Careers in Advanced Manufacturing

InDemand

Connecting today's students with the careers of tomorrow

Issue 3

Put Your Career in Gear

Join the innovative people who are creating the products of the future.

U.S. Department of Labor

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Career Voyages provides information about career options that can help you choose your future and find education and training opportunities needed to get there.

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Dear Student:

Are you a challenge junkie who enjoys solving problems? Do you like robotics, computers, and other advanced equipment? Do you ever wonder things like…What makes a ski jacket waterproof? How is it that computers are getting smaller and lighter, yet faster and smarter? What makes a surfboard float and a wet suit warm? Why are some cars safer than others? How does an iPod really work?

You may be interested to know that the answers to these questions lie in the advanced manufacturing processes used to develop new materials, semiconductors, metals, and fabrics. You may not realize it, but almost everything you touch throughout the day involves manufacturing, including this magazine! Want to learn more? This publication will tell you all about the **advanced manufacturing industry**, and it might give you an idea for a future career. It talks about what you need to learn and do to get your first great job. Do you want a job in the areas of design, production, process development, quality assurance, health and safety, supply chain logistics, or maintenance and repair? No problem! There are lots of careers in all of these areas of advanced manufacturing…and they pay well.

Assistant Secretary of Labor Emily Stover DeRocco helps workers build successful careers.

I'm Emily Stover DeRocco, Assistant Secretary of Labor for Employment and Training, and I run the federal agency that helps American workers find rewarding jobs, and get the education and training they need to succeed. Since you will soon be part of the work force, the U.S. Dept. of Labor's Employment and Training Administration wants you to have this publication. It will let you know what this industry is all about and how you can build a successful future in it.

There's a lot of great information in here! Please read it, and share what you find with your parents, teachers and guidance counselor. They can help you find the right college or university to study for a career in advanced manufacturing, or the right apprenticeship program to gain skills and job experience!

So what's *In Demand*? You are! Your knowledge…your curiosity… and your skills are all *In Demand*—and so are the many high-growth jobs that you will learn more about in this publication. Also, look for future copies of *In Demand* that tell you about great careers in other fields such as health care.

The sky is the limit! Put your career in gear, focus on assembling your knowledge and skills so that you can begin to manufacture a successful future!

Emily Stover DeRocco

Emily Stover DeRocco
Assistant Secretary of Labor

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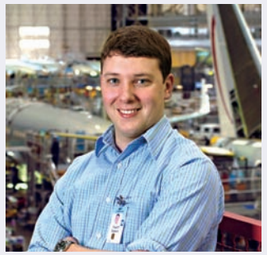

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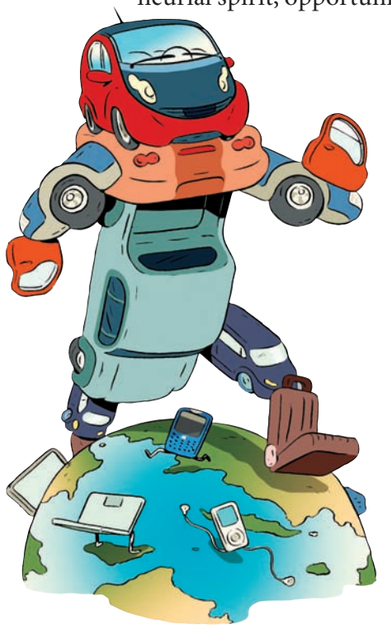

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Careers in Advanced Manufacturing

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THE AMAZING WORLD OF Manufacturing

By Pat Toensmeier

Crayons in a packing machine

PHOTO OF CRAYONS: WILLIAM THOMAS CAIN/GETTY IMAGES

Advanced Manufacturing invents and creates the products people need and want. Whether it is clothing, cell phones, computers or automobiles, CDs and DVDs, food and drink, athletic gear, medicine or cosmetics, virtually everything we use on a daily basis is manufactured. These and many other products are part of everyday life because advanced manufacturing techniques make them reliable, affordable and available.

