



www.nextgenmfg.org

Manufacture YOUR FUTURE

TEACHER'S GUIDE

A guide to getting students interested in manufacturing careers, to accompany the "Manufacture Your Future" DVD sponsored by the Connecticut Community Colleges' College of Technology's Regional Center for Next Generation Manufacturing, produced by the Connecticut Business & Industry Association. This guide is funded by a grant from the National Science Foundation.

**Researched and written by
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ASSOCIATION

Foreword

The Connecticut Community Colleges' College of Technology's Regional Center for Next Generation Manufacturing* is pleased to present this teacher's guide as an accompaniment to the "Manufacture Your Future" DVD. The guide is designed to help you and your students not only gain a greater understanding of careers and opportunities in Connecticut manufacturing, but also to introduce activities that will help students understand manufacturing processes and where there might be employment opportunities. The teacher's guide and the DVD were prepared by the Connecticut Business and Industry Association (CBIA), the Center's primary business partner.

The DVD is designed to give you a perspective on today's manufacturing, along with information on the Connecticut Community Colleges' pathway programs in engineering and technological studies. Personal profiles of young people working in manufacturing give students an idea of a typical workday in a specific career, such as CNC programming and engineering. While using this guide for class lectures and student activities, we hope you will show segments of the DVD to support your presentations as well as promote interest in manufacturing careers.

Most importantly, we hope that both this guide and the DVD will demonstrate the clean high-tech environment in today's manufacturing firms. CBIA surveys of manufacturers consistently point to the fact that impending retirements and the need for highly skilled workers are critical concerns. We need young people to see that there are opportunities for them to find rewarding, high paying, upwardly mobile careers in manufacturing. By cultivating interest in students and helping them find and prepare for these careers, we are also helping Connecticut's economy to grow.

Sincerely,

Karen Wosczyzna-Birch, Executive Director
Connecticut Community Colleges' College of Technology
Regional Center for Next Generation Manufacturing

Lauren W. Kaufman, Vice President, CBIA
Executive Director, CBIA Education Foundation

** The programs of the Regional Center for Next Generation Manufacturing are funded through the National Science Foundation.*

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PART ONE:

Exploring Today's Manufacturing

Teacher Background Information

(The “Manufacture Your Future” DVD is designed to inform students about manufacturing today, what career opportunities are available, and what educational avenues they can take to succeed in the field. Before showing your students this DVD, some background information on Connecticut manufacturing might be helpful for you as an instructor.)

What do you know about Connecticut manufacturing?

The manufacturing industry today suffers from a negative image. The perception is that the majority of manufacturing jobs are being moved overseas as a cost-cutting measure; that factory floors remain old, noisy, dark and unclean; and that manufacturers tend to be older workers who stay in dead-end, repetitive jobs. So why encourage your students to enter manufacturing careers?

While some of these perceptions may have been true, here are some real facts to ponder that might change your and your students' minds about the future of manufacturing in Connecticut and nationally:

In Connecticut:

- There are 198,700 employees working in 5,280 Connecticut manufacturing companies.
- Connecticut ranks 20th in the nation in manufacturing production.
- One-half of the top 100 companies headquartered in Connecticut are manufacturers.
- Since 1977, Connecticut manufacturers have more than tripled annual new capital investments in their facilities, from \$566 million to \$1.77 billion in current dollars.
- One-third of all U.S. fuel cell technology is developed in Connecticut, aerospace is thriving and bio-medical manufacturing is expanding.
- Connecticut ranks second in the U.S., at \$2,315 per capita, in defense contracts.
- Each new job in the key areas of Connecticut manufacturing creates 1.2 to 5 additional jobs throughout the economy.
- Average pay for a Connecticut manufacturing production worker is \$43,000.

(source: CT Dept. of Labor, 2006)

(sources: CBIA Research Dept., CT Dept. of Labor, CT Dept. of Economic and Community Development, U.S. Bureau of Labor Statistics)

In the nation:

- Manufacturing generates the strongest growth of any economic sector in the U.S.
- Manufacturing contributes more than 60% of exports.
- Manufacturing pays wages and benefits 25% higher than non-manufacturing jobs.
- Manufacturing generates 70% of America's research and development investment.
- Eighty-four percent of manufacturers expect up to 25% of their workers to retire within the next five years.

