

TECHNOLOGY EDUCATION

Grades 9-12

PROGRAM/COURSE Computer Aided Manufacturing

Draft for field test and orientation use during the  
1985-86 school year.

NOTE: Reprint for use during the 1986-87 school year.

**DRAFT**

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INSTRUCTIONS  
(NOTES)

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PHASE: Concentration

3

ELEMENT: Technology

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AREA OF CONCENTRATION: Computer Aided Manufacturing

5

MODULE: Operational Characteristics (1.1)

6

TOPICS: 1. Computer Controlled Equipment, an Introduction to Robots

7

2. Specifications, Drive Systems, Controllers and External  
Communications

8

3. Manipulation Characteristics, Capabilities and Safety

9

TOTAL TEACHING TIME: 20 Hours

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11

PREREQUISITES: Keyboarding

12

Intro courses

13

Computer Applications

14

15

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\$\$OVERVIEW

GOAL

Upon completion of this module students will have developed the skills and knowledge necessary to identify and describe the equipment and its components used in the manufacturing dictates the use of robots within specific machine applications.

DESCRIPTION

A robot is a reprogrammable, multi-functional manipulator designed to move material, parts, tools, or specialization devices, through variable programmed motions for the performance of a variety of tasks. The objectives within are provided to develop a basis of knowledge relative to the manufacturing industry's robots and their use. These topics are designed to introduced the student to robots, provide technical literacy of movements, drives, controllers and external communications.

Robots are used to perform a variety of functions such as welding, painting, inspecting parts for tolerance and accuracy. They are guided by semiconductor chips that take inputs from sensing devices such as probes and cameras that see and measure deviations from standards. These topics are designed to introduce the student to robots, provide technical literacy and understanding of movements, drives, controllers and external communications.

SKILLS, KNOWLEDGES, AND BEHAVIORS TO BE DEVELOPED

Students will use be able to describe the functional apparatus related to computer aided manufacturing. They will learn how a progrm controls and directs a robot to perform a task. Further they will be familar with the capabilities and limitations of robotic devices and perform experiments safely.

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INSTRUCTIONS  
(NOTES)

- 1 TOPIC: Computer Controlled Equipment, an Introduction to Robots (1.1.1)
- 2 PERFORMANCE OBJECTIVES/SUPPORTING COMPETENCIES
- 3 Senior high school students, having been given assigned readings, prepared  
4 instruction sheets, and having participated in classroom demonstrations  
5 relating to the way computer controlled equipment is used to perform a  
6 variety of functions. They will know what a robot is and why they are  
7 used. They will demonstrate a knowledge of the manufacturing industry's of  
8 computer controlled equipment.
- 9 In order to do this, the student must be able to:
- 10 1. Describe the major components of computer controlled equipment as  
11 used in product manufacturing systems.
  - 12 2. Demonstrate the major components of computer controlled equipment  
13 used in product manufacturing systems and tell why they are used.
  - 14 3. Describe the capabilities of robic devices.
  - 15 4. Demonstrate the capabilities of robotic devices safely.
- 16 CONTENT OUTLINE
- 17 I. Robotic Mechanisms
    - 18 A. Configurations
      - 19 1. Vehicular (mobile)
      - 20 2. Platform (positioned)
    - 21 B. Basic Arm Configurations (mobile, non-mobile and  
22 stationary)
      - 23 1. Jointed Arm
      - 24 2. Spherical
      - 25 3. Cylindrical
      - 26 4. Rectangular
  - II. CNC types devices
    - A. Shaping
    - B. Cutting
    - C. Forming
    - D. Fastening
- 27 SUGGESTED INSTRUCTIONAL STRATEGIES
- 28 1. Lecture/discussion.
  - 29 2. Choose a local industry and describe how that industry uses  
30 computer controlled equipment.
  - 31 3. Plan a production line using computer numerically controlled  
32 (CNC) machinery.
  - 33 4. Show a film from the Society of Manufacturing Engineers, "The  
34 Challenge of Manufacturing".

INSTRUCTIONS  
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1 TOPIC: Program Control (1.1.2)

2 PERFORMANCE OBJECTIVES/SUPPORTING COMPETENCIES

3 Given descriptions of computer controlled equipment by the instructor the  
4 student will effectively identify, written or orally, the specifications that  
5 correctly classify movements of robotic devices. The student will be able to  
6 identify drive systems, controllers and external communications devices.

