidal output waveform.

6.07 At the time of power-up, the power supply shall inhibit operation of the processor and I/O modules until the DC voltages are within specifications.

6.08 The supplier shall provide a power supply which has the capability of providing power to the field side of I/O modules such as analog, TTL, and low level DC.

7.00 Program Storage

7.01 The program storage medium shall be 1 K 16-bit CMOS RAM (volatile) type memory. EEPROM (non-volatile) type memory shall be available to back-up RAM.

7.02 The programmable controller system shall be capable of addressing up to 6000 words, where each word is comprised of 16 data bits.

7.03 The RAM memory segments shall be tested for validity using the checksum method of error detection. If memory is invalid, a red fault light shall illuminate.

7.04 The memory shall contain on-board battery back-up capable of retaining all stored program data through a continuous power outage for 12 months under worst case conditions.

8.00 Input and Output - General

8.01 Each input or output module shall be a self-contained unit housed within an enclosure.

8.02 The input/output enclosure (chassis) with its respective modules shall be of universal type and compatible with any programmable controller manufactured by the supplier. Racks shall be sized to accommodate I/O in increments of 32, 64, 96, 128, and 256 terminal points per chassis.

8.03 During normal operation, a malfunction in the remote input/output channel shall affect the operation of only the channel and not the operation of the CPU.

8.04 All communications on the input/output channel between the remote I/O and the CPU shall be digital in nature (discrete voltages).

8.05 Circuit components for both input and output shall be mounted on plug-in modules and keyed to prevent module insertion into the wrong slot.

8.06 Isolation shall be used between all internal logic and external power circuits. This isolation shall meet the minimum specification of 1500 vrms.

8.07 It shall be possible to replace any input or output module without disturbing field wiring.

8.08 Each I/O module shall contain a visual indicator to display ON/OFF status of individual input or output points.

8.09 Discrete output modules shall be provided with self-contained fuses for overload and short circuit protection of the module.

8.10 All user wiring to I/O modules shall be through a heavy-duty terminal strip. Pressure-type screw terminals shall be used to provide fast, secure wire connections.

8.11 All input/output modules shall be color coded and titled with a distinctive label.

8.12 All input modules shall have a specified filter time constant to limit the effects of voltage transients.

8.13 The processor shall have the capability of controlling and addressing up to 256 input and output points in any combination of analog and discrete signals. With the addition of remote scanner modules, the processor shall be able to control and address 240 input and output points in any combination of analog and discrete in the local rack and 256 discrete input and output points in up to two remote racks.

9.00 <u>Input and Output Modules</u>

9.01 The programmable controller manufacturer shall offer discrete input/output hardware consisting of the following:

Inputs:

A. AC/DC input for devices which operate at 120 VAC, 50/60 Hz., or 120 VDC, 220 VAC, 50/60 Hz. or 220 VDC.

B. AC input for devices which operate at 24 VAC, 50/60 Hz.

C. DC input for devices which operate at 5 to 30 VDC, 12 to 24 VDC, or 48 VDC.

D. Isolated AC input which provides isolation of 120 VAC or 120 VDC input signals.

E. TTL (5 volt DC) input for transistor-transistor logic, either high or low true logic, compatible with input devices such as solid state control and measuring equipment.

Outputs:

A. AC output for devices which operate at 120 VAC, 50/60 Hz.

B. AC output for devices which operate at 220/240 VAC, 50/60 Hz.

C. AC output for devices which operate at 24 VAC, 50/60 Hz.

D. DC output for devices which operate at 12 to 24, or 48 VDC.

E. DC power output for operating heavy-duty clutches, brakes, and solenoids. This should be available in 12 to 24, 48, and 125 VDC versions.

F. Isolated AC output which provides six (6) isolated outputs capable of switching 120 VAC or 220 VAC power.

G. TTL (5 volt DC) output which provides transistor-transistor logic, either high or low true logic, compatible for operating 5 VDC level electronic devices.

I. Contact output which provides four (4) normally open and four (4) normally closed reed relay outputs.

J. Contact ouput which provides eight (8) normally open reed relay outputs.

K. Contact output which provides four (4) normally open or four (4) normally closed mercury-wetted contacts.

9.02 Analog I/O modules of the following types shall be offered by the manufacturer:

A. Analog input which accepts analog signals and converts them to three digit BCD, four digit BCD or twelve (12) bit binary values. Digital resolution shall be available in 1 part in 256, 1 part in 1000 (BCD), or 1 part in 4096 (binary). Analog inputs shall be available in single-ended and sourcing and differential versions. Analog inputs shall be available in the following ranges:

1. Voltage range: 0 to +5 VDC, +1 to +5 VDC, 0 to +10 VDC, -5 to +5 VDC, -10 to +10 VDC.

2. Current range: 4 to 20 ma, 0 to 20 ma, -20 to +20 ma.

B. Analog output which converts a three digit BCD number, a four digit BCD number, or a twelve (12) bit binary number into an equivalent single-ended analog output signal. Output isolation shall be available. Analog outputs shall be available in the following ranges:

1. voltage range: 0 to +5 VDC, +1 to +5 VDC, 0 to +10 VDC, -5 to +5 VDC, -10 to +10 VDC

2. current range: 4 to 20 mA, 0 to 20 mA, -20 to +20 mA

9.03 Encoder module capable of accepting input pulses up to 50 KHz in either a single or dual channel form from an encoder shall be available. Inputs to the module shall be TTL compatible (5 VDC) or rated for 12-24 VDC. Each module shall have two output terminals rated at 500 mA maximum with open collector outputs. The counting format of the module shall be 12 bit binary or 3-digit binary coded decimal (BCD).

9.04 Specialized input modules of the following types shall be available:

A. Thermocouple input module that reads millivolt signals generated by thermocouple or millivolt devices. These signals shall be displayed as 12-bit binary or three digit BCD. Thermocouple types E, J, K, T, B, R and S are compatible with this module.

B. Resistance Temperature Detector (RTD) module that reads up to six RTD signals and displays them as four digit BCD or 12-bit binary values.

9.05 Two types of axis positioning modules shall be available.

A. A module shall be available to control the motion of up to three closed-loop servo motor axes. It shall be able to interface to differential line driver encoders and TTL encoders and shall provide scalable $\pm$ 10 V signal for various drives. It shall include hardware and software commands for features such as E-Stop, jog forward and jog reverse. It shall provide software configuration for parameters such as number of encoder lines, resolution, gain and speed.

B. A module shall be available to control the motion of up to three stepper motor axes. It shall interface to translators such as push-pull, current source and current sink. Hardware and software commands for features such as E-Stop, jog forward and jog reverse shall be available.

9.07 An I/O module shall be available to provide an interface between the controller and an ASCII peripheral device. Allowed electrical interfaces are RS-232-C and current loop.

10.00 <u>Interfacing and Peripherals</u>

10.01 The programming device shall be either:

A. An industrial terminal intended for on- or off-line programming, hereafter referred to as industrial terminal.

B. An IBM PC-XT compatible computer with programming software for off-line program development, hereafter referred to as programming terminal.

10.02 The programming device shall provide for selecting the communications rate from 110 to 9600 baud.

10.03 The program device shall be capable of displaying a rung consisting of eleven (11) series elements and six (6) parallel elements.

10.04 A user program shall be recorded into or from the processor memory using:

A. Magnetic tape cartridge equipment
B. Cassette tape equipment
C. IBM PC-XT compatible computer with programming software via communications modules
D. EEPROM Cartridge

10.05 The industrial terminal shall include a 9 inch (diagonal) CRT screen and keyboard. It shall be capable of the following functions:

A. Load, edit, test, run and monitor program remotely from I/O racks.
B. Diagramatic instruction keys for entry of ladder format program.
C. Instructions will intensify on the CRT screen to indicate positive status of an examine contact or output coil, regardless of circuit configuration.

10.06 The software for a programming terminal shall allow the following features:

A. System options totally menu selectable.
B. Develop and edit programs in office environment.
C. Organize programs in a directory and maintain a library of all programs.
D. Symbolic addressing with up to ten (10) characters of text representing an octal address.
E. Cross-reference of symbolic to octal addressing.
F. Descriptive program, section and rung comments anywhere in program file with no restriction as to comment length.
G. Comments with up to fifty (50) characters can be associated with a specific address for description of logic or file function.
H. Program print-outs will have rung and page numbers, title information, instruction addresses and/or symbols, and rung and address comments.

10.07 The manufacturer shall offer a multi-point communication network providing a data transfer path for up to 64 programmable controllers and/or mini/micro-computers. The communicating stations shall be distributed anywhere along a single bus that extends a maximum of 10,000 cable feet in length. The communication network shall support the following features:

A. Floating master system
B. Peer-to-peer communication
C. Message error checking
D. Retries of unacknowledged messages
E. Diagnostic checks on other stations
F. Interface to more than one network

G. A user-oriented command language for manipulation of data structures of variable size and organization, such as setting or resetting bits, word and file transfers, and program loading.
H. Bi-directional communication between the programmable controllers and the communication network via a standard modem interface. The protocols shall meet EIA RS-232-C electrical standards and ANSI standard communication protocols.
I. The ability to communicate with all other models of programmable controller manufactured by said manufacturer.

11.00 Programming

11.01 The programming format shall be traditional relay ladder diagram.

11.02 The system shall have the capability to address up to 488 software timers and counters in any combination. All management of these instructions into memory shall be handled by the CPU. Instructions shall permit programming timers in the "ON" or "OFF" delay modes. Timer programming shall also include the capability to interrupt timing without resetting the timers. Counters shall be programmable using up-increment and down-increment.

11.03 Timer instructions shall include selectable time bases in time increments of 1.0 second, 100 msec and 10 msec. The timing range of each timer shall be from 0 to 999 increments. It shall be possible to program and display separately the timer's preset and accumulated values.

11.04 The programmable controller shall have signed math functions consisting of addition, subtraction, multiplication, division, and square root. It shall also convert between BCD and binary and display in hexadecimal format.

11.05 Instructions shall be provided for grouping contiguous 16 bit data words into a file. File manipulation instructions such as "file to file" move, "word to file" move, and "file to word" move shall be supported by the system. Comparison instructions such as "less than", "between range", and "equal to" shall be included within the system.

11.06 It shall be possible to unload words from a file in the same order as they are loaded (i.e. The first word in will be the first word out.)

11.07 The programmable controller shall be able to take the sine or cosine of a positive or negative number and give a properly signed result.

11.08 The instruction set shall include base ten and natural logarithms and inverse logarithms of signed numbers with up to a six digit result.

11.09 The programmable controller shall have a jump instruction which will allow the programmer to jump over portions of the user program to a portion marked by a matching label instruction.

11.10 In applications requiring repeatable logic rungs it shall be possible to place such rungs in a subroutine section. Instructions which call the subroutine and return to the main program shall be included within the system. It shall be possible to program several subroutines and define each subroutine by a unique label. The program format as displayed on the CRT shall clearly define the main program and all subroutines.

11.11 It shall be possible to manually set (force) either on or off all hardwired input or output points from the CRT programming panel. Removal of these forced I/O points shall be either individually or totally through selected keystrokes. The programming terminal shall be able to display forced I/O points.

11.12 An interrupt routine shall be programmable such that the routine shall be executed regularly. The interval at which the routine is executed shall be user-specified in the range of 1 to 50 milliseconds. A diagnostic bit shall be available to indicate routines which are too long to execute normally.

11.13 Latch functions shall be internal and programmable.

11.14 When using modules where multiple channels are terminated on one module, such as analog I/O modules, it shall be possible to transfer the current status of all channels to the CPU upon execution of one program instruction. This instruction shall be bidirectional to include data transfer from the CPU to the module or from the module to the CPU.

11.15 The number of times a normally open (N.O.) and/or normally closed (N.C.) contact of an internal output can be programmed shall be limited only by the memory capacity to store these words.

11.16 To reduce the effective scan time in order to detect short pulse duration inputs, it shall be possible to program a select logic rung more than once into memory.

11.17 A clock shall be accessible in logic giving the ability to control or generate reports based on real time, date, day of the week, and year with correction for leap years.

11.18 The capability shall exist to calculate the average and standard deviation of up to 999 six-digit (6) numbers.

11.19 A proportional-integral-derivative (PID) calculation shall be included as an easily programmed block-style instruction with these features:

A. Any combination of P, I, D control modes for desired controller response.

B. Selection of direct or reverse control action.

C. Manual control override from local hardware control station and remote display/computer station.

D. Bumpless transfer between manual and automatic modes with anti-reset wind-up.

E. Scaling of setpoint, process variable and error to user-selected value range relating to appropriate engineering units.

F. Control of cascaded loops.

G. Output summation for feedforward control and proportional bias. Ability to sum a measurement input, logically calculated variable or constant.

11.20 The capability shall exist to change a contact from normally open to normally closed, add instructions, change addresses, etc. It shall not be necessary to delete and reprogram the entire rung.

11.21 It shall be possible to insert relay ladder diagram rungs anywhere in the program, even between existing rungs, insofar as there is sufficient memory to accommodate these additions.

11.22 A single program command or instruction shall suffice to delete an individual ladder diagram rung from memory. It shall not be necessary to delete the rung contact by contact.

11.23 Editing and monitoring functions of the industrial terminal shall include the following features:

A. The program format shall display all instructions on a CRT programming panel. The system shall be capable of providing a "HELP" instruction which when called by the programmer will display on the CRT a list of instructions and all data and keystrokes required to enter an instruction into the system memory.

B. The capability shall exist for adding, removing, or modifying ladder logic rungs during program operation. When changes to ladder logic are made or new logic rungs are added, it shall be possible to test the edits of such rungs for proper execution.