Advanced manufacturing also plays a major role in creating solutions for a variety of problems. Hybrid cars that reduce pollution and conserve energy; implantable medical devices that improve health care; and special airtight packages to keep perishable foods fresh, are only a few examples of the challenges advanced manufacturers tackle.

What makes manufacturing so versatile is technology. Advanced manufacturing applies cutting edge concepts in electronics, computers, software and automation to improve production. In the past 10 years, the use of computer systems and software to monitor and control processes in large and small plants has led to increased product quality and productivity. Communications technology has increased the ability of engineers and plant managers to check on operations—even if it's halfway around the world. Systems can be set up to transmit data on how much material is being used, how machines are running and if problems are occurring. The ultimate example of what can be achieved is "lights-out manufacturing," which allows a highly automated plant to be run by computers and robots, with minimal involvement by skilled human operators.

These high-tech capabilities let engineers create more exciting products than were possible just a few years ago. One example of this can be seen in electronic devices like cell phones and digital recorders, which are getting smaller and less expensive, yet have more and more features built into them. This is possible because of the miniaturization of circuitry, and the use of "clean" assembly techniques that prevent contamination of sensitive components.

One firm working on a project that's sure to be hailed as "good manufacturing" is the Boeing Co., Seattle, which is using a special material in its new 787 airliner that is lighter and stronger than metal. Called carbon-graphite composites, the material will prolong the life of a passenger airplane and reduce the amount of fuel it uses. The groundbreaking design could be a glimpse at the way passenger jets will be made in the future. One reason Boeing can build this airplane is because its engineers developed techniques for manufacturing large sections of it from composites.

One technology that could change the auto industry dramatically is fuel cells. Some car manufacturers plan to have fuel-cell-powered vehicles on the road by 2010. Fuel cells combine oxygen and hydrogen to create an electrical current that drives an electric motor. And pollution will not be an issue; all you'll ever see is water vapor!

Manufacturing encourages creativity and analytical thinking. It is an area where ideas can be tested almost immediately, and where one person's inspiration may lead to a major product breakthrough. For these reasons, students who want a career that is meaningful, exciting and rewarding, should consider advanced manufacturing. Whether a student's interest lies in production, engineering or designing, experts say there will be plenty of demand in coming years for qualified candidates—girls as well as boys.

PHOTOS OF LIPSTICK, CAR, AND CD: ISTOCKPHOTO; BICYCLE, COURTESY OF CANNONDALE BICYCLE CORP.

Advanced manufacturing creates some of the highest-paying, skilled jobs in the workforce.

A recent study released by the National Association of Manufacturers and the Manufacturing Institute, reports that 81% of American manufacturers say their biggest problem is finding qualified workers. If this problem isn't fixed, the report states it will impact our nation's economic well-being.

The Manufacturing Institute recommends that students take math and science courses starting in middle school as manufacturing is technologically driven. Computer programming skills should be studied as well, notes Ron Ross, vice president of employee relations at Battenfeld Gloucester, Gloucester, Mass., due to the importance of computer-aided design, engineering and manufacturing programs (known as CAD/CAE/CAM) in product development and machine tool operation.

For students with a firm grounding in the sciences, the opportunities are vast. When it comes to manufacturing, says Stefan Skibicki, Jr. of Lockheed Martin, Orlando, "we are only limited by our imaginations."

Think Robotics, Not Wrenches

In Advanced Manufacturing! By Housley Carr

Forget what you've heard about manufacturing jobs moving overseas. Sure, some of that's happening. But if you're only catching the bad news, you're missing out on the good. Great career and entrepreneurial opportunities abound.

The fact is that the new breed of advanced manufacturers—that make everything from computers to mountain bikes to jet parts—can't find enough trained people to hire!

"All the boring manufacturing jobs already have been outsourced" to other countries, says Dan Conroy. "The jobs that are still here are the best ones. The jobs using the latest technology—lasers, micro-machining, and nanotechnology."

Conroy should know. He's the human resources director at the Nexen Group. Nexen's plant in Webster, Wis., uses high-tech equipment to make industrial equipment that is sold around the world.