7 In order to do this, the student must be able to identify and classify  
8 computer controlled robotic movements according to specifications:

- 9 1. Specifications
- 10 2. Drive Systems
- 11 3. Programming
- 12 4. Sensors Systems

13 CONTENT OUTLINE

- 14 I. Specifications
  - 15 A. Extension/reach
  - 16 B. Grasp, force and opening
  - 17 C. Lift/payload
  - 18 D. Programming capacity
  - 19 E. Resolution/positioning accuracy
  - 20 F. Rotations
  - 21 G. Speed
- 22 II. Drive Systems
  - 23 A. Mechanical
  - 24 B. Neumatic
  - 25 C. Hydraulic
  - 26 D. Electronic
- 27 III. Programming
  - 28 A. Dynamic Programming
    - 29 1. Database
    - 30 2. Tape
  - 31 B. Tape
- 32 IV. Decision Making Sensors

33 SUGGESTED INSTRUCTIONAL STRATEGIES

- 34 1. Demonstrate limitations and capabilities of available equipment.
- 35 2. Students will label a diagram to name motion(s) of given parts.
- 36 3. Students can observe movement specifications while on a  
educational trip to a local industrial site using robotics.
- 37 4. Have students execute specified movements, define drive systems,  
program methods and sensor types on given computer controlled  
equipment.

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INSTRUCTIONS  
(NOTES)

- 1 TOPIC: Manipulation Characteristics, Capabilities and Safety (1.1.3)
- 2 PERFORMANCE OBJECTIVES/SUPPORTING COMPETENCIES
- 3 Senior high school students, having been given assigned readings, prepared  
4 instruction sheets, and having participated in classroom discussions and  
5 activities will be able to safely demonstrate an understanding of the  
6 manipulation characteristics and capabilities of computer controlled  
7 equipment.
- 8 In order to do this, the student must be able to:
- 9 1. Identify, describe and use various combinations and types of  
10 computer controlled equipment.
- 11 2. Describe and demonstrate the range of maneuvers capable with the  
12 given robotic equipment.
- 13
- 14
- 15 CONTENT OUTLINE
- 16 I. Structural components
- 17 A. electrical/electronic
- 18 B. electro-magnetic
- 19 C. hydraulic
- 20 D. pneumatic
- 21 E. servo
- 22 F. vacuum
- 23 II. Axes of movement and range of motion
- 24 A. base/waist
- 25 B. shoulder
- 26 C. elbow (pitch)
- 27 D. wrist (roll)
- 28 III. Material Handling Devicesca
- 29 A. parallel gripper
- 30 B. pincer
- 31 C. shovel
- 32 D. three finger
- 33 IV. Decision making sensors
- 34 A. alarms
- 35 B. counters
- 36 C. optical
- 37 D. pressure
- 38 E. proximity switches
- 39 F. relays/limits
- 40 G. temperature
- 41 V. Immediate mode motion control
- 42 A. motion simulation
- 43 B. keyboard control
- 44 C. teach pendant
- 45
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INSTRUCTIONS  
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- VI. Deferred mode motion control
  - A. teach controls
  - B. recording to memory
  - C. execution verification
  - D. editing motion
  - E. running

- VII. Safety
  - A. Environmental
  - B. Equipment

SUGGESTED INSTRUCTIONAL STRATEGIES

- 1. Lecture/discussion.
- 2. Demonstrate characteristics of available controlled equipment
- 3. Use slides of a local industry field trip to provoke brainstormed improvements to the productivity with the use of robots.
- 4. Have the students judge and prioritize which would be the most beneficial and profitable alterations to make in a local factory.
- 5. Describe the limitations of capabilities and hazards.
- 6. Practice programming the range of maneuvers capable with the given robotic equipment.
- 7. Program several robots to perform companion tasks in synchronization.
- 8. Visit a local industry using robotic devices, cells, or production lines.
- 9. Use NC computer processor language to control a CNC device in a specified way.