(source: National Association of Manufacturers)

Manufacturing today is not what it used to be. Companies are reorganizing to meet global competition. They're working smarter and leaner by being more efficient with their processes. Larger companies that have reorganized into smaller companies are creating job opportunities that didn't exist before. The technology is state-of-the-art, requiring higher skill levels for employees and the opportunity for cross-training so that jobs are no longer repetitive. There are also many opportunities for advancement, and salaries average \$43,000 a year, with many jobs paying more than that. Engineers, for instance, can earn well over \$100,000 a year.

Factory floors today are cleaner and more interesting than they used to be, not just because they are more technology driven, but also because industries have changed. Today, the three largest manufacturing industries in the U.S. are chemical, industrial machinery and equipment, and electronics. Fifty years ago they were food, primary metals and motor vehicles.

Perhaps more critical is the fact that a majority of manufacturers are facing massive retirements, with too few people to replace essential workers like machinists, tool-and-die makers and engineers. The average age of a manufacturing worker today is 51, and 84 percent of Connecticut manufacturers expect 25% of their workforce to retire within the next five years. *(source: CBIA 2005 Survey of Current and Future Manufacturing Jobs in Connecticut)*

Refer to the first chapter of the "Manufacture Your Future" DVD for an overview of today's manufacturing.

Which students would be interested in manufacturing careers?

Manufacturing would appeal to students who:

- Like and have an aptitude for math
- Enjoy figuring out how things work
- Like solving practical problems
- Think about developing new techniques and products
- Like taking things apart and putting them back together again
- Like making things, especially using technology, electronics, lasers and robots
- Like to work in teams

What skills and characteristics would students need to have in order to succeed and advance?

(For information on the Connecticut State Standards for manufacturing students, go to www.state.ct.us/sde/deps/Career/TechEd/.)

Employers and experts cite the following characteristics and skills as necessary for success and advancement in manufacturing:

- Strong literacy and communication skills
- Ability to work with existing technologies and learn new technologies
- Strong math and science skills
- Teamwork/interpersonal skills
- Flexibility and desire to learn new skills
- Cross-functionality — the ability to transfer skills and learn new ones in order to perform many functions in the workplace
- Professional skills (such as being at work on time, finishing assignments, dressing appropriately, having a positive attitude)
- Multicultural awareness

Manufacturers who participated in CBIAs “2005 Survey of Current and Future Manufacturing Jobs” listed the following skills as the most essential for the next five years:

- Teambuilding/problem-solving
- Lean manufacturing knowledge
- Equipment operation
- Blueprint reading
- Engineering

What are the opportunities in manufacturing?

According to the “2005 Survey of Current and Future Manufacturing Jobs,” Connecticut jobs that are in demand include:

- **Computer Numeric Design (CNC) Programmers** — cut/shape metal, plot the way machines work, using computerized processes
- **Machinists** — set up, operate a variety of machine tools, fit and assemble parts, repair, using math, mechanical knowledge, computer knowledge, study blueprints
- **Welders** — join, fabricate, and repair metal and other weldable material by applying appropriate welding techniques
- **CAD/CAM Drafters** — transform initial rough product designs using computer-aided design into working documents, review engineering drawings and designs to ensure adherence to established specifications and standards
- **Tool and Die Makers** — design, build and repair machine shop tools, work with blueprints
- **Manufacturing Technicians** — service/repair/test electronic and mechanical equipment, collaborate with engineers, inspect, evaluate equipment performance
- **Manufacturing Engineer** — design/develop/test and manufacture machines, consumer products, biotechnology computer software, etc., work with all aspects of manufacturing from production control to automation

What are the education requirements and average salary levels?