C. At the request of the programmer, data contained in system memory shall be displayed on the CRT screen. This monitoring feature shall be provided for input/output status, timer/counter data, files, and system status.

D. A diagnostic instruction shall be provided to show the state of a contact over a period of time.

11.24 The programming terminal shall be menu selectable and have the following features:

A. User selectable level of assistance.

B. Link tested program files to create a complete program.

C. Compiled software allowing a symbol change to be incorporated throughout the program.

D. Cut and paste editing of an instruction, a branch or a rung.

12.00 Quality Requirements

12.01 The programmable controller processor shall be able to withstand conducted susceptibility tests as outlined in NEMA ICS 2-230, NEMA ICS 3-304-42, section 2 of IEEE 472-1974 and ANSI C37.90A-1974.

12.02 All completed units shall be subjected to a burn-in test of 140^{O}F for at least 24 hours.

ABOVE SYSTEM TO INCLUDE:

QTY	ITEM
1	12 SLOT I/O CHASSIS(1771-A3B OR EQUIV)
1	8 PT 120V AC/DC INPUT MODULE(17711A OR EQUIV)
1	8 PT 12-24V DC INPUT MODULE(17711B OR EQUIV)
1	8 PT 0-5V ANALOG INPUT MODULE(1771-1EO2 OR EQUIV)
1	8 PT 120V AC OUTPUT MODULE(1771OA OR EQUIV)
1	8 PT 12-24V DC OUTPUT MODULE(1771OB OR EQUIV)
1	4 PT 0-5V DC ANALOG OUTPUT MODULE(1771-OF02 OR EQUIV)

TOTAL COST TO INCLUDE DELIVERY , SET UP(INSTALLATION) AND TRAINING.

MODEL PROPOSED____

UNIT COST______________________ TOTAL COST_______________

LUZERNE COUNTY COMMUNITY COLLEGE

PROGRAMMABLE LOGIC CONTROLLER SPECIFICATIONS

QUANTITY: 2 ALLEN-BRADLEY PLC 2/17 OR EQUIVALENT

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1.00 General Specifications

1.01 This specification has been developed to establish minimum requirements for a solid-state programmable controller designed to provide high reliability in industrial applications. The internal wiring of the controller is to be fixed, with the logic functions it must perform in a given application to be programmed into its memory. The controller shall be supplied with the CPU, input/output scanner, input modules, output modules, memory, power supply, and all power and interface cables necessary to function as a complete and operable programmable controller system.

1.02 The objective of the programmable controller will be to improve reliability, maintainability, and efficiency by reducing operating costs and downtime.

1.03 The specification shall be followed in accordance with the contract and all areas of questions or noncompliance shall be submitted to the purchaser for review and approval.

2.00 Services

2.01 The supplier shall provide operating instruction manuals with adequate information pertaining to the following:

(1) Programming procedures

(2) System specifications

(3) Electrical power requirements

(4) Application considerations

(5) Explanation of internal fault diagnostics

(6) Assembly and installation procedures

(7) Troubleshooting procedures

(8) Power up procedures

(9) Shut down procedures

(10) Recommended spare parts list

2.02 In cases where the programming is done by the supplier, the supplier shall provide a copy of all working programs on data cartridge tapes as well as a printed program listing.

2.03 The supplier shall provide a network of field sales and support personnel located in key cities throughout the United States and internationally. The supplier shall also provide a field service department with experienced representatives stationed in major cities with the capability to provide telephone consultation, prompt on-site service, and field replacement stock.

2.04 The supplier shall provide product application assistance by trained and experienced engineers to assist the customer with program and system development through telephone consultation and on-site check-out, debug, and start-up assistance.

2.05 The supplier shall provide a customer training program designed to teach the customer's personnel in the understanding and application of the programmable controller. The training program shall include training manuals and "hands-on" programming experience on a programmable controller of a type similar to that provided by the supplier.

2.06 The supplier shall have the capability to conduct on-site training programs at a location provided by the customer.

2.07 The supplier shall supply videotape training courses directed toward the operation and maintenance of the programmable controllers.

2.08 The supplier shall provide on magnetic tape a software package, written in FORTRAN IV, from which a translation of programmable controller binary files into ladder diagrams, including symbolic name and octal address assignments, can be run on a mini-computer such as the Digital Equipment Corporation PDP-11 or VAX family.

3.00 <u>Assembled Systems</u>

3.01 A supplier shall assume single source responsibility for system assembly. An assembled system may include mounting and wiring of relays, motor starters, transformers, and disconnecting means, or other control devices as specified by customer supplied documentation.

3.02 The supplier shall provide mounting and wiring of the programmable controller system in a NEMA type 12 or other enclosure that may be specified.

3.03 If specified, the enclosure shall be able to accommodate an electrical service of 460 volt, 3 phase, 60 Hz. The enclosure shall have sufficient room for a 460 VAC (primary) to 115 VAC (secondary) control transformer to service the processor, inputs and outputs.

3.04 The supplier shall be able to provide a sealed lexan plastic window in the NEMA 12 enclosure door(s) for observing the processor and I/O status indicating lights.

3.05 The supplier shall have the capability to supply an enclosure with special paint and graphic displays.

3.06 The supplier shall wire all programmable controller inputs and outputs to customer specified terminal blocks.

3.07 The assembled system shall include fuse blocks as sized by the customer's application.

3.08 Within the enclosure all I/O racks, processor racks, and power supplies shall be grounded to meet the manufacturer's specifications.

3.09 The supplier shall be able to provide within the enclosure a master control relay to de-energize each I/O module and inhibit machine motion. The master control relay must be de-energized directly by a hardwired Emergency Stop pushbutton.

3.10 If more than one controller is mounted within an enclosure, the capability must exist to share a single programming panel or line printer.

3.11 All pushbuttons, switches and other operator devices must be UL listed and/or CSA approved, and sufficiently large and durable to provide dependable, long life operation.

3.12 All cables (with associated plugs, connectors and receptacles) requiring user field installation, shall be designed for commercial use to withstand an industrial environment.

3.13 Upon receipt of the purchase order but prior to the start of the manufacturing of the equipment, the supplier shall submit drawings of the complete assembled system for approval by the purchaser or his consultant.

3.14 Drawings which are returned to the supplier for correction or revision shall be resubmitted for approval before starting fabrication of the work in question unless marked "approved as noted".

3.15 All drawings shall include page, sheet, and line numbers.

3.16 The first page of all drawings and schematics shall be a cover sheet consisting of a Bill of Material, purchase order number, manufacturer's job number, user's name, location, application, and shipping address.

3.17 The drawings shall include a mechanical layout detailing the overall external dimensions of the enclosure. Included shall be such pertinent information as location of door handles, windows, lifting lugs, and enclosure mounted items such as tachometer or current meters, cooling fans, etc.

3.18 The supplier shall provide documentation detailing the mounting of the processor, I/O racks, relays, motor starters, disconnect switch, fuse blocks, wireways, etc. All materials shall be labeled to provide easy cross-reference to the Bill of Material listing.

3.19 Electrical prints detailing all hardwiring, done by the supplier, to devices such as relays, motor starters, disconnect switches, fuse blocks, etc. shall be provided with individual wire numbers and relay contact cross-reference designations.

3.20 Sections describing inputs shall designate input modules by name, rack, module, and terminal location.

3.21 Each limit switch, pushbutton or other input device shall be connected to only one individual input point.

3.22 Each output device shall be connected to only one individual output point.

3.23 The last sheet in the set shall be for terminal block designations each containing their individual terminal numbers.

3.24 At the time the equipment is shipped, one (1) reproducible copy of each drawing mentioned above shall be provided with the equipment.

4.00 Design Description

4.01 A major consideration of the programmable controller system shall be its modular, field expandable design allowing the system to be tailored to the customer's machine and/or process control application. The capability shall exist to allow for expansion of the system by the addition of hardware and user software.

4.02 The processor plus input and output circuitry shall be of a modular design with interchangeability provided for all similar modules.

4.03 Modules are defined herein as devices which plug into a chassis and are keyed to allow installation in only one direction. The design must prohibit upside down insertion of the modules as well as safeguard against the insertion of a module into the wrong slot.

4.04 The programmable controller shall have downward compatibility whereby all new module designs can be interchanged with all similar modules in an effort to reduce obsolescence.

4.05 All hardware of the programmable controller shall operate at an ambient temperature of 0^o to 60^oC (32^o to 140^oF), with an ambient temperature rating for storage of -40^o to $+ 85^oC$ (-40^o to 185^oF).

4.06 The programmable controller hardware shall function continuously in the relative humidity range of 5% to 95% with no condensation.

4.07 The programmable controller system shall be designed and tested to operate in the high electrical noise environment of an industrial plant.

4.08 The programmable controller shall provide a means for mounting the chassis in a standard cabinet or 19 inch rack.

4.09 Each input and output module shall be a self-contained unit housed within an enclosure.

4.10 The programmable controller shall include the capability of addressing remote input and output modules up to 10,000 cable feet from the processor. The communication link between the CPU and any remote input and output distribution chassis shall be via a 20 AWG tinned copper twinaxial cable with braided and foil shields or via fiber optic cable.

4.11 The communication rate between the CPU and the remote input and output modules shall be user selectable between 57.6 and 115 K bauds. At a distance of 10,000 cable feet between the processor and the input and output modules the transmission rate shall be no less than 57,600 baud. If the distance in cable feet is reduced, then this transmission rate may be increased.

5.00 <u>Processor Hardware</u>

5.01 The operating system shall be mounted on plug-in modules which allow for easy field replacement.

5.02 Each module within the system shall perform internal diagnostic checking and give visual indication to the user by illuminating a "green" indicator when no fault is detected and a "red" indicator when a fault is detected.

5.03 All system modules, main and remote chassis shall be designed to provide for free air flow convection cooling. No internal fans or other means of cooling, except heat sinks, shall be permitted.

5.04 The processor shall include a connector that provides a communication for peripheral support devices.

5.05 When the battery goes low, two events shall occur:

1. A bit shall be set in the processor, which can be used for an alarm.

2. A red LED, located on the front of the processor, shall illuminate.

5.06 The processor front panel shall include a two-color indicator showing either that the processor is in run mode or that a fault is present in the system.

5.07 Memory shall be protectable by a hard-wired switch to prevent inadvertent changes to program, messages or data table values.

5.08 A switch shall be located on the front of the processor to cause transfer of memory from RAM to EEPROM for back-up storage.

5.09 A key switch shall be mounted on the front of the processor to transfer between program, run/program and run modes.

6.00 Power Supplies

6.01 The programmable controller shall operate in compliance with an electrical service of either 120 VAC or 220/240 VAC, single phase, in the frequency range from 47 to 63 Hz.

6.02 The manufacturer shall provide as standard equipment a system power supply capable of converting 120 VAC or 220/240 VAC line power to the DC power required to operate the programmable controller system.

6.03 A choice of either internal or external power supplies shall be available to supply power for CPU operating system, memory and at least 1.75 Amperes of logic power to the inputs/outputs modules in that rack. Power supplies shall be available for additional local and remote inputs/outputs.

6.04 The power supply shall automatically shut down the programmable controller system whenever its output current is detected as exceeding 125% of its rated current.

6.05 The power supply shall monitor the incoming AC line voltage for proper levels. When the power supply is wired to utilize 120 VAC power, the system shall function properly within the range of 97 to 132 VAC. If the voltage level is detected as being out of range for more than one-half line cycle, the power supply shall automatically shut down the system and remain disabled until the proper voltage level returns. In addition, the power supply shall provide surge protection, isolation, and outage carry-over up to 2 cycles of the AC line.

6.06 In cases where the AC line is especially unstable or subject to unusual variations it shall be possible to install a constant voltage transformer having a sinusoidal output waveform.

6.07 At the time of power-up, the power supply shall inhibit operation of the processor and I/O modules until the DC voltages are within specifications.

6.08 The supplier shall provide a power supply which has the capability of providing power to the field side of I/O modules such as analog, TTL, and low level DC.

7.00 Program Storage

7.01 The program storage medium shall be 6K 16-bit CMOS RAM (volatile) type memory. EEPROM (non-volatile) type memory shall be available to back-up RAM.

7.02 The programmable controller system shall be capable of addressing up to 6000 words, where each word is comprised of 16 data bits.

7.03 The RAM memory segments shall be tested for validity using the checksum method of error detection. If memory is invalid, a red fault light shall illuminate.

7.04 The memory shall contain on-board battery back-up capable of retaining all stored program data through a continuous power outage for 12 months under worst case conditions.

8.00 Input and Output - General

8.01 Each input or output module shall be a self-contained unit housed within an enclosure.

8.02 The input/output enclosure (chassis) with its respective modules shall be of universal type and compatible with any programmable controller manufactured by the supplier. Racks shall be sized to accommodate I/O in increments of 32, 64, 96, 128, and 256 terminal points per chassis.

8.03 During normal operation, a malfunction in the remote input/output channel shall affect the operation of only the channel and not the operation of the CPU.

8.04 All communications on the input/output channel between the remote I/O and the CPU shall be digital in nature (discrete voltages).

8.05 Circuit components for both input and output shall be mounted on plug-in modules and keyed to prevent module insertion into the wrong slot.

8.06 Isolation shall be used between all internal logic and external power circuits. This isolation shall meet the minimum specification of 1500 vrms.

8.07 It shall be possible to replace any input or output module without disturbing field wiring.

8.08 Each I/O module shall contain a visual indicator to display ON/OFF status of individual input or output points.

8.09 Discrete output modules shall be provided with self-contained fuses for overload and short circuit protection of the module.