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PHASE: Concentration

ELEMENT: Technology

AREA OF CONCENTRATION: Computer Aided Manufacturing

MODULE: Applications (1.2)

TOPICS: 1. Computer Aided Manufacturing (CAM)  
2. Flexible System Characteristics  
3. Flexible Manufacturing Ssystems (FMS)  
4. Social Outcomes

TOTAL TEACHING TIME: 30 Hours

PREREQUISITES: Keyboarding  
Intro courses  
Computer Applications  
Computer Aided Manufacturing Module 1.1

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INSTRUCTIONS  
(NOTES)1 \$\$OVERVIEW

## 2 GOAL

3 Upon completion of this module students will have developed the skills  
4 and knowledge necessary to identify and describe why computers are used in  
5 the manufacturing industry. They will know how computers effect industry,  
6 how computerized industry effects them personally, and how it effects society  
7 as a whole. Further they will have experience with microprocessor controlled  
8 robotics that will give them the ability to program and control robotic  
9 devices.

## 7 DESCRIPTION

8 Recent trends in the computerization and mechanization of industry have  
9 changed from a concentration on the production process itself to an improve-  
10 ment of productivity in organizing, scheduling and managing the total manu-  
11 facturing into a network of commonly available information has sparked a  
12 technological revolution in manufacturing. The objectives within are  
13 provided to develop a basis of knowledge relative to the manufacturing  
14 industry's use of computers.

15 The CAM System's contribution to productivity is having the  
16 technological capacity to link design, management and manufacturing into a  
17 network of commonly available information. An unprecented diversity of  
18 operations can be performed by a fully automated flexible manufacturing  
19 system. Work begins with product design on a computer aided drafting and  
20 design system that conveys information to a central system. Directed by  
21 computer parts carriers, deliveries of materials are made to the production  
22 line. Loaded automatically at the storage area, carriers are guided by low  
23 frequency radio signals transmitted through a wire buried in the floor.  
24 Remote terminals allow management to keep track of the activity on the  
25 unmanned manufacturing line, manufacturing updates, models manufactured,  
26 etc. Robots unload raw materials from carrier carts, place them into the  
27 machining tools and then transfer the semi-finished parts to a conveyer.  
28 Guided by touch and vision sensors, robots pick and place the parts in their  
29 respective locations. Many different models of a product can be produced  
30 simultaneously, in fact each item could be one of a kind. Revolving holders  
31 supply the appropriate tools for each part to be machined, all directed by  
32 the central controller, which is also prescribing the cutting operations.  
33 Continuing the programmed sequence of operations, assembly robots put the  
34 parts together. From a programmable controller (computer terminal) work is  
35 directed and reprogrammed by human supervisor. Robots disengage products  
36 from the assembly line by placing finish in transport vehicles that will  
37 carry parts to shipping and/or storage. Red lights are used to alert human  
38 tenders, should something go wrong.

## 25 SKILLS, KNOWLEDGES, AND BEHAVIORS TO BE DEVELOPED

26 Students will be able to explain the role of computers in the  
27 manufacturing process and the implications of their influences on industry  
28 and society. Students will program a robot to perform a task predetermined  
29 by the students or the instructor.

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INSTRUCTIONS  
(NOTES)1 TOPIC: Computer Aided Manufacturing (CAM) (1.2.1)

2 PERFORMANCE OBJECTIVES/SUPPORTING COMPETENCIES

3 Senior high school students, having been given assigned readings, prepared  
4 instruction sheets, and having participated in classroom demonstrations  
5 relating to the way computer are used in manufacturing industries. Students  
6 will learn how manufacturers use computers to assist, manage, and control the  
7 manufacturing process and its logistical necessities.

6 In order to do this, the student must be able to:

- 7 1. Recognize the function of manufacturing and its component parts
- 8 2. Describe how computers are used in the three types of product  
9 manufacturing systems, continuous stream, batch processing and  
10 discrete products.