(Note: All salary ranges are based on current Connecticut averages, entry level to advanced, obtained from www.salary.com.)

| For individuals with high school diploma/ apprenticeship and college associate's degree | For individuals with a bachelor's degree |
|--|--|
| CNC Programmer \$33,000 – \$48,000 <i>(to \$68,000 w/4-year degree)</i> | Manufacturing Engineer \$54,000 – \$92,000 |
| CAD Drafter \$31,000 – \$61,000 | Biomedical Engineer \$41,000 – \$110,000 |
| Machinist \$28,000 – \$70,000 | |
| Welder \$28,000 – \$64,000 | |
| Manufacturing Technician \$22,000 – \$58,000 | |
| Engineering Technician \$33,000 – \$48,000 | |
| Tool and Die Maker \$34,000 – \$57,000 | |

Considerable overtime pay is available in manufacturing, resulting in many employees earning far above these amounts.

PART TWO:

What is Manufacturing?

(This part of the teacher's guide gives students the opportunity to discover what manufacturing is and the various development cycles that products go through. It would be a good idea to show the "Next Generation Manufacturing – How Has Manufacturing Changed" chapter of your DVD. The following activities are suggested to get students thinking about what goes into manufacturing and how manufacturing touches our lives every day.)

Student Activity #1 – "Made in Connecticut" Quiz

BEFORE SHOWING THE DVD

Almost everything in our daily lives has been created and manufactured by someone else. Before showing the DVD, ask students to identify anything in the classroom that has been manufactured. Then, ask them:

- What is the item made from?
- How do you think it was made?

Next, hand out the "*Made in Connecticut*" Quiz. The answers are as follows:

- What is it that a rock star can't do without?
Answer: Ovation guitar, made by Kaman Music, Inc.
- What is one of the most powerful nuclear defense products in the world, likes water, and is named after former President Jimmy Carter?
Answer: Nuclear submarine, The Jimmy Carter, made by General Dynamics, Electric Boat
- Name a favorite local chocolate that you can find at a Connecticut mall.
Answer: Munsons Chocolates
- What Connecticut company is one of the largest suppliers in the world of a piece of medical equipment? (Hint: You've probably encountered this medical device used as a preventive measure to keep you healthy.)
Answer: Becton, Dickinson and Company, suppliers of retractable syringes.
- Name a plastic ball with holes that is usually hit with a bat.
Answer: Wiffle Ball
- What does Black Hawk refer to?
Answer: Helicopter made by Sikorsky, a United Technologies Company.

- What connection does Connecticut have with the third-tallest building in the world?
Answer: Otis Elevator-United Technologies Corp. designed and built the elevator.
- This laser company cuts the metals used to make Harley-Davidson motorcycles.
Answer: Trumpf Inc.
- What does an astronaut need when he or she is in space?
Answer: Space Pak made by Hamilton Sundstrand-United Technologies
- What company powers half of all the world's commercial planes?
Answer: Pratt & Whitney-United Technologies Corp.
- Name a soap that's named after a bird.
Answer: Dove, made by Unilever Home Products
- What's the name of the candy made in Connecticut that comes in a dispenser with cartoon heads (Sponge Bob for one)?
Answer: Pez Candy

TEACHER DISCUSSION

You might want to talk about the largest manufacturing industries in Connecticut, which are:

Defense/Aviation – Connecticut ranks second in U.S. defense contracts and provides parts for more than half of the world's commercial airplanes.

Fuel Cell Technology – Connecticut has one-third of the U.S. market in fuel cells. Fuel cells are an economical source of energy that is being explored as an alternate energy source for industrial and home heating, and cars.

Biotechnology – Connecticut is a leader in the manufacture of medical equipment, devices and medical drugs.