8.10 All user wiring to I/O modules shall be through a heavy-duty terminal strip. Pressure-type screw terminals shall be used to provide fast, secure wire connections.

8.11 All input/output modules shall be color coded and titled with a distinctive label.

8.12 All input modules shall have a specified filter time constant to limit the effects of voltage transients.

8.13 The processor shall have the capability of controlling and addressing up to 256 input and output points in any combination of analog and discrete signals. With the addition of remote scanner modules, the processor shall be able to control and address 240 input and output points in any combination of analog and discrete in the local rack and 256 discrete input and output points in up to two remote racks.

9.00 <u>Input and Output Modules</u>

9.01 The programmable controller manufacturer shall offer discrete input/output hardware consisting of the following:

Inputs:

A. AC/DC input for devices which operate at 120 VAC, 50/60 Hz., or 120 VDC, 220 VAC, 50/60 Hz. or 220 VDC.

B. AC input for devices which operate at 24 VAC, 50/60 Hz.

C. DC input for devices which operate at 5 to 30 VDC, 12 to 24 VDC, or 48 VDC.

D. Isolated AC input which provides isolation of 120 VAC or 120 VDC input signals.

E. TTL (5 volt DC) input for transistor-transistor logic, either high or low true logic, compatible with input devices such as solid state control and measuring equipment.

Outputs:

A. AC output for devices which operate at 120 VAC, 50/60 Hz.

B. AC output for devices which operate at 220/240 VAC, 50/60 Hz.

C. AC output for devices which operate at 24 VAC, 50/60 Hz.

D. DC output for devices which operate at 12 to 24, or 48 VDC.

E. DC power output for operating heavy-duty clutches, brakes, and solenoids. This should be available in 12 to 24, 48, and 125 VDC versions.

F. Isolated AC output which provides six (6) isolated outputs capable of switching 120 VAC or 220 VAC power.

G. TTL (5 volt DC) output which provides transistor-transistor logic, either high or low true logic, compatible for operating 5 VDC level electronic devices.

I. Contact output which provides four (4) normally open and four (4) normally closed reed relay outputs.

J. Contact ouput which provides eight (8) normally open reed relay outputs.

K. Contact output which provides four (4) normally open or four (4) normally closed mercury-wetted contacts.

9.02 Analog I/O modules of the following types shall be offered by the manufacturer:

A. Analog input which accepts analog signals and converts them to three digit BCD, four digit BCD or twelve (12) bit binary values. Digital resolution shall be available in 1 part in 256, 1 part in 1000 (BCD), or 1 part in 4096 (binary). Analog inputs shall be available in single-ended and sourcing and differential versions. Analog inputs shall be available in the following ranges:

1. Voltage range: 0 to +5 VDC, +1 to +5 VDC, 0 to +10 VDC, -5 to +5 VDC, -10 to +10 VDC.

2. Current range: 4 to 20 ma, 0 to 20 ma, -20 to +20 ma.

B. Analog output which converts a three digit BCD number, a four digit BCD number, or a twelve (12) bit binary number into an equivalent single-ended analog output signal. Output isolation shall be available. Analog outputs shall be available in the following ranges:

1. voltage range: 0 to +5 VDC, +1 to +5 VDC, 0 to +10 VDC, -5 to +5 VDC, -10 to +10 VDC

2. current range: 4 to 20 mA, 0 to 20 mA, -20 to +20 mA

9.03 Encoder module capable of accepting input pulses up to 50 KHz in either a single or dual channel form from an encoder shall be available. Inputs to the module shall be TTL compatible (5 VDC) or rated for 12-24 VDC. Each module shall have two output terminals rated at 500 mA maximum with open collector outputs. The counting format of the module shall be 12 bit binary or 3-digit binary coded decimal (BCD).

9.04 Specialized input modules of the following types shall be available:

A. Thermocouple input module that reads millivolt signals generated by thermocouple or millivolt devices. These signals shall be displayed as 12-bit binary or three digit BCD. Thermocouple types E, J, K, T, B, R and S are compatible with this module.

B. Resistance Temperature Detector (RTD) module that reads up to six RTD signals and displays them as four digit BCD or 12-bit binary values.

9.05 Two types of axis positioning modules shall be available.

A. A module shall be available to control the motion of up to three closed-loop servo motor axes. It shall be able to interface to differential line driver encoders and TTL encoders and shall provide scalable $\pm$ 10 V signal for various drives. It shall include hardware and software commands for features such as E-Stop, jog forward and jog reverse. It shall provide software configuration for parameters such as number of encoder lines, resolution, gain and speed.

B. A module shall be available to control the motion of up to three stepper motor axes. It shall interface to translators such as push-pull, current source and current sink. Hardware and software commands for features such as E-Stop, jog forward and jog reverse shall be available.

~~9.06 Proportional/Integral/Derivative (PID) control for one or two PID loops shall be provided on a single I/O module. Features such as cascade, feed-forward, decouple, bias, square root calculation and scaling shall be available.~~

9.07 An I/O module shall be available to provide an interface between the controller and an ASCII peripheral device. Allowed electrical interfaces are RS-232-C and current loop.

10.00 Interfacing and Peripherals

10.01 The programming device shall be either:

A. An industrial terminal intended for on- or off-line programming, hereafter referred to as industrial terminal.

B. An IBM PC-XT compatible computer with programming software for off-line program development, hereafter referred to as programming terminal.

10.02 The programming device shall provide for selecting the communications rate from 110 to 9600 baud.

10.03 The program device shall be capable of displaying a rung consisting of eleven (11) series elements and six (6) parallel elements.

10.04 A user program shall be recorded into or from the processor memory using:

A. Magnetic tape cartridge equipment
B. Cassette tape equipment
C. IBM PC-XT compatible computer with programming software via communications modules
D. EEPROM Cartridge

10.05 The industrial terminal shall include a 9 inch (diagonal) CRT screen and keyboard. It shall be capable of the following functions:

A. Load, edit, test, run and monitor program remotely from I/O racks.
B. Diagramatic instruction keys for entry of ladder format program.
C. Instructions will intensify on the CRT screen to indicate positive status of an examine contact or output coil, regardless of circuit configuration.

10.06 The software for a programming terminal shall allow the following features:

A. System options totally menu selectable.
B. Develop and edit programs in office environment.
C. Organize programs in a directory and maintain a library of all programs.
D. Symbolic addressing with up to ten (10) characters of text representing an octal address.
E. Cross-reference of symbolic to octal addressing.
F. Descriptive program, section and rung comments anywhere in program file with no restriction as to comment length.
G. Comments with up to fifty (50) characters can be associated with a specific address for description of logic or file function.
H. Program print-outs will have rung and page numbers, title information, instruction addresses and/or symbols, and rung and address comments.

10.07 The manufacturer shall offer a multi-point communication network providing a data transfer path for up to 64 programmable controllers and/or mini/micro-computers. The communicating stations shall be distributed anywhere along a single bus that extends a maximum of 10,000 cable feet in length. The communication network shall support the following features:

A. Floating master system
B. Peer-to-peer communication
C. Message error checking
D. Retries of unacknowledged messages
E. Diagnostic checks on other stations
F. Interface to more than one network

G. A user-oriented command language for manipulation of data structures of variable size and organization, such as setting or resetting bits, word and file transfers, and program loading.
H. Bi-directional communication between the programmable controllers and the communication network via a standard modem interface. The protocols shall meet EIA RS-232-C electrical standards and ANSI standard communication protocols.
I. The ability to communicate with all other models of programmable controller manufactured by said manufacturer.

11.00 Programming

11.01 The programming format shall be traditional relay ladder diagram.

11.02 The system shall have the capability to address up to 488 software timers and counters in any combination. All management of these instructions into memory shall be handled by the CPU. Instructions shall permit programming timers in the "ON" or "OFF" delay modes. Timer programming shall also include the capability to interrupt timing without resetting the timers. Counters shall be programmable using up-increment and down-increment.

11.03 Timer instructions shall include selectable time bases in time increments of 1.0 second, 100 msec and 10 msec. The timing range of each timer shall be from 0 to 999 increments. It shall be possible to program and display separately the timer's preset and accumulated values.

11.04 The programmable controller shall have signed math functions consisting of addition, subtraction, multiplication, division, and square root. It shall also convert between BCD and binary and display in hexadecimal format.

11.05 Instructions shall be provided for grouping contiguous 16 bit data words into a file. File manipulation instructions such as "file to file" move, "word to file" move, and "file to word" move shall be supported by the system. Comparison instructions such as "less than", "between range", and "equal to" shall be included within the system.

11.06 It shall be possible to unload words from a file in the same order as they are loaded (i.e. The first word in will be the first word out.)

11.07 The programmable controller shall be able to take the sine or cosine of a positive or negative number and give a properly signed result.

11.08 The instruction set shall include base ten and natural logarithms and inverse logarithms of signed numbers with up to a six digit result.

11.09 The programmable controller shall have a jump instruction which will allow the programmer to jump over portions of the user program to a portion marked by a matching label instruction.

11.10 In applications requiring repeatable logic rungs it shall be possible to place such rungs in a subroutine section. Instructions which call the subroutine and return to the main program shall be included within the system. It shall be possible to program several subroutines and define each subroutine by a unique label. The program format as displayed on the CRT shall clearly define the main program and all subroutines.

11.11 It shall be possible to manually set (force) either on or off all hardwired input or output points from the CRT programming panel. Removal of these forced I/O points shall be either individually or totally through selected keystrokes. The programming terminal shall be able to display forced I/O points.

11.12 An interrupt routine shall be programmable such that the routine shall be executed regularly. The interval at which the routine is executed shall be user-specified in the range of 1 to 50 milliseconds. A diagnostic bit shall be available to indicate routines which are too long to execute normally.

11.13 Latch functions shall be internal and programmable.

11.14 When using modules where multiple channels are terminated on one module, such as analog I/O modules, it shall be possible to transfer the current status of all channels to the CPU upon execution of one program instruction. This instruction shall be bidirectional to include data tra. sfer from the CPU to the module or from the module to the CPU.

11.15 The number of times a normally open (N.O.) and/or normally closed (N.C.) contact of an internal output can be programmed shall be limited only by the memory capacity to store these words.

11.16 To reduce the effective scan time in order to detect short pulse duration inputs, it shall be possible to program a select logic rung more than once into memory.

11.17 A clock shall be accessible in logic giving the ability to control or generate reports based on real time, date, day of the week, and year with correction for leap years.

11.18 The capability shall exist to calculate the average and standard deviation of up to 999 six-digit (6) numbers.

11.19 A proportional-integral-derivative (PID) calculation shall be included as an easily programmed block-style instruction with these features:

A. Any combination of P, I, D control modes for desired controller response.

B. Selection of direct or reverse control action.

C. Manual control override from local hardware control station and remote display/computer station.

D. Bumpless transfer between manual and automatic modes with anti-reset wind-up.

E. Scaling of setpoint, process variable and error to user-selected value range relating to appropriate engineering units.

F. Control of cascaded loops.

G. Output summation for feedforward control and proportional bias. Ability to sum a measurement input, logically calculated variable or constant.

11.20 The capability shall exist to change a contact from normally open to normally closed, add instructions, change addresses, etc. It shall not be necessary to delete and reprogram the entire rung.

11.21 It shall be possible to insert relay ladder diagram rungs anywhere in the program, even between existing rungs, insofar as there is sufficient memory to accommodate these additions.

11.22 A single program command or instruction shall suffice to delete an individual ladder diagram rung from memory. It shall not be necessary to delete the rung contact by contact.

11.23 Editing and monitoring functions of the industrial terminal shall include the following features:

A. The program format shall display all instructions on a CRT programming panel. The system shall be capable of providing a "HELP" instruction which when called by the programmer will display on the CRT a list of instructions and all data and keystrokes required to enter an instruction into the system memory.

B. The capability shall exist for adding, removing, or modifying ladder logic rungs during program operation. When changes to ladder logic are made or new logic rungs are added, it shall be possible to test the edits of such rungs for proper execution.

C. At the request of the programmer, data contained in system memory shall be displayed on the CRT screen. This monitoring feature shall be provided for input/output status, timer/counter data, files, and system status.

D. A diagnostic instruction shall be provided to show the state of a contact over a period of time.

11.24 The programming terminal shall be menu selectable and have the following features:

A. User selectable level of assistance.

B. Link tested program files to create a complete program.

C. Compiled software allowing a symbol change to be incorporated throughout the program.

D. Cut and paste editing of an instruction, a branch or a rung.

12.00 Quality Requirements

12.01 The programmable controller processor shall be able to withstand conducted susceptibility tests as outlined in NEMA ICS 2-230, NEMA ICS 3-304-42, section 2 of IEEE 472-1974 and ANSI C37.90A-1974.

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MODEL PROPOSED ______________________________

UNIT COST ______________________ TOTAL COST ______________

LUZERNE COUNTY COMMUNITY COLLEGE

PROGRAMMABLE LOGIC CONTROLLER SPECIFICATIONS

QUANTITY: 2 ALLEN-BRADLEY PLC 5/15 OR EQUIVALENT

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2.07 The supplier shall supply videotape training courses directed toward the operation and maintenance of the programmable controllers.

3.00 <u>Assembled Systems</u>

3.01 A supplier shall assume single source responsibility for system assembly. An assembled system may include mounting and wiring of relays, motor starters, transformers, and disconnecting means, or other control devices as specified by customer supplied documentation.

3.02 The supplier shall provide mounting and wiring of the programmable controller system in a NEMA type 12 or other enclosure that may be specified.

3.03 If specified, the enclosure shall be able to accommodate an electrical service of 460 volt, 3 phase, 60 Hz. The enclosure shall have sufficient room for a 460 VAC (primary) to 115 VAC (secondary) control transformer to service the processor, inputs and outputs.

