

Describe Various Industry Uses of CADD

Unit: Computer-Aided Drafting and Design (CADD)

Problem Area: Introduce CADD

Lesson: Describe Various Industry Uses of CADD

- **Student Learning Objectives.** Instruction in this lesson should result in students achieving the following objectives:

- 1 Explain computer-aided manufacturing (CAM).**
- 2 Describe the process of rapid prototyping (RP).**
- 3 Explain computer-aided engineering (CAE).**

- **List of Resources.** The following resources may be useful in teaching this lesson:

CAD Forum. Home page. Accessed Sept. 13, 2007.

<<http://www.cad-forum.com>>.

Giesecke, Frederick E., et al. *Technical Drawing*, 12th ed. Pearson Prentice Hall, 2003.

Madsen, David A., David P. Madsen, and J. Lee Turpin. *Engineering Drawing & Design*, 4th ed. Thomson Delmar Learning, 2007.

TII Technical Education Systems. Home page. Accessed Sept. 13, 2007.

<<http://www.tii-tech.com>>.



■ **List of Equipment, Tools, Supplies, and Facilities**

- ✓ Overhead or PowerPoint projector
- ✓ Visual(s) from accompanying master(s)
- ✓ Copies of sample test, lab sheet(s), and/or other items designed for duplication
- ✓ Materials listed on duplicated items
- ✓ Computers with printers and Internet access
- ✓ Classroom resource and reference materials

■ **Terms.** The following terms are presented in this lesson (shown in bold italics):

- ▶ computer-aided design/computer-aided manufacturing (CAD/CAM)
- ▶ computer-aided engineering (CAE)
- ▶ computer-aided manufacturing (CAM)
- ▶ computer-integrated manufacturing (CIM)
- ▶ computer numerical control (CNC)
- ▶ G-codes
- ▶ M-codes
- ▶ rapid prototyping (RP)

■ **Interest Approach.** Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situation. A possible approach is included here.

For both large and small companies, product design usually involves the preparation of analytical and physical models, or prototypes, of the desired product. The construction and analysis of prototypes have been simplified in recent years through the discipline of computer-aided design and drafting (CADD). Ask the students whether they are familiar with the various industry uses of CADD, such as rapid prototyping (RP) and computer-aided manufacturing (CAM). How have these processes changed industry practices?

SUMMARY OF CONTENT AND TEACHING STRATEGIES

Objective 1: Explain computer-aided manufacturing (CAM).

Anticipated Problem: What is computer-aided manufacturing (CAM)?

- I. Nowadays, computers are integral to the manufacturing process. **Computer-aided manufacturing (CAM)** is the use of computer and digital technology to generate manufacturing control data, plans, and operations.
 - A. Computer-aided design/computer-aided manufacturing (CAD/CAM)
 1. **Computer-aided design/computer-aided manufacturing (CAD/CAM)** refers to the integration of computers into the entire design-to-production cycle of a product.
 2. In a CAD/CAM system, a product is designed on the computer and then transmitted directly to the computer-driven machine tools that manufacture the product.
 - B. Computer numerical control (CNC)
 1. **Computer numerical control (CNC)** is the technique of operating a machine, such as a mill, in which motion is generated in response to numerically coded commands.
 2. The motors of the machine rotate according to the speed, direction, and length of time specified in these commands, known as G-codes and M-codes.
 - a. **G-codes** are preparatory functions, such as tool moves.
 - b. **M-codes** are miscellaneous functions, such as coolant settings and tool changes.
 3. A significant innovation in manufacturing, CNC has led to increased productivity, lower manufacturing costs, greater product quality, and the development of new techniques.
 - C. Computer-integrated manufacturing (CIM)
 1. **Computer-integrated manufacturing (CIM)** refers to the complete automation of a factory, from delivery of the raw material to shipping of the finished product.
 2. The field of CIM incorporates the disciplines of CADD, CAM, robotics, hydraulics, pneumatics, electronics, and computer programming. In a CIM system, all employees of the firm have access to the same database used by the designers and the engineers.
 3. CIM also offers the following advantages:
 - a. Better use of materials, machinery, and personnel
 - b. Reduced inventory

- c. Responsiveness to rapid changes in market demand and product modification
- d. High-quality products at low cost
- e. Better control of production and management of the total manufacturing operation

Many techniques can be used to help students master this objective. Refer to Figure 10.17 in Technical Drawing, 12th ed., to illustrate an automated manufacturing system. Use VM–A to review the advantages of computer-integrated manufacturing.

Objective 2: Describe the process of rapid prototyping (RP).

Anticipated Problem: What is rapid prototyping (RP)?