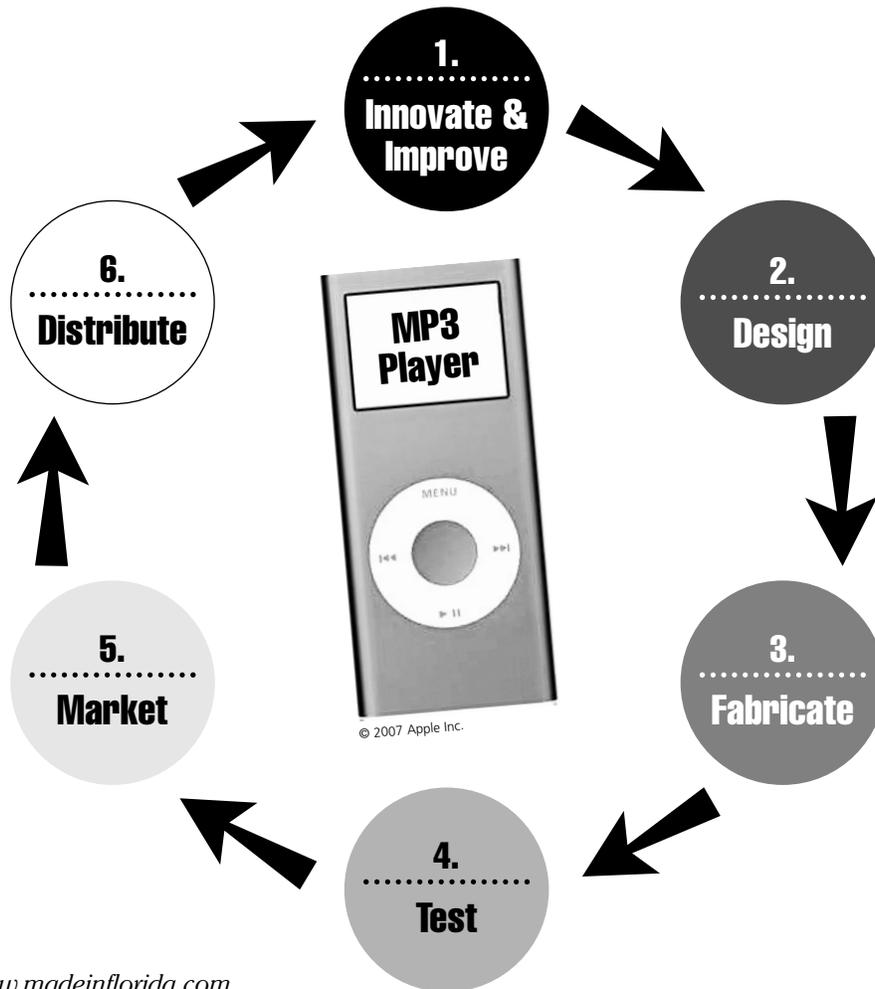
SHOW THE NEXT GENERATION MANUFACTURING CHAPTER OF THE DVD, giving an overview of today's manufacturing.

Student Activity #2 – Team discussions of student manufactured products

Ask students to get into small groups or teams and talk about anything they may have created and then sold (for example, baked goods, bird feeders, science projects, arts and crafts). Have them share how they came up with the idea, how they designed the product and how they went about selling it. Ask them if they felt they were successful and if they made a profit. As a team, have them write down the steps they took to make the product successful. Also have them determine any mistakes they may have made and what they did to correct the problems. Have a team leader report their findings to the class.

Student Activity #3 – Questions on the manufacturing cycle

While there are many different processes involved in manufacturing a product, the most common steps involved are:



source: www.madeinflorida.com

MP3 players give music lovers the opportunity to listen to hundreds of songs any time, day or night, because their small size allows music lovers to carry them with them in as simple a way as placing it in a pocket.

Ask students other reasons why MP3 players were such a good invention.

INNOVATION is a response to a market need for a new idea to solve a practical problem.

REASONS WHY MP3 PLAYERS WERE A GOOD IDEA



© 2007 Apple Inc.

- Small size
- Convenient
- Storage
- High-quality sound
- Internet downloads

Ask students what they should think about before designing a product.
What are some of the challenges?

DESIGN takes the initial concept and transforms it into a working model.