3.04 The supplier shall be able to provide a sealed lexan plastic window in the NEMA 12 enclosure door(s) for observing the processor and I/O status indicating lights.

3.05 The supplier shall have the capability to supply an enclosure with special paint and graphic displays.

3.06 The supplier shall wire all programmable controller inputs and outputs to customer specified terminal blocks.

3.07 The assembled system shall include fuse blocks as sized by the customer's application.

3.08 Within the enclosure all I/O racks, processor racks, and power supplies shall be grounded to meet the manufacturer's specifications.

3.09 The supplier shall be able to provide within the enclosure a master control relay to de-energize each I/O module and inhibit machine motion. The master control relay must be de-energized directly by a hardwired Emergency Stop pushbutton.

3.10 If more than one controller is mounted within an enclosure, the capability must exist to share a single programming panel or line printer.

3.11 All pushbuttons, switches and other operator devices must be UL listed and/or CSA approved, and sufficiently large and durable to provide dependable, long life operation.

3.12 All cables (with associated plugs, connectors and receptacles) requiring user field installation, shall be designed for commercial use to withstand an industrial environment.

3.13 Upon receipt of the purchase order but prior to the start of the manufacturing of the equipment, the supplier shall submit drawings of the complete assembled system for approval by the purchaser or his consultant.

3.14 Drawings which are returned to the supplier for correction or revision shall be resubmitted for approval before starting fabrication of the work in question unless marked "approved as noted".

3.15 All drawings shall include page, sheet, and line numbers.

3.16 The first page of all drawings and schematics shall be a cover sheet consisting of a Bill of Material, purchase order number, manufacturer's job number, user's name, location, application, and shipping address.

3.17 The drawings shall include a mechanical layout detailing the overall external dimensions of the enclosure. Included shall be such pertinent information as location of door handles, windows, lifting lugs, and enclosure mounted items such as tachometer or current meters, cooling fans, etc.

3.18 The supplier shall provide documentation detailing the mounting of the processor, I/O racks, relays, motor starters, disconnect switch, fuse blocks, wireways, etc. All materials shall be labeled to provide easy cross-reference to the Bill of Material listing.

3.19 Electrical prints detailing all hardwiring, done by the supplier, to devices such as relays, motor starters, disconnect switches, fuse blocks, etc. shall be provided with individual wire numbers and relay contact cross-reference designations.

3.20 Sections describing inputs shall designate input modules by name, rack, module, and terminal location.

3.21 Each limit switch, pushbutton or other input device shall be connected to only one individual input point.

3.22 Each output device shall be connected to only one individual output point.

3.23 The last sheet in the set shall be for terminal block designations each containing their individual terminal numbers.

3.24 At the time the equipment is shipped, one (1) reproducible copy of each drawing mentioned above shall be provided with the equipment.

4.00 Design Description

4.01 A major consideration of the programmable controller system shall be its modular, field expandable design allowing the system to be tailored to the customer's machine and/or process control application. The capability shall exist to allow for expansion of the system by the addition of hardware and user software.

4.02 The processor plus input and output circuitry shall be of a modular design with interchangeability provided for all similar modules.

4.03 Modules are defined herein as devices which plug into a chassis and are keyed to allow installation in only one direction. The design must prohibit upside down insertion of the modules as well as safeguard against the insertion of a module into the wrong slot.

4.04 The programmable controller shall have downward compatibility whereby all new module designs can be interchanged with all similar modules in an effort to reduce obsolescence.

4.05 All hardware of the programmable controller shall operate at an ambient temperature of 0o to 60oC (32o to 140oF), with an ambient temperature rating for storage of -40o to + 85oC (-40o to 185oF).

4.06 The programmable controller hardware shall function continuously in the relative humidity range of 5% to 95% with no condensation.

4.07 The programmable controller system shall be designed and tested to operate in the high electrical noise environment of an industrial plant.

4.08 The programmable controller shall provide a means for mounting the chassis in a standard cabinet or 19 inch rack.

4.09 The CPU shall have the capability of addressing up to 512 input and 512 output points.

4.10 Each input and output module shall be a self-contained unit housed within an enclosure. These input/output enclosures with their respective modules shall be field expandable up to 128 unique locations.

4.11 The programmable controller shall include as a standard feature the capability of addressing remote input and output modules up to 10,000 cable feet from the processor. The communication link between the CPU and any remote input and output distribution chassis shall be via a 20 AWG tinned copper twinaxial cable with braided and foil shields or via fiber optic cable.

4.12 The communication rate between the CPU and the remote input/output modules shall be user selectable on a per channel basis. At a distance of 10,000 cable feet between the processor and the input and output modules the transmission rate shall be no less than 57,600 baud. If the distance in cable feet is reduced, then this transmission rate may be increased.

4.13 The programmable controller shall use two independent, asynchronous scans. One scan shall be designated for processing of input and output information only, with the second scan dedicated exclusively to the processing of the logic program. With this criterion it shall be possible to group remote discrete input and output devices to achieve an I/O update time of 6 milliseconds per 128 I/O. Input and output devices located in the same backplane (Local I/O) as the CPU should be scanned in under 2ms. Concurrent with this I/O update time, the processing of a typical logic program shall not exceed 2 milliseconds for 1024 relay type instructions with a maximum overhead of 4 milliseconds.

5.00 Main Frame Hardware

5.01 The CPU shall be a self-contained unit, and will provide Ladder Rung program execution and support remote or local programming. This device will also supply I/O scanning and inter processor and peripheral communication functions.

5.02 The operating system shall be contained in removable programmable devices which allow for easy field replacement.

5.03 In a single chassis system all system and signal power to the CPU, support modules shall be distributed on a single motherboard or backplane. No interconnecting wiring between these modules via plug-terminated jumpers shall be acceptable.

5.04 The CPU within the system shall perform internal diagnostic checking and give visual indication to the user by illuminating a "green" indicator when no fault is detected and a "red" indicator when a fault is detected.

5.05 All system modules, main and expansion chassis shall be designed to provide for free air flow convection cooling. No internal fans or other means of cooling, except heat sinks, shall be permitted.

5.06 All modules within the system shall be mechanically interlocked to prevent insertion or removal of modules under power which in turn helps to prevent damage to the modules and/or system.

5.07 The mains CPU front panel shall include a connector that provides inter-processor communication and communication to peripheral support devices. This connector will support communication to a programming device up to 10000 cable feet away, at no less then 57.6K baud.

5.08 The main chassis front panel shall include two-color indicators showing the following status information:

A. If power is applied to the CPU
B. Program or Run mode of the CPU
C. The run/fault status of the CPU
D. Enabled/Disabled state of outputs
E. State of the I/O adapters
F. If Forcing is active
G. If a remote device is talking via the inter-processor communications link.

5.09 Processor mode and status of the I/O shall be selected by a toggle switch mounted on the front panel of the CPU.

5.10 Non-volatile memory shall store the operating system information to protect against loss in the case of power loss or system shut-down. Only at the time of a hardware change shall this configuration status be altered or re-entered.

6.00 Power Supplies

6.01 The programmable controller shall operate in compliance with an electrical service of either 120 VAC, single phase, in the frequency range from 47 to 63 Hz, or 24 VDC.

6.02 The manufacturer shall provide as standard equipment a system power supply capable of converting 120 VAC line power to the DC power required to operate the programmable controller system.

6.03 A single main power supply shall have the capability of supplying power to the CPU and local input/output modules. Auxiliary power supplies shall provide power to remotely located racks.

6.04 The power supply shall automatically shut down the programmable controller system whenever its output current is detected as exceeding 125% of its rated current.

6.05 The power supply shall monitor the incoming AC line voltage for proper levels. When the power supply is wired to utilize 120 VAC power, the system shall function properly within the range of 97 to 132 VAC. If the voltage level is detected as being out of range for more than one-half line cycle, the power supply shall automatically shut down the system and remain disabled until the proper voltage level returns. In addition, the power supply shall provide surge protection, isolation, and outage carry-over up to 2 cycles of the AC line.

6.06 In cases where the AC line is especially unstable or subject to unusual variations it shall be possible to install a constant voltage transformer having a sinusoidal output waveform.

6.07 Design features of the programmable controller power supply shall include diagnostic indicators mounted in a position to be easily viewed by the user. These indicators shall provide the operator with the status of AC and DC power applied. In addition, a means of disabling power to the CPU shall be possible from a power disconnect switch mounted in a position easily accessible by the operator.

6.08 At the time of power-up, the power supply shall inhibit operation of the processor and I/O modules until the DC voltages are within specifications.

7.00 Program Storage

7.01 The program storage medium shall be of solid state RAM (volatile) type.

7.02 The programmable controller system shall be capable of addressing up to 14K words, where each word is comprised of 16 data bits.

7.03 Memory shall be available in 6K, 10K, 14K, word segments of RAM memory. Memory capacity shall be sized to allow for the most economical match to the intended application. As a means of upgrading the system each memory segment shall be field expandable up to the maximum number of memory words addressable by the programmable controller.

7.04 Memory shall contain battery back-up capable of retaining all stored program data through a continuous power outage for 12 months under worst case conditions. The capability shall exist to remove all batteries from the system without removing system power.

7.05 The programmable controller system should provide the capability to use EEPROM as a backup for volatile memory.

7.06 The operator should be able to backup volatile memory, including data and program logic onto either a data cartridge, 3 1/2 inch floppy diskette or winchester hard disk, at his option.

7.07 A minimum of 6144 16-bit words shall be allocated from main memory for the purpose of data storage. The programmable controller system shall be capable of storing the following data:

1) External Output Status
2) External Input Status
3) Timer Values
4) Counter Values
5) Signed Integer Numbers (16 bit)
6) Floating Point Numbers
7) Decimal Numbers
8) Binary Numbers
9) Direct and Indexed addressing
10) Internal Processor Status Information
11) ASCII and Control Structures

The above listed data types shall be distinguishable to the CPU by the addressing format. Management of the data types into memory subsections shall be an automatic function of the CPU operating system.

Any data can be displayed in either Binary, Octal, Hexadecimal, Decimal, or ASCII radices.

7.08 If contacts or entire rungs are intentionally deleted from an existing logic program, the remaining program shall be automatically repositioned to fill this void. Whenever contacts or entire rungs are intentionally inserted into an existing program, the original program shall automatically be repositioned to accommodate the enlarged program.

7.09 To reduce the effective scan time in order to detect short pulse duration inputs, it shall be possible to program a select logic rung more than once into memory.

7.10 The number of times a normally open (N.O.) and/or normally closed (N.C.) contact of an internal output can be programmed shall be limited only by the memory capacity to store these instructions.

8.00 <u>Input and Output - General</u>

8.01 Each input or output module shall be a self-contained unit housed within an enclosure.

8.02 The input/output enclosure (chassis) with its respective modules shall be of universal type and compatible with any programmable controller manufactured by the supplier. Racks shall be sized to accommodate I/O in increments of 32, 64, 96, and 128 terminal points per chassis.

8.03 During normal operation, a malfunction in any remote input/output channel shall affect the operation of only that channel and not the operation of the CPU or any other channel.

8.04 Any remote input/output channel shall be field selectable to shut down the CPU upon failure of that channel.

8.05 Upon remote channel shutdown the CPU shall see all inputs on the malfunctioning channel as they were when the shutdown occurred and all outputs shall de-energize on that channel.

8.06 All communications on the input/output channels between the remote I/O and the CPU shall be digital in nature (discrete voltages).

8.07 Circuit components for both remote input and output shall be mounted on plug-in modules and keyed to prevent module insertion into the wrong slot.

8.08 Isolation shall be used between all internal logic and external power circuits. This isolation shall meet the minimum specification of 1500 vrms.

8.09 It shall be possible to replace any input or output module without disturbing field wiring.

8.10 Each I/O module shall contain a visual indicator to display ON/OFF status of individual input or output points.

8.11 Discrete output modules shall be provided with self-contained fuses for overload and short circuit protection of the module.

8.12 All user wiring to I/O modules shall be through a heavy-duty terminal strip. Pressure-type screw terminals shall be used to provide fast, secure wire connections.

8.13 All input/output modules shall be color coded and titled with a distinctive label.

8.14 All input modules shall have a specified filter time constant to limit the effects of voltage transients.

9.00 Input and Output Modules

9.01 The programmable controller manufacturer shall offer discrete input/output hardware consisting of the following:

Inputs:

A. AC/DC input for devices which operate at 120 VAC, 50/60 Hz., or 120 VDC, 220 VAC, 50/60 Hz. or 220 VDC.

B. AC input for devices which operate at 24 VAC, 50/60 Hz.

C. DC input for devices which operate at 5 to 30 VDC, 12 to 24 VDC, or 48 VDC.

D. Isolated AC input which provides isolation of 120 VAC or 120 VDC input signals.

E. TTL (5 volt DC) input for transistor-transistor logic, either high or low true logic, compatible with input devices such as solid state control and measuring equipment.

Outputs:

A. AC output for devices which operate at 120 VAC, 50/60 Hz.

B. AC output for devices which operate at 220/240 VAC, 50/60 Hz.

C. AC output for devices which operate at 24 VAC, 50/60 Hz.

D. DC output for devices which operate at 12 to 24, or 48 VDC.

E. DC power output for operating heavy-duty clutches, brakes, and solenoids. This should be available in 12 to 24, 48, and 125 VDC versions.

F. Isolated AC output which provides six (6) isolated outputs capable of switching 120 VAC or 220 VAC power.

G. TTL (5 volt DC) output which provides transistor-transistor logic, either high or low tr logic, compatible for operating 5 VDC level electronic devic s.