- II. **Rapid prototyping (RP)** is a manufacturing process by which solid physical models are made directly from 3-D computer models. This process is also known as stereolithography.
 - A. The three Rs of rapid prototyping are rough, rapid, and right.
 - 1. In the early stages of production, perfecting models is a waste of time. Therefore, the early models are made rough and rapidly.
 - 2. Later in the process, the models are made right. But that doesn't mean the models work. It simply refers to building many small models that focus on specific problems.
 - B. RP equipment accepts 3-D CADD files, slices the data into thin cross sections, and builds layers from the bottom up, bonding one on top of the other, to produce an actual object.
 - C. CADD software, such as AutoCAD and SolidWorks, has the capability to export files from a solid model in a form usable by a RP machine.
 - D. Rapid prototyping has significantly altered product design and manufacture.
 - 1. The development of physical models is accomplished much quicker with RP than with traditional machining processes.
 - 2. Changes to an object are made on the CAD 3-D model, and the model is then sent to the RP equipment for quick reproduction.
 - 3. Medical models, such as replacement teeth, are quickly developed using RP.

Many techniques can be used to help students master this objective. Refer to Figures 3.5 and 3.6 in Engineering Drawing & Design, 4th ed., to illustrate the process of rapid prototyping.

Objective 3: Explain computer-aided engineering (CAE).

Anticipated Problem: What is computer-aided engineering (CAE)?

- III. **Computer-aided engineering (CAE)** is the use of computers in the design, analysis, and manufacture of a product, project, or process. It is often referred to as an umbrella discipline that includes CADD, CAD/CAM, CIM, CNC, and RP.
- A. In a CAE system, the computer and its software handles most, if not all, aspects of the manufacturing operation.
1. Information from the CAD/CAM design database is used to analyze the functional characteristics of a product under design and to simulate its performance under various conditions.
 2. CAE allows engineers and designers to detect and fix potentially costly design flaws.
- B. The following are just some of the specific topics included in computer-aided engineering.
1. Surface and solid modeling
 2. Mechanical design and product development automation
 3. Product data management (PDM)
 4. Simulation, analysis, testing, and optimization of mechanical systems
 5. Utilization of computers, including personal computers, workstations, and networking
 6. Utilization of the Internet and other technologies to collaborate on projects

Many techniques can be used to help students master this objective. Use VM-B to review some of the topics included in computer-aided engineering.

- **Review/Summary.** Use the student learning objectives to summarize the lesson. Have students explain the content associated with each objective. Student responses can be used in determining which objectives need to be reviewed or taught from a different angle. Questions at the ends of chapters in the textbook may also be used in the review/summary.
- **Application.** Use the included visual masters and lab sheet to apply the information presented in the lesson.
- **Evaluation.** Evaluation should focus on student achievement of the objectives for the lesson. Various techniques can be used, such as student performance on the application activities. A sample written test is provided.

■ **Answers to Sample Test:**

Part One: Multiple Choice

1. a
2. d
3. c
4. b
5. a
6. c

Part Two: Completion

1. Computer-aided engineering (CAE)
2. rapid prototyping (RP)
3. computers
4. computer-integrated manufacturing (CIM)
5. rough; rapidly
6. Computer-aided design/computer-aided manufacturing (CAD/CAM)

Part Three: Short Answer

1. Any three of the following:
 - a. Better use of materials, machinery, and personnel
 - b. Reduced inventory
 - c. Responsiveness to rapid changes in market demand and product modification
 - d. High-quality products at low cost
 - e. Better control of production and management of the total manufacturing operation
2. RP equipment accepts 3-D CADD files, slices the data into thin cross sections, and builds layers from the bottom up, bonding one on top of the other, to produce an actual object.

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► Part One: Multiple Choice

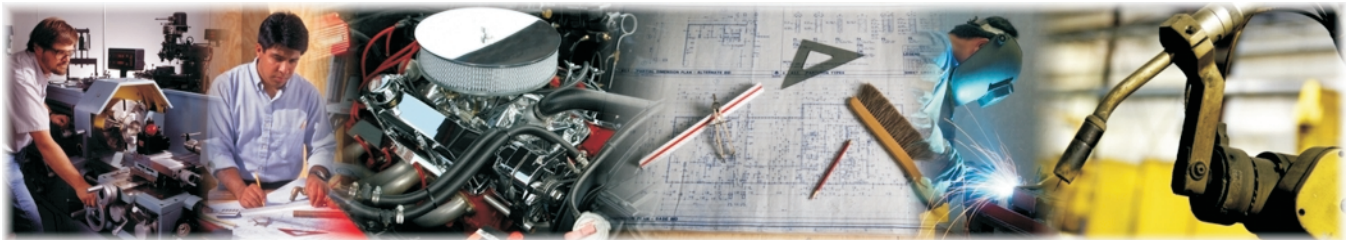
Instructions: Write the letter of the correct answer.