Conroy says that finding trained people for Nexen's good-paying jobs is hard work. "It doesn't make sense, because these are really good jobs. It's just that people don't know that there are awesome career opportunities in advanced manufacturing."

According to the Washington, D.C.-based Manufacturing Institute, an individual who works in manufacturing will be paid 22% more than the average U.S. worker.

Teamwork also rules at the Cannondale bicycle plant in Bedford, Penn. Its 350 employees "work really closely together, trying to solve problems as they come up," says Scott Collins, human resources supervisor. "We're like family."

The technology at our plant "runs from old-school to lasers," says Collins. The company's edge in the bike market is the level of quality that is hard to get from overseas, he says. Perfect cuts on frame tubing. Flawless welds. Smooth-as-silk gears.

"We have some employees with high school diplomas, a lot with two-year degrees, and some with four-year degrees. But no matter what job you have here, you're involved in quality control. We want people who really care about their work, and who pay attention to the detail. That will make you or break you at Cannondale," says Collins.

Because so many of the workers are into cycling in a big way, there's an extra rush that comes with the paycheck. "I welded for 10 years before taking the hiring gig," says Collins. "Each bike gets the stamp of the welder. I knew that every bike I welded was going out into the world with my initials on it. There's real pride in that."

Collins says that no matter where you work in manufacturing, you have to be comfortable with computers. And it really helps to have at least a two-year technical degree. A four-year degree is even better.

Technical schools, community colleges and universities expose you to what the best companies are looking for. Computer-aided design and computer-aided manufacturing. Robotics. Metrology—measuring the tiniest things. Equipment installation and repair.

Education beyond high school also gives you a chance to get better at other stuff that really matters in manufacturing. "Things like creative thinking, teamwork, and problem-solving," says Nettie Simon-Owens. She is the coordinator of workplace services at Danville Community College in Virginia, which offers an advanced manufacturing technology program. The program involves "applied learning," says Simons-Owens. "There's a lot of hands-on work so that graduates can flow right into a good job, anxiety-free. (Well, almost.)"

"We work with Griffin Technical College" in Griffin, Ga., and

PHOTO OPPOSITE PAGE: COURTESY OF THE MANUFACTURING INSTITUTE; PHOTO THIS PAGE: COURTESY OF BAYER MATERIAL SCIENCE

Photo left:
The automobile industry relies on advanced manufacturing technology and high-tech workers to produce quality products.

PAYDAY

Average annual salaries for advanced manufacturing staff

Assembler	$32,900
Avionics Technician	$46,570
Chemical Engineer	$78,030
CNC Machine Operator	$43,320
Cost Estimator	$50,870
Drafter	$47,300
Electrical Engineer	$79,680
Electrician	$41,760
Electromechanical Equipment Technician	$39,580
Environmental Engineer	$70,830
Fabric and Apparel Patternmaker	$35,530
Industrial Engineer	$67,820
Inspector	$31,590
Precision Instrument Repairer	$46,400
Machine Setter & Operator	$27,790
Manufacturing Engineer	$65,230
Material Mover	$31,350
Mechanical Engineer	$71,110
Medical Equipment Technician	$31,550
Metal Fabricator	$31,260
Model Maker (Metal and Plastic)	$45,520
Painter (Transportation Equipment)	$36,980
Petroleum Engineer	$92,840
Plant Manager	$109,090
Plastics Fabricator	$31,260
Printing Machine Operator	$32,300
Safety Technician	$39,300
Semiconductor Engineer	$90,000
Tool and Die Maker	$44,620
Welder	$31,430

CHART SOURCE: U.S. DEPT. OF LABOR, BUREAU OF LABOR STATISTICS

> "There are tons of jobs in advanced manufacturing for those with education, training and good work ethics."
>
> —DAN CONROY, NEXEN GROUP

some other schools, says Shane Sumner. He is the president and chief executive officer at Snapper, the lawnmower company. Sumner runs a huge plant in McDonough, Ga., that is three times as productive as it was only 10 years ago.