H. Contact output which provides four (4) normally open and four (4) normally closed reed relay outputs.

I. Contact ouput which provides eight (8) normally open reed relay outputs.

J. Contact output which provides four (4) normally open or four (4) normally closed mercury-wetted contacts.

9.02 Analog I/O modules of the following types shall be offered by the manufacturer:

A. Analog input which accepts analog signals and converts them to three digit BCD, four digit BCD or twelve (12) bit binary values. Digital resolution shall be available in 1 part in 256, 1 part in 1000 (BCD), or 1 part in 4096 (binary). Analog inputs shall be available in single-ended and sourcing and differential versions. Analog inputs shall be available in the following ranges:

   1. Voltage range: 0 to +5 VDC, +1 to +5 VDC, 0 to +10 VDC, -5 to +5 VDC, -10 to +10 VDC.

   2. Current range: 4 to 20 ma, 0 to 20 ma, -20 to +20 ma.

B. Analog output which converts a three digit BCD number, a four digit BCD number, or a twelve (12) bit binary number into an equivalent single-ended analog output signal. Output isolation shall be available. Analog outputs shall be available in the following ranges:

   1. Voltage range: 0 to +5 VDC, +1 to +5 VDC, 0 to +10 VDC, -5 to +5 VDC, -10 to +10 VDC

   2. Current range: 4 TO 20 MA, 0 TO 20 MA, -20 TO +20 MA

9.03 Encoder module capable of accepting input pulses up to 50 KHz in either a single or dual channel form from an encoder shall be available. Inputs to the module shall be TTL compatible (5 VDC) or rated for 12-24 VDC. Each module shall have two output terminals rated at 500 mA maximum with open collector outputs. The counting format of the module shall be 12 bit binary or 3-digit binary coded decimal (BCD).

9.04 Specialized input modules of the following types shall be available:

A. Thermocouple input module that reads millivolt signals generated by thermocouple or millivolt devices. These signals shall be displayed as 12-bit binary or three digit BCD. Thermocouple types E, J, K, T, B, R and S are compatible with this module.

B. Resistance Temperature Detector (RTD) module that reads up to six RTD signals and displays them as four digit BCD or 12-bit binary values.

9.05 Two types of axis positioning modules shall be available.

A. A module shall be available to control the motion of up to three closed-loop servo motor axes. It shall be able to interface to differential line driver encoders and TTL encoders and shall provide scalable + 10 V signal for variou drives. It shall include hardware and software commands for features such as E-Stop, jog forward and jog reverse. It shall provide software configuration for parameters such as number of encoder lines, resolution, gain and speed.

B. A module shall be available to control the motion of up to three stepper motor axes. It shall interface to translators such as push-pull, current source and current sink. Hardware and software commands for features such as E-Stop, jog forward and jog reverse shall be available.

9.06 Proportional/Integral/Derivative (PID) control for one or two PID loops shall be provided on a single I/O module. Features such as cascade, feed-forward, decouple, bias, square root calculation and scaling shall be available.

9.07 An I/O module shall be available to provide an interface between the controller and an ASCII peripheral device. Allowed electrical interfaces are RS-232-C and current loop.

9.08 An I/O module that can contain BASIC programs in its resident, battery-backed memory shall be available. Non-volatile EPROM memory will be optional. This module shall interface to various devices through RS-232-C, RS-422 or RS-423A. Multiple peripheral devices shall interface to the module at one time.

10.00 <u>Interfacing and Peripherals</u>

10.01 The programming means shall be a portable, industrial quality programming terminal. The terminal shall include a 9 inch (diagonal) CRT screen and a keyboard for program entry, editing, search and monitoring functions.

10.02 The terminal keyboard shall allow for loading of the program format and ASCII characters.

10.03 The terminal shall be able to function as a stand-alone ASCII (alphanumeric) data terminal with a RS-232-C interface allowing connection to an in-house computer, data terminal, or modem.

10.04 The programming terminal shall be compatible for interfacing with an electrical service of either 120 VAC, 50/60 Hz. or 220 VAC, 50/60 Hz.

10.05 The terminal shall provide for selecting the communication rate between 110 and 9600 baud for RS-232 communications and also provide 57.6K baud for the inter-processor communications and programming link.

10.06 The terminal shall be capable of displaying a minimum of thirty (30) graphic (line drawing) characters.

10.07 The programming terminal shall be capable of displaying a rung consisting of a maximum of seven (7) series elements and six (6) parallel elements.

10.08 The programming terminal shall have the capability to be remotely located a maximum of 10,000 cable feet from the processor.

10.09 The means to indicate contact or output status shall be by intensification of the contact or output on the CRT screen. Each element's status shall be shown independently, regardless of circuit configuration.

10.10 The programmable controller system shall be able to interface with a data terminal which is RS-232-C compatible (up to 9600 baud) to generate hard copy logic diagrams and/or message generation.

10.11 The system shall have the capability to interface to a 3 1/2 inch magnectic floppy disk and or a winchester hard disk for loading a user program into, or recording the contents of, the processor's memory. It shall be possible to load or record the entire contents or selected portions of memory.

10.12 The system shall utilize an ASCII protocol for interfacing with most available RS-232-C compatible computers. Capabilities shall include reading and writing I/O status with a central computer.

10.13 The manufacturer shall offer a multi-point communication network providing a data transfer path for up to 64 programmable controllers and/or mini/micro-computers. The communicating stations shall be distributed anywhere along a single bus that extends a maximum of 10,000 cable feet in length. The communication network shall support the following features:

A. Token passing system
B. Peer-to-peer communication
C. Message error checking
D. Retries of unacknowledged messages
E. Diagnostic checks on other stations
F. Interface to more than one network
G. A user-oriented command language for manipulation of data structures of variable size and organization, such as setting or resetting bits, word and file transfers, and program loading.
H. Bi-directional communication between the programmable controllers and the communication network via a standard modem interface. The protocols shall meet EIA RS-232-C electrical standards and ANSI standard communication protocols.
I. The ability to communicate with all other models of programmable controller manufactured by said manufacturer.
J. The ability to monitor the status of any processor remotely via the network.

11.00 Programming Techniques

11.01 The programming format shall be traditional relay ladder diagram.

11.02 It shall be possible to program a maximum instruction matrix of 7 wide by 6 deep containing as many as 77 examine instructions.

11.03 The capability shall exist to change a contact from normally open to normally closed, add instructions, change addresses, etc. It shall not be necessary to delete and reprogram the entire rung.

11.04 It shall be possible to insert relay ladder diagram rungs anywhere in the program, even between existing rungs, insofar as there is sufficient memory to accommodate these additions.

11.05 A single program command or instruction shall suffice to delete an individual ladder diagram rung from memory. It shall not be necessary to delete the rung contact by contact.

11.06 It shall be necessary to issue a two part command in order to delete all relay ladder rungs from memory. This will provide a safeguard wherein the operator must verify his intentions before erasing the entire program.

11.07 A clock/calendar feature shall be included within the CPU. Access to the time and date shall be from the programming terminal, user program, or message generation.

11.08 Latch functions shall be internal and programmable.

11.09 The system shall have the capability to address up to 1000 software timers and 1000 software counters in any combination. All management of these instructions into memory shall be handled by the CPU. Instructions shall permit programming timers in the "ON" or "OFF" delay modes. Timer programming shall also include the capability to interrupt timing without resetting the timers. Counters shall be programmable using up-increment and down-increment.

11.10 Timer instructions shall include selectable time bases in time increments of 1.0 second, and 10 msec. The timing range of each timer shall be from 0 to 32,767 increments. It shall be possible to program and display separately the timer's preset and accumulated values.

11.11 The programmable controller shall use a signed integer format ranging from -32,768 to +32,767 for data storage and counter preset and accumulated values.

11.12 The programmable controller shall store data in the following formats:

A. Signed Integer Numbers ranging from -32,768 to +32,767
B. Floating Point Numbers consisting of six (6) digit mantissa. For numbers larger than six digits the CPU shall convert the number into exponential form with a range of $\pm$1.175494 E -38 to $\pm$3.402824 E +38.

C. Decimal Numbers ranging from 0 to 9,999.

11.13 The programmable controller shall have signed math functions consisting of addition, subtraction, multiplication, division, and square root.

11.14 When using modules such as analog where multiple channels are terminated on one module, it shall be possible to transfer the current status of all channels to the CPU upon execution of one program instruction. This instruction shall be bidirectional to include data transfer from the CPU to the module or from the module to the CPU.

11.15 Instructions shall be provided for grouping contiguous 16 bit data words into a file. The system shall address up to 1000 files with up to 1000 words per file. File manipulation instructions such as high speed "file copy" and "file fill", "file to file" move, "element to file" move, and "file to element" move shall be supported by the system. The four function math instructions and instructions for performing "logical or", "logical and", "exclusive or" and comparison instructions such as "less than", "greater than", and "equal to" shall be included within the system. All instructions shall execute on either single words or files.

11.16 The system shall contain instructions which will construct asynchronous and synchronous 16 bit word shift registers. Additional instructions shall be provided to construct synchronous bit shift registers.

11.17 The programmable controller shall have a jump instruction which will allow the programmer to jump over portions of the user program to a portion marked by a matching label instruction.

11.18 In applications requiring repeatable logic rungs it shall be possible to place such rungs in a subroutine section. Instructions which call the subroutine and return to the main program shall be included within the system. It shall be possible to program several subroutines and define each subroutine by a unique label. The processor will support nesting of subroutines up to eight levels deep. The program format as displayed on the CRT shall clearly define the main program and all subroutines.

11.19 It shall be a function of the CPU to automatically manage all data types. For example, if a word stored in the Integer section of memory is transferred into the Floating Point section, the CPU shall convert the integer value into floating point prior to executing the transfer.

11.20 The program format shall display all instructions on a CRT programming panel with appropriate mnemonics to define all data entered by the programmer. The system shall be capable of providing a "HELP" instruction which when called by the programmer will display on the CRT a list of instructions and all data and keystrokes required to enter an instruction into the system memory.

11.21 At the request of the programmer, data contained in system memory shall be displayed on the CRT programming panel. This monitoring feature shall be provided for input/output status, timer/counter data, files, and system status. Ladder logic rungs shall be displayed on the CRT with rung numbers in sequential order. However, the programmer shall have the option of selecting and displaying logic rungs non-contiguously.

11.22 The system shall have the capability to enter rung comments above ladder logic rungs. These comments may be entered at the same time the ladder logic is entered.

11.23 The capability shall exist for adding, removing, or modifying ladder logic rungs during program execution. When changes to ladder logic are made or new logic rungs are added, it shall be possible to test the edits of such rungs before removal of the prior logic rung is executed.

11.24 It shall be possible to manually set (force) either on or off all hardwired input or output points from the CRT programming panel or the main chassis front panel. Removal of these forced I/O points shall be either individually or totally through selected keystrokes. The programming terminal shall be able to display forced I/O points.

11.27 The execution of the program logic shall be accelerated by scanning the rung only until a positive decision as to the state of the outputs has been made. In many cases this will mean skipping over logic elements if the output condition has been predetermined.

11.28 A means to program a fault recovery routine shall exist. When a major system fault occurs in the system, the fault recovery routine shall be executed and then the system shall determine if the fault has been eliminated. If the fault is eliminated, program execution resumes. If the fault still exists, the system will shut down.

11.29 An interrupt routine shall be programmable such that the routine shall be executed regularly. The interval at which the routine is executed shall be user-specified in the range of 1 to 65,535 milliseconds.

12.00 Quality Requirements

12.01 The programmable controller processor shall be able to withstand conducted susceptibility tests as outlined in NEMA ICS 2-230, NEMA ICS 3-304-42, section 2 of IEEE 472-1974 and ANSI C37.90A-1974.

12.02 All completed units shall be subjected to a burn-in test of 60 degrees C for at least 96 hours.

ABOVE SYSTEM TO INCLUDE:

QTY	ITEM
1	12 SLOT I/O CHASSIS(1771-A3B OR EQUIV)
1	8 PT 120V AC/DC INPUT MODULE(17711A OR EQUIV)
1	8 PT 12-24V DC INPUT MODULE(17711B OR EQUIV)
1	8 PT 0-5V ANALOG INPUT MODULE(1771-1E02 OR EQUIV)
1	8 PT 120V AC OUTPUT MODULE(17710A OR EQUIV)
1	8 PT 12-24V DC OUTPUT MODULE(17710B OR EQUIV)
1	4 PT 0-5V DC ANALOG OUTPUT MODULE(1771-OF02 OR EQUIV)

TOTAL COST TO INCLUDE DELIVERY , SET UP(INSTALLATION) AND TRAINING.

MODEL PROPOSED____________________________________

UNIT COST______________________ TOTAL COST__________________

LUZERNE COUNTY COMMUNITY COLLEGE

Robotic Work Cell

Quantity: 1 (Robotic Work Cell)

Robotic Work Cell

To be a complete hardware/software robotic work cell which combines the integration of one (1) materials handling DC Servo Robot, one (1) industrial machine vision system, one (1) gravity feeder, one (1) linear slide base, one (1) linear conveyor, and one (1) infrared/force sensing system.

The system is to be capable of automatically loading/unloading CNC machines, performing various machining operations, object recognition and robotic guidance, materials handling and sensing, through the integration of personal computers and peripheral control devices. (The college to provide existing computers for integration.)