- ____ 1. Miscellaneous functions, such as coolant settings and tool changes, are called:
 - a. M-codes
 - b. G-codes
 - c. Bar codes
 - d. Zip codes

- ____ 2. ____ refers to the complete automation of a factory, from delivery of the raw material to shipping of the finished product.
 - a. CAE
 - b. RP
 - c. CADD
 - d. CIM

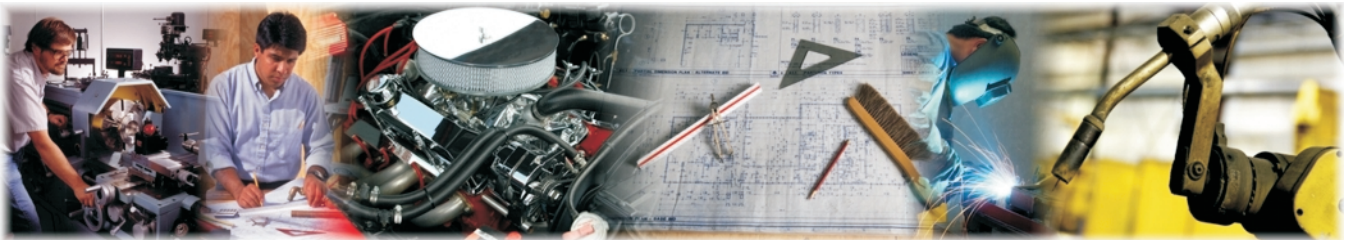
- ____ 3. ____ is a manufacturing process by which solid physical models are made directly from 3-D computer models.
 - a. CAM
 - b. CAD/CAM
 - c. RP
 - d. CNC

- ____ 4. Preparatory functions, such as tool moves, are called:
 - a. M-codes
 - b. G-codes
 - c. Bar codes
 - d. Zip codes



ADVANTAGES OF COMPUTER-INTEGRATED MANUFACTURING (CIM)

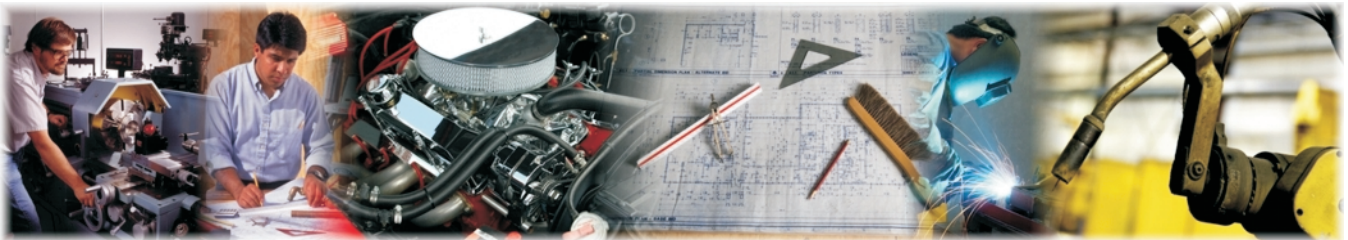
- ◆ Better use of materials, machinery, and personnel
- ◆ Reduced inventory
- ◆ Responsiveness to rapid changes in market demand and product modification
- ◆ High-quality products at low cost
- ◆ Better control of production and management of the total manufacturing operation



COMPUTER-AIDED ENGINEERING (CAE)

Topics included:

- ◆ Surface and solid modeling
- ◆ Mechanical design and product development automation
- ◆ Product data management (PDM)
- ◆ Simulation, analysis, testing, and optimization of mechanical systems
- ◆ Utilization of computers, including personal computers, workstations, and networking
- ◆ Utilization of the Internet and other technologies to collaborate on projects



Creating a List of CADD Publications

Purpose

The purpose of this activity is to enhance your awareness of the current industry trends in computer-aided design and drafting (CADD).

Objectives

1. Create a list of publications dealing with the various industry uses of CADD.
2. Read at least one article a week from one of the publications on your list.

Materials

- ◆ lab sheet
- ◆ writing utensil

Procedure

1. Use the Internet or your library's resources to locate professional trade journals and magazines dealing with the various industry uses of CADD (e.g., rapid prototyping, computer-aided manufacturing, computer-aided engineering, etc.).
2. Keep a list of the publications that you find. Try to find at least one publication in each of the areas discussed in this lesson.
3. Throughout the school year, read at least one article a week from a publication on your list. Choose a different publication each week.