## 10 CONTENT OUTLINE

- 11 I. Types of industry that use Computer Aided Manufacturing (CAM)  
12 and what extent.
- 13 II. Continuous Stream Manufacturing - closed loop feedback systems  
(e.g. paper, chemicals, petroleum)
- 14 III. Batch Process Manufacturing (e.g. steel, brewing)
- 15 IV. Discrete Products Manufacturing (e.g. fabrication and assembly  
16 of; automobiles, aircraft, computers and microelectronic  
17 components, furniture, appliances, food, clothing, packaging,  
18 building materials and machine tools)

## 16 SUGGESTED INSTRUCTIONAL STRATEGIES

- 17 1. Choose a local industry and describe how that industry used CAM  
18 or CAM cells to produce their products.
  - 19 2. Use flow charts and organizational structure charts to  
20 demonstrate relationships.
  - 21 3. Given a small group situation have students develop an  
22 organizational model for production of a hypothetical product.
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INSTRUCTIONS  
(NOTES)1 TOPIC: Flexible System Characteristics (1.2.2)

2 PERFORMANCE OBJECTIVES/SUPPORTING COMPETENCIES

3 Senior high school students, having been given assigned readings, prepared  
4 instruction sheets, and having participated in classroom demonstrations  
5 relating to the way computer are being used to produce parts of a similar  
6 nature, in a flexible manufacturing system.

6 In order to do this, the student must be able to:

- 7 1. Describe the characteristics of a flexible manufacturing system.
- 8 2. Describe the limitations of a flexible manufacturing systems.
- 9 3. Develop a plan to produce a part series or sequence on available  
10 equipment simulating a flexible manufacturing system or component  
11 cell.

## 11 CONTENT OUTLINE

- 12 I. Operational characteristic
- 13 II. Range of flexibility
- 14 III. Limitations
- 15 IV. Material restrictions
- 16 V. Efficiency

## 16 SUGGESTED INSTRUCTIONAL STRATEGIES

- 17 1. Practice programming the range of actions available with the  
18 given robotic equipment.
- 19 2. Program a microprocessors driven robot to perform a predetermined  
20 task.
- 21 3. Use slides of a local industry field trip to provoke brainstormed  
22 improvements to the productivity with the of FMS or CAM.
- 23 4. Have the students judge and prioritize which would be the most  
24 beneficial and profitable alterations to make on a local factory.
- 25 5. Show a film from the Society of Manufacturing Engineers, " The  
26 Challenge of Manufacturing".

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INSTRUCTIONS  
(NOTES)1 TOPIC: Flexible Manufacturing System (FMS) (1.2.3)

2 PERFORMANCE OBJECTIVES/SUPPORTING COMPETENCIES

3 Senior high school students, having been given assigned readings, prepared  
4 instruction sheets, and having participated in classroom demonstrations  
5 relating to the way manufacturers implement computer technology to produce  
6 goods.

5 In order to do this, the student must be able to:

- 6 1. Describe the advantages of a Flexible Manufacturing System in  
7 relation to productivity, efficiency and economy.
- 8 2. Demonstrate the programming of a given manufacturing situation  
9 with available robotic equipment.
  - 10 a. immediate mode
  - 11 b. deferred mode

10

11 CONTENT OUTLINE

- 12 I. Gain in productivity
- 13 II. Different products made in the same line by batch processing
- 14 III. 24 hour productivity
- 15 IV. Minimal working conditions required (e.g. lights, heat, etc.)
- 16 V. Efficient single item manufacturing lines designed to produce  
17 multiple parts (economy of scope)
- 18 VI. Freedom from large scale investment commitments for inflexible  
19 production lines

16

17 SUGGESTED INSTRUCTIONAL STRATEGIES

- 18 1. Program a robot to perform a predetermined task or tasks.
- 19 2. Set up a product manufacturing system using as many FMS/CAM  
20 features as can be employed to modify product outputs.
- 21 3. Program several robotic devices to perform companion tasks in  
22 synchronizations.

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INSTRUCTIONS  
(NOTES)

1 TOPIC: Social Outcomes (1.2.4)

2 PERFORMANCE OBJECTIVES/SUPPORTING COMPETENCIES

3 Senior high school students, having been given assigned readings, prepared  
4 instruction sheets, and having participated in classroom demonstrations  
5 relating to the social impacts of flexible manufacturing systems.

5 In order to do this, the student must be able to:

- 6 1. Describe the personal impact of a flexible manufacturing system  
and effects.
- 7 2. Describe the industrial impact of a flexible manufacturing system  
and effects.
- 8 3. Describe the social impact of a flexible manufacturing system and  
effects.