To contain the following components:

(1) Scorbot-ER III Robotics Arms:

A five axis, vertical articulated, dc-servo, closed loop, robotic arm

Specifications:

Power Requirements
  Motors 12 VDC
  Encoders 5 VDC

Number of Axes
  Mechanical arm - 5 plus gripper
  Simultaneously controlled axes - 8 (7 plus gripper)

Construction
  Vertically articulated arm

Load Capacity:
  1 KG. (2.2lbs, at arm extension)

Repeatability:
  0.5 MM. (0.02 ins.)

Speed:
  10 speeds

Maximum speed:
330 MMS. per second (13.2 ins. per second, at arm extension)

Actuators:
Six D.C. Servo Motors with closed loop control

Feedback:
Optical encoders on all axes

Working Envelope:
Body Joint - 325
Shoulder Joint - $\pm$ 85
Elbow Joint - $\pm$ 150
Pitch Joint - $\pm$ 150
Roll Joint - Unlimited
Maximum Radius of Operation - 610 MMS. (24.4 ins.)

75MM (3 ins) (excluding rubber pads)
65MM (2.5ins) (with rubber pads)
(rubber pads removable)

Sensors - Gripper Can Measure Object Size

Power Transmission:
Direct drive on base, shoulder and gripper
Indirect drive on elbow, wrist pitch/roll
Method: gears, timing belt, leadscrew

Weight - 24.2 lbs.

Safety Features
Motors stop automatically should robot arm strike obstacle without loss of data from memory. Immediate brake - user can stop robot immediately with any loss of data from memory. Encoders and all "live" electrical components are totally enclosed.

(1) Scorbot-ER III Robot Controller:

This unit connects the computer (or Teach Pendant) to the robotic arm. It services operation, logic, and drives for all electric motors. Also controls encoders, inputs, outputs, microswitches and diagnostic routines. All motors connect to the controller through one cable connection.

Specifications:

Power requirements - 110V A.C. 60 Hz

Weight - 11 lbs.

Size - 11"W X 12"D X 4-1/2"H

Power Supplies:
- +12V, 8 amps to motors
- -12V, 8 amps to motors
- +12V, 1 amp to RS232
- -12V, 1 amp to RS232
- + 5V, 1 amp to logic and microprocessor

CPU 8031

Communications - RS232 serial

EPROM 4k bytes

Control 8 axes
- 5 robot
- 1 gripper
- 2 external (motor 6 and motor 7)

4 outputs with LED displays (relay switches N.O. or N.C.)

4 outputs with LEDdisplays only for didactic purposes

8 on/off input connections

Controller reset switch

Lamp test switch for all LEDS

Self diagnosis on all motors

Controller operates
- motors
- encoders
- inputs
- outputs
- micro-switches
- self diagnosis

DB 25 connector input for computer

DB 25 connector input for Teach Pendant

(1) Scorbase Control Language Software set:

Three levels of software designed to lead the student from the basic programming commands through the more advanced programming techniques. No previous programming is necessary to learn SCORBASE.

Specifications:

Replicates industrial software (go point to point at X speed)

Three levels of competency:
- Beginner - Level 1
- Intermediate - Level 2
- Advanced - Level 3

Menu driven:
- Teach
- Edit
- Program Handling
- Run
- Home Menus (levels 2 &3)

Teach by XYZ coordinates in space (level 3)

Teach relative positioning (level 3)

All positions can be listed in encoder pulses

All positions can be listed in XYZ coordinates (level 3)

Edit menu is off line

Program for communications with external devices through the I/O ports (levels 2 & 3)

Sense size by gripper (level 3)

Motor error interrupt (level 3)

Automatic search for hard home

Ten speeds - allow acceleration/deceleration control in Teach and Run Program modes

Available for Apple II+ or IIe, IBM PC, Commodore 64

400 command lines of programming available to user

100 positions capability

(1) Viewflex Machine Vision System:

A software and hardware vision application package designed to work with IBM PC/XT/AT computers which allows industrial machine vision system training.

Specifications:

Compatible with IBM PC/Xt/AT

Controller contains:
1. - Digitizer - 320 X 200 pixels (64,000 maximum) Digitizer controls up to 4 frames from as many as 4 cameras, up to 255 objects per frame, and 64 gray scale levels.
2. - I/O card with 10 DC inputs and 34 outputs which enable easy integration of the system into various environments, providing dired communication with peripheral items whose operation will be determined by the analysis of the images. It is easily connected to a programmable logic controller. Each input and output has its own LED indicator. Two inputs and two outputs are sync connections for integrated synchronization. Eight outputs are industrial relays. 24 outputs are open collector relays for logic communications.
3. - On-Board color graphic card.
4. - Communication card for IBM PC/XT/AT and connecting cable.

The system stores up to 255 images in memory.

Cameras need only comply with RS170 or CCIR output type.

Application generator software is operated via user friendly data screens, action screens, and menus.

Software capabilities include:
- CAMERA SETUP
Frame definition: position, size, sequence.

Camera's black and white levels.

- GLOBAL SETUP
  Global actions definition: min./max. size of object, computational setup, etc

- OPERATIONAL MODE
  Input source. Learn, identify, and overview modes and screen reports Operational selection via RS232, I/O, manual, or internal sequencer.

- HISTOGRAM SETUP
  Distribution histogram, accumulative histogram, thresholding.

- IDENTIFICATION SETUP
  Identification methods, parameters, and tolerances definition.

- MASK SETUP
  Low pass, binary, erode/dilate filters.

- ROBOT SETUP
  A robot synchronization control module.

- DATABASE MANAGER
  Control, manipulate, and change the system's vision database.

- FILE MANAGER
  Loading, sorting, and saving of various vision related files. A special sequence is provided to facilitate creating, editing, and testing of the vision applications (off-line programming). Allows the user to define and select desired recognition and operational parameters.

Camera digitizer set-up for switching between cameras, window definition, digitization parameters

Screen reporting - The user can define real-time reports for monitors

Applications -

- Identification
- Location
- Counting
- Sorting
- Process verification

- Trait verification
- Orientation
- Robot guidance
- Quality control
- Measurement

RS232 Serial communication to external devices or robots can be installed as an option in the controller, or through computer COM1

ROBOTVISION software can be optionally included in package to allow the integration of the system with SCORBOT-ER III robot

ROBOTVISION software includes all features found in SCORBASE operational software together with machine vision software that operates the vision portion of the system

Teacher/user can pre-define length of program, from 3-400 lines

(2) Vidicon Cameras and Lens:

The Vidicon Camera is a CTC 2000 camera with a 16 mm f 1.6 lens.

Specifications:

2 to 1 interlace

Latest circuitry for increased performance and reliability

External power module 117 VAC and 15-18 VDC

Connecting cable to vision system

16mm, F 1.6 lens

(2) Composite Monitors:

MV-105 composite monitor.

Specifications:

CRT:
- Size deflection angle - 10 in., 90
- Area - 44 sq. in.

Electrical specs:
- Horizontal resolution - Minimum 800 lines
- DC resolution - Maintains black level to less of peak luminence
- Shades of gray - 10 minimum
- AFC horizontal time constant - compatible with Helical Scan VTR's
- Video response - 14 MHZ
- Horizontal scan frequency
  15,750 HZ EIA
  15,625 HZ CCIR
- Vertical scan frequency - 50/60 HZ
- Video input level - 0.25 - 2 volt
- Synch - Negative
- Impedance - Switch selectable 75 OHM or high lamp
- Video input connector - 2 UHF loop thru
- Power consumption - 50 watts

Mechanical specs:
- Width - 9 5/8"
- Depth - 10 1/2"
- Weight - 16 lb.

Environmental - 14 - 122F

(2) Vision System Camera Stands:

Mounting stand for IBM vision systems which allows various positioning of the cameras.

Specifications:

Base: 16" X 20"

Height 55" maximum

Cameras mount slides on vertical pipe with roller bearings

Camera mount horizontal reach - 9"

Vertical, 3-section interlocking pipe

(2) Light Tables:

8" X 12" X 2" translucent work table for vision experiments using backlighting.

Specifications:

8" X 12" X 2" light box

Plexiglass work surface with white translucent back

1 fluorescent bulb

110 VAC

(1) Scorbot-ER III Teach Pendant:

A sophisticated hand held computer which enables direct control and programming of the robot in a manner similiar to that used with industrial robots. Teach Pendant connects directly to robot controller, provides software to up-load, down-load to host computer.

Specifications:

Teaches up to 100 positions in space

Can write up to 250 command lines

Save programs from teach pendant to computer

Load program from host computer to pendant

Run programs consist of:
- one line at a time
- run continuously
- jump to line

Find robot home

Run a demo (resident) program

CPU 8031, 16k byte EPROM, 4k byte RAM

Emergency braking

RS232 connection

Two line 32 character LCD display

Thirty multi-functional keys arranged in 6 rows

Color coded for teach, edit and mode

Advanced software (level 4) for host computer to up-load, down-load programs from and to teach pendant

(1) Scorbot Gravity Feeder:

A sturdy aluminum gravity feeder capable of supplying or receiving parts for use in a robotic materials handling or machine tending operation. The feeder will accommodate bar stock or flat parts. It is adjustable for part size, part location, and angle of slope. The feeder can be used to off-load or on-load parts for a linear conveyor of 3" to 4" height.

Specifications:

Dimensions:
Feeder plate - 1/8" X 6" X 12"
Two leg supports:
1 - 4" high
1 - 6" high
Two guide rails - "L" shaped, 1/2" X 12"

All anodized aluminum

Adjustable leg heights:
1" to 4 1/2"
3" to 6 1/2"

Adjustable guide rails - for parts 1" to 4" long

Adjustable end stops on guide rails

Adjustable slide angle from 0 to 40 degrees

Usable for bar stock or flat stock

Notches for robot gripper access to parts

Usable as on or off feeder

Locator/mounting holes on legs

(1) Scorbot-ER III Linear Slide Base:

Industrial grade linear slide for mounting robot, providing accurate positioning of the robot at multiple work stations. The continuous support, dual rail system uses highly polished steel rails, ball slide bearing, ball screw/ball nut drive, under dc-servo, closed loop control.

Specifications:

48" dual rails with continuous support

40" overall travel

2.5 in./sec. travel velocity

.002" accuracy

Positional control at all points of travel

50 lb. payload capacity under dc-servo control

Pre-drilled mounting holes for fastening to bench

DC motor with 5.9:1 gear ratio, and with optical encoder to provide feedback

(1) Scorbot-ER III Linear Conveyor:

Used to move parts in a linear motion. Conveyor is controlled by an axis on the controller. Also used for parts distribution when located within a materials handling work cell.

Specifications:

Dimensions - 31-1/2"L X 4"W X 3-1/2" H

Metal base

12 VDC motor with optical encoder

7 wire cable with DB 9 connector

Belt 3-1/2" W

8 location ports for proximity and optical sensors

2 supports which allow for tilting up to 5 degrees

Travel speed - 180 mm/sec.

Heavy duty PVC belt

<u>(1) Scorbot-ER III Indexing Rotary Table:</u>

Used to index parts placed on table. Table is controlled by an axis on the controller. Also used for parts distribution when located within a materials handling work cell.

<u>Specifications:</u>

Table base dimensions - 9"D X 7-1/2" H

Rotary plate dimensions - 12"D X 1/2"T

Cable with DB 9 connector

One dc-servo motor with 426:1 gear ratio and antiback-lash mechanism

Four metal fixtures on ratary plate to hold and position work pieces

Rotary table works on direct drive or as an additional axis of the robot

Hard home position utilizing a microswitch

Six machined holes in base for fastening

(1) Infra-red Sensor System:

An infra-red emitter and detector combination, used to identify an object has been placed or passed between them. The sensor sends information to the robot controller, indicating a change in status, which can be read as an input to the robot's control system. The system includes mounts for installation on a linear conveyor and a 12 VDC power supply for operation.

Specifications:

Infra-red emitter and amplifier
- Narrow beam, short range (5" or less)

Infra-red detector and amplifier

12 VDC power supply

Sensor mounts

Connecting cables to robot inputs

(1) Gripper Force Sensor System:

An adjustable gripper attachment which allows the user to specify how much force is applied to objec in the robots gripper. The control box has a knob to turn to increase or decrease force levels.

Specifications:

Gripper mount for force sensor (attaches to gripper pad screws)

Force translator system

Adjustable pressure from 0 PSI to 12 PSI

Cables for attachment to robot harness and arm, running to control box

Control box
Plug for 12 VDC power supply
Threshold adjustment knob
Input connecotrs from sensor
Output connectors to robot controller

12 VDC power supply

(1) Scorbase Advanced Cell Control Software:

(Software package for work cell control and force sensing)

A floppy diskette available for IBM PC/XT/AT and compatible computers which uses menu driven commands to integrate complex sensing and work cell operations. The software enables safety sensing equipment to stop the robot or cell operation. The addition of a gripper sensor will enable the robot's gripper to be programmed to close to a pre-specified pressure. Multiple external machine operations can also be controlled and synchronized with the robot. Real-time position teaching in the run mode allows the robot to learn new positions while in an automatic operation mode. User utilities allow the user to select desired algorithms and to select preferred logic parameters in programming. A "search home" command allows the robot to be re-calibrated during the automatic run mode. The Integrated Action display shows real-time robot operation. A special "GO LINEAR" commmand controls the robot by linear interpolated movements, allowing near-straight line motion control.