Now, lasers cut the parts. Computers control the steel-stamping presses and robots do the welding. All this happens under the watchful eyes of trained people. The end result is a better lawnmower.

If you really want to go places in advanced manufacturing, get an engineering degree. Employers will be fighting over you come graduation, says Cynthia Redwine. She is the director of the Career Resources Center at the University of Michigan's School of Engineering.

"We get recruiters from companies like Boeing, General Electric, Ford, and Northrop-Grumman," says Redwine. In 2005, mechanical engineering graduates got jobs with average starting salaries of $52,150, she says. Stay on for a master's degree in manufacturing engineering and you could start at about $70,000.

Even for an entry-level manufacturing worker, the pay is good. According to the federal government's Bureau of Labor Statistics, the average hourly wage for a production worker making transportation equipment was over $21 an hour in late 2005. That's about $43,000 a year—without overtime.

For someone making computers or electronic equipment, the average wage was almost $18 an hour. Steelmakers make about the same. And it goes up from there.

Gain more work experience and continue your education and you may find yourself a production control manager. They make an average of $76,000 per year. What about a plant manager? They make an average of $109,000 per year. Thinking really big? A manufacturing executive makes approximately $210,000.

"There are tons of jobs in advanced manufacturing for those with education, training, and good work ethics," says Conroy, from Nexen. "And the opportunities to advance are great too. A career in advanced manufacturing is really something young people should think about."

Want to hear the best soundtrack at a manufacturing-careers website? Tap your way to **www.dreamit-doit.com**. The site's full of good info, including a career quiz, videos of stuff being made, and a search engine to find that perfect school. Well worth a visit.

PHOTOS LEFT TO RIGHT: DIGITAL VISION/GETTY IMAGES; COURTESY OF DELL INC.

There is something for everyone in the

Advanced Manufacturing Industry

Job titles range so broadly that you are only limited by your imagination

Account Executive ✦ Assembler ✦ Biochemist ✦ Book Binder ✦ Buyer ✦ CAD Operator
Chemist ✦ Computer Programmer ✦ **CNC MACHINE OPERATOR** (10) ✦ Contractor ✦ Cost Estimator
Customer Support Specialist ✦ Designer ✦ Die Maker ✦ Drafter ✦ Electrical Engineer ✦ Electrician
ELECTROMECHANICAL EQUIPMENT TECHNICIAN (15) ✦ **ENTREPRENEUR** (24) ✦ Environmental Engineer
Fabric and Apparel Patternmaker ✦ Facilities Manager ✦ Fashion Designer ✦ **FIXTURE DESIGNER** (18)
Food Scientist ✦ Graphic Designer ✦ **HEALTH AND SAFETY ENGINEER** (16) ✦ HVAC Technician
INSPECTOR (19) ✦ Instrument Repairer ✦ Inventor ✦ Industrial Engineer ✦ **MACHINE OPERATOR** (10)
Machine Setter ✦ **MACHINE TOOL TESTER** (21) ✦ Manager ✦ **MANUFACTURING ENGINEER** (12)
Marketing Manager ✦ Material Mover ✦ Mechanical Engineer ✦ **METAL FABRICATOR** (20)
OPERATIONS MANAGER (11) ✦ Ophthalmic Laboratory Technician ✦ Packaging Engineer ✦ Packer ✦ Painter
PHARMACEUTICAL PROCESS ENGINEER (13) ✦ Planner ✦ Plant Manager ✦ **PLASTICS FABRICATOR** (14)
Precious Stone and Metal Worker ✦ Print Operator ✦ **PROCESS CONTROL TECHNICIAN** (17)
PROCESS TECHNOLOGY DEVELOPMENT ENGINEER (13) ✦ Quality Control Technician ✦ Researcher
ROBOTICS OPERATOR (11) ✦ Sales Representative ✦ Scheduler ✦ Scientist ✦ Semiconductor Engineer
Sewing Machine Operator ✦ Shipping Clerk ✦ Superintendent ✦ Supplier ✦ Tool Maker ✦ Welder ✦ Woodworker