9

10 CONTENT OUTLINE

- 11 I. Personal Effects
  - 12 A. Work
  - 13 B. Leisure
- 14 II. Industrial Effects
  - 15 A. Productivity
  - 16 B. Environmental changes
  - 17 C. Economic changes
- 18 III. Societal Effects
  - 19 A. Unemployment
  - 20 B. Demographics

16

17 SUGGESTED INSTRUCTIONAL STRATEGIES

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- 18 1. Interview a placement of an employment bureau to determine what  
19 jobs are affected by FMS and what alternatives exist for those  
20 effected.
- 21 2. Interview a local manufacturer to get their insights on short  
22 range and long range expectations for effects.
- 23 3. Compare industrial revolutions of past generations and how  
24 cultures coped with changes as opposed to the effects of flexible  
25 manufacturing systems.

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PHASE: Concentration

ELEMENT: Technology

AREA OF CONCENTRATION: Computer Aided Manufacturing

MODULE: Careers

TOPICS: Career Areas

TOTAL TEACHING TIME: 10 Hours

PREREQUISITES: Keyboarding  
Intro courses  
Computer Applications  
Computer Aided Manufacturing Modules 1.1 and 1.2.

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OVERVIEW OF TOPIC

GOAL

This topic is designed to give the student an understanding of the careers available in computer aided manufacturing.

DESCRIPTION

The student needs to have a basic understanding of the skill requirements of the various occupations of the computer aided manufacturing environment. An awareness of those occupations will improve their ability to make sound career decisions.

SKILLS, KNOWLEDGES AND BEHAVIORS TO BE DEVELOPED

The student will understand the implications of flexible manufacturing system occupations. Each student will be able to determine whether it is feasible to enter this field of endeavor.

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INSTRUCTIONS  
(NOTES)

- 1 TOPIC: Career Areas (1.3)
- 2 PERFORMANCE OBJECTIVES/SUPPORTING COMPETENCIES
- 3 Senior high school students, having been given assigned readings, prepared  
4 instruction sheets, and having participated in classroom demonstrations  
5 relating to the career areas of flexible manufacturing systems.
- 5 In order to do this, the student must be able to:
- 6 1. Describe the personal careers available in a flexible  
7 manufacturing system.
  - 7 2. Determine whether or not to attempt the described field of  
8 computer aided manufacturing.
  - 8 3. Identify the area of computer aided manufacturing that might best  
9 suit the skills of the individual student.
  - 9 4. Determine other occupations that computer aided manufacturing  
10 skill could aid.
- 11 CONTENT OUTLINE
- 12 I. Programmer
    - 13 A. Job responsibilities and duties
    - 14 B. Wages and salary benefits
    - 15 C. Job skills needed
    - 16 D. Educational requirements
    - 17 E. Advancement opportunities
    - 18 F. Job categories
  - 16 II. Technician
    - 17 A. Job responsibilities and duties
    - 18 B. Wages and salary benefits
    - 19 C. Job skills needed
    - 20 D. Educational requirements
    - 21 E. Advancement opportunities
    - 22 F. Job categories
  - 20 III. Mechanic
    - 21 A. Job responsibilities and duties
    - 22 B. Wages and salary benefits
    - 23 C. Job skills needed
    - 24 D. Educational requirements
    - 25 E. Advancement opportunities
    - 26 F. Job categories

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IV. Designer

- A. Job responsibilities and duties
- B. Wages and salary benefits
- C. Job skills needed
- D. Educational requirements
- E. Advancement opportunities
- F. Job categories

V. Manager and Production and Plant and Accounting etc.

- A. Job responsibilities and duties
- B. Wages and salary benefits
- C. Job skills needed
- D. Educational requirements
- E. Advancement opportunities
- F. Job categories

VI. Design Engineer

- A. Job responsibilities and duties
- B. Wages and salary benefits
- C. Job skills needed
- D. Educational requirements
- E. Advancement opportunities
- F. Job categories

VII. Inventor

- A. Job responsibilities and duties
- B. Wages and salary benefits
- C. Job skills needed
- D. Educational requirements
- E. Advancement opportunities
- F. Job categories

SUGGESTED INSTRUCTIONAL STRATEGIES

1. Take a field trip to a local progressive industry that uses computer manufacturing systems, flexible manufacturing systems of CAM cells.
2. Administer interest inventories to help the student identify his areas of strength and weakness to assist in reality training.
3. Interview a local personnel agent to identify more specific information about the student area of interest.