- What will it look like?*
- What will it feel like?*
- What will it sound like?*
- How will it perform?*
- How can it be built?*
- How much will it cost?*



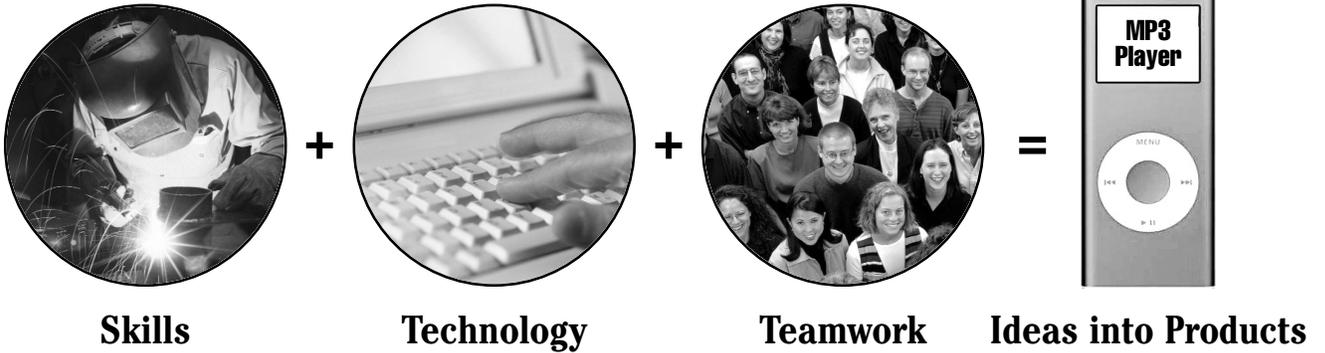
© 2007 Apple Inc.



Making ideas a reality requires engineering, computer-assisted drawing, prototyping, and selection or development of the tools and processes that will be used to manufacture the new product.

FABRICATION requires skilled technicians to transform ideas into blueprints and into actual products.

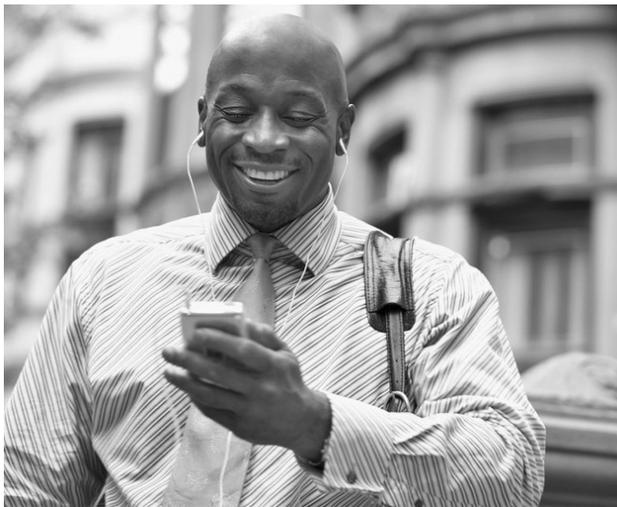
MAKING THINGS HAPPEN — IMPLEMENTING A BLUEPRINT



Ask students what kinds of workers they think would be on the manufacturing team to create an MP3 player.

(Examples: electronic technicians, welders, assemblers, laser and optics specialists)

TEST Products must be tested to make sure they perform as designed.



Inspection for:

- Design specifications
- Durability
- Customer satisfaction and use

All products must be inspected and tested before they are assembled and sent to customers. In addition to the many specialized skills required to produce a product, other skills are needed for quality control.

Ask students: If they were on the team that produced the first MP3 player,

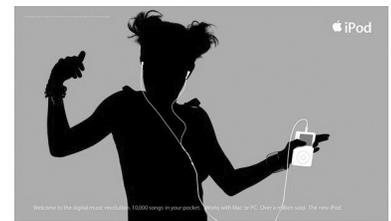
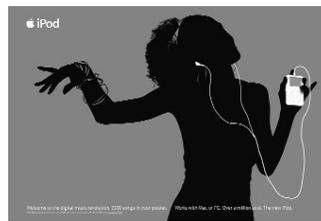
- What skills would they need to have?
- What questions would they ask?
- How would they test the product to see that it met the goals of the original design?

MARKETING

Once products are produced, they need to be promoted.

MP3 player marketing

- Advertising
- Sales
- Customer support



Let students know that there are many different kinds of non-manufacturing jobs that support manufacturing functions. In addition, there are opportunities for promotions within these support areas.