Career opportunities abound for all kinds of jobs in the advanced manufacturing industry, with dozens of job titles from manufacturing engineer, to robotics operator. There is something for everyone, from hands on (machine operator) to high-tech (semiconductor engineer), to creative (design engineer), to scientist (pharmaceutical researcher). Advanced manufacturing offers many kinds of work environments. You can work at a manufacturing plant using your hands, in an office using computers to design parts, doing research in a lab, or negotiating deals in a conference room. You can work for a large firm or small start-ups, or even explore entrepreneurial opportunities. We will detail 14 popular career paths in advanced manufacturing on the following pages and answer some of the questions you may have. What do the people who have these jobs do? Why are these jobs important? How much money can you make? These stories could help you decide, "Is this job for me?"

Something for EVERYONE

Machine Operator

What will I do?

Machine operators play a major role in producing most everything we rely on every day. They use machine tools, such as lathes, milling machines, and spindles, to produce parts. Many machines are computer numerically controlled (CNC). Machine operators often plan the sequence of work, make the first production run, and choose which adjustments need to be made. Some machine operators specialize in one or two types of machinery, but most are trained to set up or operate a variety of machines. Working on different types of machines makes the work more interesting, but also requires workers to have a wider range of skills.

> Many machines are computer numerically controlled (CNC).

What training will I need?

Machine operators need a good knowledge of the machinery and the products being manufactured. Most employers prefer to hire applicants with good basic skills. Many require employees to have a high school education and to read, write, and speak English. Good communication skills, mechanical aptitude, manual dexterity, and experience working with machinery are also helpful. High school courses in math, shop, computers, and blueprint reading are also very useful. Those interested in becoming machine operators should be mechanically inclined, able to work independently, and able to do highly accurate work that requires concentration and physical effort.

How can I get it?

Machinists train in apprenticeship programs, informally on the job, and in high schools, vocational schools, or community or technical colleges. Many machine operators learn their skills on the job. Trainees begin by observing and assisting experienced workers, sometimes in formal training programs. Eventually, they become responsible for their own machines. Some companies have formal training programs for machine operators. These programs often combine classroom instruction with on-the-job training.

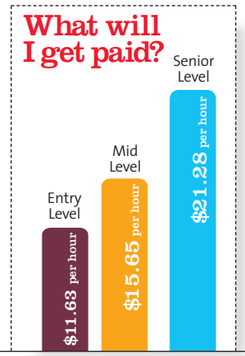


CHART SOURCE: U.S. DEPT. OF LABOR, BLS

Q&A Heather Ziemba, 26

Behlen Manufacturing, Columbus, Neb.

CNC Machine Operator

Q: How did you decide to become a CNC Machine Operator?

A: I was looking for a career that would offer variety, challenge, and growth opportunities. This job helps me learn important technical skills, and working as a CNC machine operator gives me opportunities to move within the industry. Many manufacturing companies use similar machines, which are operated automatically rather than manually, and it provides me with valuable, marketable skills.

Q: How did you get your current job?

A: I worked at several manufacturing companies and took technical classes such as welding. When I applied for a job at Behlen Manufacturing, my previous work experience and courses helped me land the job.

Q: What do you do in your job?

A: I use different types of machinery to make parts. Each day, I receive a list showing the types and number of parts that need to be made. I type in the part specifications to adjust the machine's settings. I get the type of metal that is used to make the part, and I start making them. I work on several types of machines during each shift.

Q: Why do you like your job?

A: There is never a dull moment in my job. There are lots of activities on the floor, and there is a lot of camaraderie between the operators. There is always something new and challenging.

PHOTO THIS PAGE: COURTESY OF BEHLEN MFG. CO.; OPPOSITE PAGE: COTY: ANDY GOODWIN; KEITH: LEE WHITE

Q&A Coty Weil, 29

Ford Motor Company, Kansas City, Mo.

Robotics Operator

Q: How did you decide to become a robotics operator electrician?