Specifications:

All functions of SCORBASE Level 3 Software

Menu driven (screens and all programming commands)

Interrupt programming for response to sensor data
- Input ON --> OFF
- Input OFF --> ON

User utilities:
- Mathematical algorithm selection
- Logic parameter selection

Off-line run - Provides program simulation off-line

Real-time postion teaching during run mode

Real-time re-calibration during run mode

Roll axis can be articulated to user-defined angle (ie. spray painting applications)

Teach positions menu displays current positions in:

- Robot coordinates (encoder units, each axis)
- Cartesian coordinates (Xmm, Ymm, Zmm, pitch, roll)
- Spherical coordinates (alpha, radius, height, pitch, roll)
- Cylindrical coordinates (alpha, beta, radius, pitch, roll)

Positions can be printed in all coordinate systems
- On screen
- Hard copy

Positions can be taught off-line using all coordinate systems

Relative positions can be taught using all coordinate systems

Teach Pendant can be used simultaneously for position teaching

Editor commands allow user program parameter definition
- Positon numbers can be assigned value of "X"
- Values can be changed
- Calculations and values can be assigned by: +. -, *, /, MOD, POWER, OR, AND, XOR
- Value comparisons: B=C, B>C, B<C, B<>C, B>/=C, B</=C
- Parameters can get values in real time or off-line

SAVE and LOAD menu provides program storage facilities:
- Positions and program lines
- Only positions
- Only lines
- Replace resident positions with positions from diskette
- Merge resident positions with positions on diskette
- Replace diskette program lines with resident program lines
- Merge two programs
- Insert programs into other programs at specific lines

Linear interpolation can be achieved using "GO LINEAR" command

Integrated Action display shows real-time status of robot

All items included in the Robotic Work Cell to be as manufactured by Eshed Robotec, Inc. or approved equal. Bid price to include all shipping costs and four days of installation and training by qualified factory technicians.

MODEL PROPOSED____

UNIT COST____________________TOTAL COST________________

5/13/88

INDUSTRIAL TYPE 5-AXIS ROBOT

DESCRIPTION

Robot, industrial type, 5-axis type, electro-mechanical with controller. Robot to be 208 vac., 3 phase electrical and have a 29.7" dia. base; 33 lb. payload; 300o base rotation; 21.6" Z-travel; 45.8" vertical travel; 19.7" arm reach; 300o wrist roll; and ±0.002" repeatability. Robot to have a cast iron mounting base; timing belt drive in base axis; anti-friction ball screw drive in Z-travel and reach axes; sealed for life bearings on all critical rotating elements; safety limit switches for over travel protection; accordion-type protective covers for ball screws; sealed electrical connections through each housing; and FANUC servo drives. Robot to be complete with wrist F1 with controls, operational and maintenance manuals.

GMF #II A-200 OR EQUAL

MODEL PROPOSED____

UNIT COST______________________TOTAL COST______________________

ACCESSORIES

(1) each Robot, Karel controller, 28" wide x 28" deep x 67" high. controller to be a self-diagnostic control system with full program and edit capabilities. Unit to incorporate multiple motorola 68000 microprocessors I/O rack, operator panel and teach pendant.

Central Processing Unit to feature backplane implemented "MAP" interface; up to 4 mega bytes of non-volatile program storage; up to 9 axis simultaneous control; force sensing capability; real-time vision interface; modular expandability; and program execution from battery backed CMOS.

Input/Output System shall be designed to support a variety of discrete and analog I/O. Discrete inputs shall allow (24) VDC both isolated and non-isolated and (120) VAC, 60 Hz isolated. Outputs shall allow (24) VDC isolated; (120) and (240) vac., 60 Hz isolated. analog inputs shall allow (34) channels per module, voltage or current input and (12) bit resolution. Output shall allow (2) channels per module, voltage or current output and (12) bit resolution. I/O system to include quick disconnect terminal strips, individual LED indicators for visual status of signals and fused output modules with blown fuse indicator.

Robot, continued

Programming Language to include full menu driven operator commands; basic arithmetic plug trigonometric and logarithmetric functions; program branching and looping; condition monitoring and user interrupts; relative motion statements to reduce the number of taught positions; coordinate transformations for position shift, offset and rotate; continuous path motion; reference positions, program variables and I/O with English names; user programmed messages displayed at either CRT or Teach pendant and user comments for documenting the program.

Teach Pendant to be a hand held type with an 8 line by 40 character display. Unit to have a keyswitch protected to prevent unauthorized use; "Deadman" safety switch for programmer protection; industrial keypad; emergency stopswitch; menu driven function display; and monitor the status of system I/O.

Karel Controller to be complete with basic software, 192kb ramboard, 128kb data memory, (16) 24v inputs, (16) 24v outputs, (16) 120v inputs, (16) 120v outputs, 7M robot connection cable, and (1) set documentation manuals.

(1) Each Robot, End of Arm Tooling Accessor Package. Package shall include:

- (1) small pneumatic parallel gripper .625" stroke 24lb gripping force.
- (1) large pneumatic parallel gripper 1.25" stroke 48lb gripping force.
- (1) vacuum type end -of arm tool
- (1) aluminum framework
- (1) venturi type vacuum pump 2.1 cfm at 58 psi
- (4) vacuum cups 1.69" diameter bellows type
- (1) sealing gun simulation end-of-arm tool
- (3) 24Vdc valves
- (5) end-of-arm tooling/robot faceplate adapter plates

- (1) Each Robot, Sensor Package. Sensor package shall include:
- (1) capacitive proximity sensor
- (1) inductive proximity sensor
- (1) large limit switch
- (1) micro switch
- (1) vacuum switch
- (2) fluidic sensors

NOTE: Bidder to provide 3-days (24-hour) instructor training on Robot and Controller System.

DISTRIBUTION

QTY.	ROOM	ITEM #
1	COMPUTER INTEGRATED MANUFACTURING	

LUZERNE COUNTY COMMUNITY COLLEGE

MODEL #AT6065-23 FLUID POWER TRAINING SYSTEM QUANTITY 2

HYDRAULIC TRAINING SYSTEM

COURSEWARE

The Hydraulic Trainer shall consist of a three level training system: Introductory, Intermediate, and Advanced. The student manuals shall be a compentency-based, self-paced study of hydraulics, complete with Objectives, Program Discussion, Procedures, Conclusion, Exercise Questions, and Unit Tests. Pre and Post Tests shall be provided at each program level. Courseware outline, test answers, and support material shall be found in the Instructor's Guide. The courseware must pertain to the training bench and follow the objectives set forth. Actual equipment and exercises in the manuals must relate to and function on the training bench. Fewer than ten percent of the exercises shall be "dry lab activities" not fully utilizing the training system components or relying on additional outside equipment.

The Introductory course shall be comprised of hydraulic theory, behavior of fluids, characteristics, force pressure, area and volume relationships. Other curriculum topics shall include symbology (ANSI and ISO), circuitry, fluid transmission, distribution, conditioning, filtration, pressure, flow measurement, and control. Identification and operation of basic hydraulic system components, consisting of hydraulic pumps, reservoirs, pressure controls, flow controls, rotary and linear actuators will also be covered.

The Intermediate level of training expands upon the component hardware and courseware to the Introductory level, with the Introductory course as a prerequisite. Advanced circuits, alternate power sources, pilot operated, directional and pressure control, actuators (linear, limited, and continuous rotation) complete with static and dynamic loading devices and readouts are included in the program.

The Advanced level combines training skills from the Introductory and Intermediate levels with the added enhancements of electrical control and interfacing of components. Fundamentals in standard relay logic and ladder diagramming are introduced, transitioning into an optional Programmable Logic Controller, (PLC) and personal computer interfacing. Advanced circuits, standard industrial relays, switching, indicators, meters, limit switch, and remote sensing are inclusive at this level of training. An optional sensor package consisting of proximity switches, capacitive, inductive, photo electric, fiber optic, infrared, magnetic reed switches, are an additional feature to the Advanced program. Other options are the PLC and personal computer interface that are also complimentary of the Advanced Electrical Training and sensor package.

HARDWARE

The Hydraulic Trainer shall be a mobile training device, utilizing a variable.volume power supply, for each workstation. The Trainer shall measure 84" (152 cm) long by 30" (76 cm) wide by 72" (175 cm) high with the angled work surface configuration and 36" (91 cm) high with the horizontal.

Each bench shall be double-sided and contain two hydraulics, two pneumatics and two electrical workstations. The bench shall be equipped with lockable storage drawers, comprised of two heavy duty ball bearing slides, one handle and 4.67 cubic feet (.13 cubic meters) of storage space, two component storage racks with individual NFPA/ISO component labels for inventory control, Access panels shall be easily removable with quarter-turn screws for inspection and servicing of the power supply.

The frame shall be of heavy duty, welded steel construction, painted with primer. A baked-on enamel finish will be applied. It will be supported by four (4) lockable, heavy duty swivel casters. The bench shall be capable of containing two power supplies and four storage drawers.

The workstations, comprised of work surfaces and "A" frames, shall be modular in design, allowing flexibility of a fixed 70 degree angled work surface, horizontal, or a combination of both. The stations can be easily installed or removed with bolts used for securing purposes. With the angled workstation configuration the bench must allow students to work comfortably and without restriction on both sides of the bench, two students per station, four students total. Each work surface shall be 26" (66 cm) by 22.5" (57 cm), constructed of reinforced 18 gauge steel and plated with corrosion resistant zinc. Each tray is perforated to reduce oil build up and for component mounting with an adapter bracket.

Latching, quick release component adapter brackets shall be used, allowing the students to select each component by identifying the correct symbol and placing the component on the work surface, thereby simulating actual circuit layout. All components must be flexible, easily moved in the circuit for setup, but once in place, they are securely fastened to the work surface. The adapter bracket shall be constructed of 14 gauge, 303 stainless steel for durability and corrosion resistance. Components, permanently secured to the work surface are unacceptable.

The Hydraulic Console and its enclosure shall be 25.5" (65 cm) by 12" (30 cm). The Console must contain three 3.5" (9 cm), 0-1500 psi gages and one 3.5" (9 cm) compound 30-0-300 vacuum to pressure gage. All gages must have male quick disconnects for ease of circuit setup. The Console must be flexible in mounting to accommodate the angled, horizontal and remote applications. All Console components must be silkscreen labeled for ease of identification and permanency.

The Electrical Console and its enclosure shall be 25.5" (65 cm) by 12" (30 cm). the Console must contain 24 VDC main power and 24 VAC auxiliary power. A circuit breaker must be incorporated in the panel along with plug in style quick connect terminals, industrial quality push buttons and switches, multimeter with LCD read-out, four plug in style relays, two modular type timer cubes, eight indicator lights and one lead set. The Console will be flexible in mounting to accommodate the angled, horizontal, and remote applications. All Console components must be silk screened labeled for ease of identification and permanency.

The training system shall contain standard industrial rated components manufactured primarily with a quality metallic construction. Each component shall contain at least one adapter, compatible with the work surface, one-quarter inch male, brass quick disconnect fitting rated for a working pressure of 4,000 psi (28000 kPa) will be supplied. All pressure controls, directional controls, and flow controls shall have a working pressure of 3,000 psi (21000 kPa), cylinders will be 2,000 psi (13790 kPa).

Each hydraulic module shall be comprised of the following components and devices:

INTRODUCTORY PARTS LIST

1.(1) DIRECT OPERATED RELIEF VALVE, CARTRIDGE STYLE

2.(1) DIRECT OPERATED PRESSURE REDUCING VALVE, CARTRIDGE STYLE

3.(1) DIRECT OPERATED SEQUENCE VALVE, CARTRIDGE STYLE

4.(1) IN-LINE FLOWMETER, 0-5 GPM

5.(2) NON-COMPENSATED FLOW CONTROL, CARTRIDGE STYLE

6.(1) PRESSURE COMPENSATED FLOW CONTROL, CARTRIDGE STYLE

7.(2) CHECK VALVES, CARTRIDGE STYLE

8.(1) DIRECTIONAL CONTROL VALVE, 4-WAY, 2-POSITION, SPRING OFFSET, MANUALLY OPERATED, SUBPLATE MOUNTED

9.(1) DIRECTIONAL CONTROL VALVE, 4-WAY, 3-POSITION, CLOSED CENTER, MANUALLY OPERATED, SUBPLATE MOUNTED

10.(1) SINGLE-ACTING, SPRING RETURN CYLINDER, 1-1/8" BORE, 6" STROKE

11.(1) DOUBLE-ACTING CYLINDER, 1-1/8" BORE, 6" STROKE

12.(1) DOUBLE-ACTING CYLINDER, 1-3/8" BORE, 6" STROKE

13.(1) HYDRAULIC MOTOR, GEAR LOAD DEVICE

14.(1) SET HYDRAULIC HOSES

15.(1) HOSE RACK

16.(3) THREE PORT MANIFOLD

17.(3) FOUR PORT MANIFOLD

18.(1) GRADUATED MEASURING DEVICE

19.(1) DIRECTIONAL CONTROL VALVE, 4-WAY, 3-POSITION, TANDEM CENTER, MANUALLY OPERATED, SUBPLATE MOUNTED

INTERMEDIATE PARTS LIST

1.(1) 15" 3-1/4 LITER ACCUMULATOR

2.(1) CAM OPERATED DIRECTIONAL VALVE, 2-WAY, 2-POSITION, SUBPLATE MOUNTED

3.(1) SHUTTLE VALVE - COMPOSITE BLOCK, CARTRIDGE STYLE

4.(1) PILOT OPERATED RELIEF, CARTRIDGE STYLE

5.(1) PILOT OPERATED SEQUENCE VALVE, CARTRIDGE STYLE

6.(1) PILOT OPERATED, COUNTER BALANCE VALVE, CARTRIDGE STYLE

7.(1) PILOT OPERATED PRESSURE REDUCING VALVE, CARTRIDGE STYLE

8.(1) PILOT OPERATED CHECK VALVE, CARTRIDGE STYLE

9.(1) PILOT OPERATED BRAKE VALVE, CARTRIDGE STYLE

10.(1) DIRECTIONAL CONTROL VALVE, 4-WAY, 3-POSITION, DOUBLE PILOT OPERATED, SUBPLATE MOUNTED

11.(1) CYLINDER LOAD DEVICE (HYDRAULICALLY LOADED)

12.(1) ROTARY ACTUATOR - LIMITED ROTATION

13.(1) DOUBLE-ACTING CYLINDER, DOUBLE ROD, 1-3/8" BORE x 6-1/2" STROKE

14.(1) HYDRAULIC MOTOR, GEAR TYPE, LOW SPEED HIGH TORQUE, WITH MECHANICAL LOAD DEVICE.