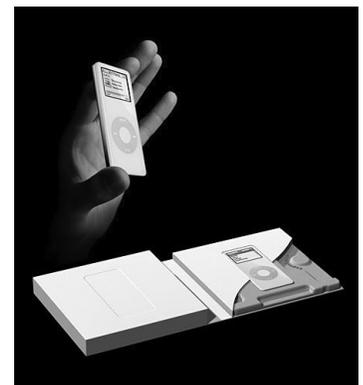
DISTRIBUTION

The final cycle in manufacturing involves packaging and shipping the products to consumers.

Questions to ask:

- How to best package the product?
- How much volume does it need?
- How much protection?
- What materials to use in shipping?
- What is the cost of the shipping?

Products need to be transported by air, land or sea to consumers. The same transportation networks might be used to deliver the materials needed by the manufacturer.



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Ask students: What questions would you ask before shipping the MP3 players to a distributor?

PART THREE:

Is Manufacturing for Me?

(Part Three gives students the opportunity to explore Connecticut manufacturing and to find out firsthand what it's like working in manufacturing. At this time it would be a good idea to show any or all of the five personal story segments of the DVD.)

TEACHER DISCUSSION

Reinforce the idea with your students that manufacturing today has changed: that it's high-tech, requiring a number of skills, the jobs are not repetitive, and environments are clean. Talk about some of the major technologies in Connecticut and the jobs in demand mentioned in the "Teacher Background" chapter. Remind them that there are many different kinds of job opportunities and that there is the potential to earn a good living.

SHOW PERSONAL STORY SEGMENT(S) FROM THE DVD.

Student Activity #1 – Manufacturing careers discussion, essay and poster

Materials: "Manufacture Your Future" DVD – Individual Career Chapters

Time: One Class Period; Homework

This class gives you the opportunity to show any one of the personal segments highlighted in the "Manufacture Your Future" DVD. You can choose to show as many as you like. Reinforce the information learned from the "Teacher Background" chapter about the different kinds of job opportunities in manufacturing, and mention salary potentials and educational requirements.

Following the viewing of the personal stories in the DVD, talk about some of the other careers mentioned in the "Teacher Background" material. List possible careers, such as:

- Engineering (manufacturing, biomedical, mechanical, etc.)
- Engineering technician
- CAD drafter
- CNC operator
- Machinist
- Tool and die maker
- Welder

HAND OUT THE ONE-PAGE FLYER "CONNECTICUT OUTLOOK ON MANUFACTURING."

Assign students a homework assignment where they have to research a Connecticut company and a chosen career in that company. They can choose to do this research in one of two ways: either a personal essay requiring the student to write in the first person what a typical day would be like for workers in a chosen career; or a student can interview a person currently working for a Connecticut manufacturer. (If they choose the interview, you might consider giving them extra points.)

Questions to consider when either writing their personal essay or interviewing a manufacturing employee include:

- How would you describe your workplace?
- What does your company manufacture?
- What job duties and responsibilities do you have?
- What benefits does your company offer?
- What technical skills and abilities do you use?
- What personal and professional skills do you use?
- What communication skills do you use?
- Why did you choose this career path?
- What do you like about the job?
- What are the challenges on the job?
- What educational background do you have?
- How did your education prepare you for this job?
- How is manufacturing different today from what it was 20 years ago?

POSTER

To accompany the report, students can either create a poster or a brochure on that particular career. Students should use the information from the report and pick out the most important points that would encourage someone to work in the manufacturing industry. They can be as creative as they like, using online clipart or pictures from magazines.

PART FOUR:

Getting There

(This chapter supports the idea that education beyond high school is becoming more and more essential in order to be successful in manufacturing. Innovative community college programs are a great way to get the necessary skills to work in today's manufacturing industry. At this time, it would be a good idea to show the chapter from the DVD on the College of Technology.)

TEACHER DISCUSSION

The previous generation of manufacturers more than likely didn't have to be concerned about taking courses beyond high school. Today's manufacturing is different. The technologies involved and the way that manufacturers have to do business to remain competitive require higher skill levels. Not only are strong math, science and technological skills necessary, but being able to communicate effectively, working in a team environment, and being flexible and open to learning new skills are essential.