A: After high school, I took a job on the production line at the Ford plant to earn extra money for college. The company offered an apprenticeship test and I decided to take it. I scored high enough on the test and was offered an apprenticeship.

Q: How did you get your current job?

A: The apprenticeship consisted of taking college courses and working a certain number of hours to gain on-the-job experience. Ford sent me to college, where I took classes in electricity, math, electronics, industrial electricity, and computers. I graduated in 2001 and went back to work for Ford. Two years ago, I moved to the body shop and began my current job.

Q: What do you do in your job?

A: I am responsible for one of the robotics operation lines. I watch the line and fix any problems that may come up. Sometimes a piece of material will get stuck on the welding robot while other times the metal parts aren't bent right and the robots aren't able to see the parts and move them through the line. Robots are unpredictable so anything could happen.

Q: Why do you like your job?

A: The troubleshooting aspect is really interesting. You have to know how the stuff works because it can be tricky when the problem isn't as obvious as a broken wire. I like working with robots and automation. I find it very interesting.

Q&A Keith Kamel, 29

Sports Illustrated, Time Inc., New York, N.Y.

Assistant Operations Manager

Q: What do you do?

A: From a production standpoint, I am the voice of Sports Illustrated to the outside world. I give manufacturing instructions to printing experts, and try to get the magazine printed in the most efficient way possible. I talk with people in other departments to make sure that enough paper is ordered for printing, and I make certain that it gets to the printing plant on time. I also ensure that the magazines get from the trucks to the newsstands on time. We need to make sure that we're building well-constructed magazines that can go out in a timely fashion, while saving Time Inc. money.

Q: What's the best part of your job?

A: Having the magazine at the end of the week. There's a lot of work that goes into it beforehand—from the paper, color, the inserts, to the way the magazine is produced. It's nice to be able to see your work at the end of the day.

Q: Where do you see yourself in five years?

A: Working at a magazine as a manager or director.

Q: What's so great about the printing world?

A: It's exciting to be part of the big world of publishing and production. You get to be part of making a product for a consumer to buy or read. And whether you realize it or not, you are part of the news.

Engineer

What will I do?

There are many different branches of engineering, such as manufacturing, chemical, electrical, mechanical, aerospace, and industrial engineering. Engineers rely strongly on creativity, academic skills, and technology to solve problems. They use math, science, and computers to model real life situations and design new products. Most engineering work is easy to recognize—computers, airplanes, snow boards, televisions, large buildings, DVDs, and cars. Engineers need to stay up-to-date with new technologies because they are responsible for making sure that their design can be built easily, easily installed and maintained, functions properly, and is not too expensive to produce.

> It is essential for engineers to stay up-to-date with new technologies.

What training will I need?

A bachelor's degree in engineering from a four-year university is required for almost all entry-level engineering jobs. It's necessary to study math, science, English and writing. Engineers spend a great deal of time writing reports and consulting with other engineers, so communication skills are important.

How can I get it?

The U.S. is renowned for its engineering schools. Bachelor degree programs typically take four years. In a typical curriculum, the first two years are spent studying math, basic sciences, introductory engineering, humanities, and social sciences. In the last two years, most courses are in engineering, usually with a focus in one branch. It is also a good idea to participate in an engineering internship while in college. It offers you a chance to apply classroom knowledge to a work situation.

What will I earn?

Starting salaries are higher than many other jobs. A recent survey found that engineers with bachelor's degrees and less than a year's experience earned over $43,000. Depending on experience and discipline, salaries range from $40,000 to more than $100,000 a year.

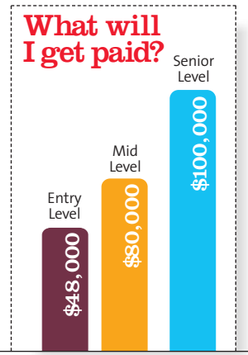


CHART SOURCE: U.S. DEPT. OF LABOR, BLS

Q&A Fred Siebert, 25

The Boeing Company, Seattle, Wash.