ADVANCED PARTS LIST

1.(1) DIRECTIONAL CONTROL VALVE, 3-WAY, 2-POSITION, SPRING OFFSET, SINGLE SOLENOID OPERATED, SUBPLATE MOUNTED

2.(1) DIRECTIONAL CONTROL VALVE, 4-WAY, 2-POSITION, SPRING OFFSET, SINGLE SOLENOID, SUBPLATE MOUNTED

3.(1) DIRECTIONAL CONTROL VALVE, 4-WAY, 3-POSITION, SPRING CENTER, CLOSED CENTER, DOUBLE SOLENOID OPERATED, SUBPLATE MOUNTED.

4.(1) HYDRAULIC PRESSURE SWITCH WITH DIFFERENTIAL

5.(1) PHOTO ELECTRIC SWITCH

6.(2) ROLLER, LIMIT SWITCHES

7.(1) SOLID STATE RELAY

8.(2) REED SWITCHES WITH INDICATOR LIGHTS

9.(1) LEAD SET AND STORAGE RACK

PNEUMATIC TRAINING SYSTEM

COURSEWARE

The Pneumatic Trainer shall consist of a three level training system: Introductory, Intermediate, and Advanced. The student manuals shall be a compentency-based, self-paced study of pneumatics, complete with Objectives, Program Discussion, Procedures, Conclusion, Exercise Questions, and Unit Tests. Pre and Post tests shall be provided at each program level. Courseware outline, test answers, and support material shall be found in the Instructor's Guide. The courseware must pertain to the training bench and follow the objectives set forth. Actual equipment and exercises in the manuals must relate and function on the training bench. Fewer than ten percent of the exercises shall be "dry lab activities" not fully utilizing the training system components or relying on additional outside equipment.

The Introductory course shall be comprised of pneumatic theory, behavior of compressed air, characteristics, force pressure, area and volume relationships. Other curriculum topics shall include symbology (ANSI and ISO), circuitry, fluid transmission, distribution, conditioning, filtration, pressure, flow measurement and control. Identification and operation of basic pneumatic system components, consisting of compressors, receivers, pressure controls, manually operated directional controls, flow controls, rotary and linear actuators will also be covered.

the Intermediate level of training expands upon the component hardware and courseware to the Introductory level, with the Introductory course as a prerequisite. Advanced circuits, alternate power sources, pilot operated directional and pressure controls, actuators (linear, limited and continuous rotation) complete with static and dynamic loading devices and readouts are included in this program. An optional Air Logic program, capable of interfacing with the Intermediate level is available. Skills in miniature pneumatic switching and control are developed through the use of ladder logic circuitry and hardware.

The Advanced level combines training skills from the Introductory and Intermediate levels with the added enhancements of electrical control and interfacing of components. Fundamentals in standard relay logic and ladder diagramming are introduced, transitioning into an optional Programmable Logic Controller (PLC) and personal computer interfacing. Advanced circuits, standard industrial relays, switching, indicators, meters, limit switch and remote sensing are inclusive at this level of training. An optional sensor package consisting of proximity switches, capacitive, inductive, photo electric, fiber optic, infrared, magnetic reed switches are an additional feature of the Advanced program. Other options are the PLC and personal computer interface that is also complimentary of the advanced electrical training and sensor package.

HARDWARE

The Pneumatic Trainer shall be a mobile training device, as stated above, utilizing shop air or an optional air compressor.

Latching, quick release component adapter brackets shall be used, allowing the students to select each component by identifying the correct symbol and placing the component or work surface, simulating actual circuit layout. All components must be flexible, easily moved in the circuit for setup, but once in place they are securely fastened to the work surface. The adapter bracket shall be constructed of 14 gauge, 303 stainless steel for durability and corrosion resistance. Components, permanently secured to the work surface, are unacceptable.

The Pneumatic Console and its enclosure shall be 25.5" (65 cm) by 12" (30 cm). The Console must contain filtration, pressure regulation, lubricator, main shutoff, manifold with four individual shutoff valves, two pressure gages and a flowmeter with scfm calibration. The Console must be flexible in mounting to accommodate the angled, horizontal, and remote applications. All Console components must be silk screen labeled for ease of identification and permanency.

The Electrical Console and its enclosure shall be 25.5" (65 cm) by 12" (30 cm). The Console must contain a system circuit breaker, 24 VDC power supply plug in style quick connect terminals, industrial quality push buttons and switches, multimeter with LCD read-out, four plug in style relays and two modular type timer cubes, eight indicator lights and one lead set. The Console will be flexible in mounting to accommodate the angled, horizontal, and remote applications. All console components must be silk screened labeled for ease of identification and permanency.

The training system shall contain standard industrial rated components manufactured primarily with a quality metallic construction. Each component shall contain at least one adapter bracket, compatible with the work surface, 1/4" tube fittings, constructed of brass and featuring quick connection and release will be covered. All pressure controls, directional controls, and flow controls shall have a working pressure of 150 psi (1,000 kPa), cylinders 200 psi (1400 kPa).

Each Pneumatic module shall be comprised of the following components and devices:

INTRODUCTORY PARTS LIST

1.(1) AIR REGULATOR, NON-RELIEVING

2.(1) FILTER, 5 MICROMETER

3.(1) FILTER, COALESCING

4.(1) RELIEF VALVE, SAFETY

5.(1) ACCUMULATOR

6.(1) PRESSURE SWITCH, WITH DIFFERENTIAL

7.(1) MUFFLER

8.(1) GAGE, 0-160 PSI

9.(2) IN-LINE CHECK VALVE

10.(2) NEEDLE VALVE

11.(2) FLOW CONTROL VALVE

12.(1) DIRECTIONAL CONTROL VALVE, 3-WAY, 2-POSITION, SPRING OFFSET, MANUALLY OPERATED

13.(1) DIRECTIONAL CONTROL VALVE, 5-WAY, 2-POSITION, SPRING OFFSET, MANUALLY OPERATED

14.(1) DIRECTIONAL CONTROL VALVE, 5-WAY, 3-POSITION, SPRING CENTERED, CLOSED CENTER, MANUALLY OPERATED

15.(1) SPRING-RETURN CYLINDER, 1-1/8" BORE x STROKE x 3/8" ROD

16.(1) DOUBLE-ACTING CYLINDER, 1-1/8" BORE x 6" STROKE x 3/8" ROD

17.(1) DOUBLE-ACTING CYLINDER, 1-3/8" BORE x 6" STROKE x 1/2" ROD

18.(1) CYLINDER LOAD DEVICE, SPRING TYPE

19.(1) AIR MOTOR

20.(1) AIR BEARING

21.(1) TOOL BOX

INTERMEDIATE PARTS LIST

1.(1) VACUUM TRANSDUCER

2.(2) CAM OPERATED, 3-WAY, 2-POSITION DIRECTIONAL VALVE

3.(1) SHUTTLE VALVE

4.(1) QUICK EXHAUST VALVE

5.(1) PILOT OPERATED CHECK VALVE

6.(1) DIRECTIONAL CONTROL VALVE, 3-WAY, 2-POSITION, SPRING OFFSET, PILOT OPERATED

7.(1) DIRECTIONAL CONTROL VALVE, 4-WAY, 2-POSITION, DETENTED PILOT OPERATED

8.(1) DIRECTIONAL CONTROL VALVE, 4-WAY, 3-POSITION, CLOSED CENTERED, PILOT OPERATED

9.(1) ROTARY ACTUATOR, LIMITED ROTATION

10.(1) DOUBLE-ACTING, DOUBLE ROD CYLINDER, 1-3/8" BORE x 6-1/2" STROKE x 1/2" ROD

11.(1) CYLINDER LOAD DEVICE (HYDRAULICALLY LOADED)

12(1) AIR MOTOR LOAD DEVICE (MECHANICALLY LOADED)

ADVANCED PARTS LIST

1.(1) DIRECTIONAL CONTROL VALVE, 3-WAY, 2-POSITION, SPRING OFFSET, SOLENOID OPERATED

2.(1) DIRECTIONAL CONTROL VALVE, 4-WAY, 2-POSITION, SPRING OFFSET, SINGLE SOLENOID

3.(1) DIRECTIONAL CONTROL VALVE, 4-WAY, 3-POSITION, CLOSED CENTERED, DOUBLE SOLENOID OPERATED

4.(1) PHOTOELECTRIC SWITCH

5.(2) LIMIT SWITCHES

6.(2) REED SWITCHES WITH INDICATOR LIGHTS

7.(1) LEAD SET AND STORAGE RACK

8.(1) SOLID STATE RELAY

ELECTRICAL INSTRUMENT CONSOLE

AS 60889
1.3 AMP circuit breaker

2.24 VDC power supply

3.Illuminated ON/OFF rocker switch

4.(3) momentary pushbuttons

5.(1) 3 position maintained switch

6.Multimeter

7.(4) plug in relays

8.(2) timer relays

9.Indicator lights

10.Banana jack connections

11.Labled instrument panel

12.Instrument enclosure

13.(2) adapter brackets

14.6 foot electrical cord

EACH WORKSTATION SHALL BE COMPLETE WITH THE FOLLOWING ACCESSORIES:

MODEL #AS60913 PROGRAMMABLE LOGIC CONTROLLER
The Programmable Controller shall have 16 I/O circuits. It will include three I/O expansion units, namely the basic expansion unit, the relay output expansion unit, and the analog input expansion unit. This will provide a maximum I/O of 112. The I/O will consist of 10 inputs and 6 relay (hard contact) outputs.

The Processor Unit shall have the following capability: Incoming power voltage ranges shall be 85-132/170-265 VAC, 50/60 Hz. The external I/O input circuits shall be 10-30 V AC/DC. The output circuits shall be 10-250 VAC/10-125 VDC.

The memory will be CMOS RAM type with battery back-up. There shall be provisions for optional EEPROM memory module. The module chall plug into the front of the processor and have the capability of storing programs in the EEPROM. It will also load programs from the EEPROM to the processor RAM. The user memory size will consist of a maximum 885 words.

The internal control relays shall consist of a maximum of 181, regular or latched. There will be a maximum of 32 timers/counters/sequencers.

The Pocket Programmer is plug compatable with the processor and will have programming, monitoring, editing, and troubleshooting capabilities. The unit will include an LED display for desplaying address, data, rung, and mode number. It will display prompt and error messages.

The Personal Computer Interface Software will permit off-line programming, on-line monitoring and storage, and print-out capabilities. Rung comments and instruction labels will be provided for ladder diagrams. There shall be cross reference tables for organizing instructions, addresses, rung numbers, and comments.

The PLC shall be compatable with any IBM PC or IBM compatable computer with MSDOS or PCDOS for 2.10 version or later (IBM AT, version 3.0 or later). An RS-232-C/RS-422 interface converter is required to provide communications between the computer and the controller.

The PLC shall be prewired with plug in style quick connect terminals, input terminals, output terminals and jack to connect feedback sensors. It shall be secured to a metal frame and have two latching, quick release component adapter brackets for securing the unit to the work surface.

PROGRAMMABLE LOGIC CONTROLLER

1. Processor Unit

- 16 I/O
- 885 word memory
- CMOS RAM
- EPROM module
- 181 internal control relays
- timers, counters, sequencers
- timer range .1 to 999.9 counts
- counter capacity, 9999 counts
- sequencer capacity, 8 bit groups, cascadable time or even driven
- diagnostic indicators, PC run, DC power, CPU fault, forced I/O battery low
- 85-132/170-265 VAC, 50/60 Hz

1 Hand Held Programmer

- LED display, indicates address, data, rung, and mode numer (prompt and error messages are displayed to aid in programming and troubleshooting)

- supply voltage, from processor
- communication RS-422
- all instruction manuals included

1 EEPROM Memory Module

- non-volatile memory
  save, load, (read) programs into RAM

MODEL #AS60921 PERSONAL COMPUTER INTERFACE SOFTWARE

- Software on 5-1/4" floppy disk
- User/self teach manuals included
- RS 232-C/RS-422 interface converter, with 6 ft. interface cable and 8" ribbon with 25 pin connector for computer

MODEL #AS60897 ELECTRONIC SENSOR PACKAGE

1. INDUCTIVE PROXIMITY SWITCH WITH L.E.D. INDICATOR
2. CAPACITIVE PROXIMITY SWITCH WITH L.E.D. INDICATOR
3. INFRARED PHOTOELECTRIC AMPLIFIER UNIT WITH L.E.D. INDICATOR
4. FIBER OPTIC BIFURCATED CABLE
5. FIBER OPTIC THROUGH-BEAN CABLE
6. MOUNTING BRACKETS AND CONNECTORS

MODEL #AS60905 ELECTRONIC MONITOR DEVICES

1 Timer, solid state

- multi-program
- digital settings
- LCD bar graph readout

TO BE THE ABOVE MENTIONED LAB-VOLT MODEL NUMBERS OR APPROVED EQUAL

Total cost to include delivery, installation, set-up and training.

MODEL PROPOSED ______________________________

UNIT COST ____________________ TOTAL COST ________________