While some jobs in manufacturing don't require postsecondary education, anyone entering a manufacturing career would be better prepared and have more opportunities with additional education. Entry-level workers who have associate's degrees have a much greater potential for advancement, earn higher wages, and can pursue pathways to higher-level professions like engineering. For students who enter manufacturing directly after high school, employers will often pay for continuing education.

HAND OUT THE ONE-PAGE FLYER ON SALARIES AND EDUCATION LEVELS.

One of the best ways students can get the training they will need to succeed is through an innovative Community College program available in Connecticut called the Connecticut Community Colleges' College of Technology.

SHOW THE DVD CHAPTER ON THE COLLEGE OF TECHNOLOGY.

Explain to the students that the Connecticut Community Colleges' College of Technology offers specialized programs that allow a student to complete an A.S. degree in technological studies or engineering science at any of the state's community colleges, and that the programs provide complete, transferable credits into four-year engineering and technological studies programs at select Connecticut four-year universities.

HAND OUT THE BROCHURE ON "NEXT GENERATION OF MANUFACTURING."

Reinforce the idea that community colleges work closely with industry to get the most up-to-date

information on workforce needs, and that the associate's programs are tailored around careers in high-growth fields, such as:

- Precision machining
- Fiber optics
- Electrical utilities technologies

Industry-driven courses are offered in such areas as:

- Laser manufacturing
- Green engineering
- Nanotechnology
- Fuel cells
- Biomedical applications

For engineering students, the program is particularly beneficial in that upon completion of the associate's in engineering science, students (if accepted through the admission process) can enter four-year engineering programs as a junior at the University of Connecticut, University of Hartford, Fairfield University, University of New Haven, Charter Oak State College, or in engineering technology or industrial technology at Central Connecticut State University.

Additional Activities and Resources

for Teacher/Student Explorations in Manufacturing

FOR TEACHERS:

- **Teacher Externships (or Internships):** Participate in a teacher externship program, working with a local manufacturer for a minimum of one to two weeks. Teacher externships are one of the best ways to experience current practices in manufacturing today and a great way to update your skills. An externship also gives you the opportunity to partner with a manufacturer for future school-to-career activities. One way to get the most out of the experience is to engage your students in a work-based learning project that is based on your own externship experience. For more information on teacher externship programs, go to the Connecticut Business & Industry Association's Web site at <http://www.cbia.com/ed>.
- **Job Shadow:** If you can't find the time to participate in a teacher externship program, the next best thing is to spend a day with industry professionals to observe what they do, and to experience the company's environment.
- **Guest Speakers:** Invite industry professionals to visit your class to talk about their careers, what they like about them, what skills they bring, and how they obtained those skills, and let them interact with students.
- **Company Visits:** Arrange to have your students visit manufacturers so they can get a firsthand look at what goes on in a manufacturing company and what the environment is like, and give them an opportunity to interact with industry professionals.

FOR STUDENTS:

- Conduct a "take apart" or "reverse engineering" workshop in class. Ask each student to bring in a non-working household appliance or electronic device and tools to work with. Carefully disassemble the appliance into the smallest possible pieces and discuss such questions as:
 - Exactly how does the appliance work?
 - What materials are used on the outside? The inside? Why do you think those materials were selected for those locations and functions?
 - What screws, rivets, fasteners are used?
 - How is electricity used?
 - How would you improve the appliance?

Additional Resources Available on the Web

Regional Center for Next Generation Manufacturing
www.NextGenMfg.org

Connecticut Business & Industry Association
www.cbia.com

National Association of Manufacturers
www.nam.org

Connecticut Department of Labor
www.CTdol.state.ct.us

Florida ATE Center for Manufacturing Education
www.madeinflorida.org

Manufacturing is Cool!
www.manufacturingiscool.com

Dream It, Do It!
www.dreamit-doit.com

Smaller Manufacturers Association of Connecticut
www.sma-ct.com

Career Voyages in Advanced Manufacturing
www.careervoyages.gov

Bureau of Labor Statistics
www.bls.gov/k12