Manufacturing Engineer

Q: What does Boeing do?
A: Boeing is the world's leading aerospace company and the largest manufacturer of commercial jetliners and military aircraft, with capabilities in rotorcraft, electronic and defense systems, missiles, satellites, launch vehicles and advanced information and communication systems.

Q: What's a typical day at the office for you?
A: On a typical day, I work with a diverse group of people to solve a problem or build a product. I work with aerospace technology to develop high-quality assemblies that make it possible to put an airplane together easily and efficiently on the factory floor, and I always keep manufacturing in mind.

Q: What do you like about your job?
A: I face new challenges every day and I get to work with people from around the world. One moment I'll be meeting with an airline customer and the next minute I'll be talking to a mechanic on the floor. There are exciting technologies that go into building an airplane and I like being part of this process.

Q: What would interest others about your job?
A: Putting an airplane together is an amazing experience. Watching the final assembly and then seeing the airplane fly away is incredible. Plus, there are many opportunities to work with new technology.

PHOTO THIS PAGE: COURTESY OF BOEING; OPPOSITE: DANYELLE: BRANT BULGARELLI; YONGFA: ROBERT CARDIN

Q&A Danyelle Sinclair, 23

Bristol-Myers Squibb, New Brunswick, N.J.

Pharmaceutical Process Engineer

Q: How did you start out in your career?
A: I graduated from Carnegie Mellon University with a B.S. in Chemical Engineering. I started with Bristol-Myers Squibb in June 2004 as a process supervisor in our bulk pharmaceutical pilot plant. In this role, I made the active ingredients for drugs to be used in clinical trials. Then I became involved in transitioning a process that was created in the laboratory to a larger scale in our pilot plant. I was in charge of setting up the process, managing the process and operators, and ensuring that we created a quality product.

Q: What are you working on now?
A: Currently, I'm working on the qualification, validation, and start up of our sterile filling facility. In this facility we will make clinical supplies of injectable drugs. This facility also has an advanced process control and data collection system.

Q: Why do you like your job?
A: It's wonderful to go to work every day knowing that what I am doing and the drugs I'm creating will help someone feel better.

Q&A Yongfa Fan, 35

Intel Corp., Santa Clara, Calif.

Senior Process Technology Development Engineer

Q: How did you decide to work in the semiconductor field?
A: I pursued this job for several reasons. I was interested in physics and electronic devices, and there is a very high demand for well-educated engineers in this industry. The U.S. is a great place to study to become a semiconductor engineer and there are many excellent opportunities for work.

Q: How did you get your current job?
A: I graduated from university in China with a degree in polymeric materials. I worked as a professor for two years before coming to the U.S. I completed two master's degrees in materials science and in microelectronics manufacturing. I then began working on my doctorate degree in microsystems engineering. I worked on a research project that caught the attention of my current employer, Intel Corp., and when I finished my doctorate, I was offered my job.

Q: What do you do in your job?
A: I mostly work with new technologies in the lab. I research and experiment with materials. Sometimes I use a computer to do design simulations. My work is a key step in integrated circuits manufacturing.

Q: Why do you like your job?
A: My job is full of challenges. No two days are alike. Everyday, I face a new challenge and that keeps my work exciting and interesting.

Something for EVERYONE

Plastics Fabricator

What will I do?

It would be nearly impossible to list all the things that plastic fabricators create. You can see their work everywhere you look. They make the plastic and composite parts that are used on everything from airplanes to the soles of your shoes, and all the things in between. Many plastic fabricators use different kinds of synthetic compounds and work with high-tech machines in plants that manufacture products for just about every industry in the world.

> Plastics fabricators make the plastic and composite parts that are used on everything from airplanes to the soles of your shoes, and all the things in between.

How and where can I get my training?

You can start a career in plastics manufacturing in a variety of different ways. Many plastic fabricators start out with on-the-job training. More formal training is available by enrolling in industrial arts programs at technical and community colleges, pursuing an engineering or manufacturing degree at four-year universities, or by completing an apprenticeship program at a shop or trade union.

How much will I earn?

Plastic fabricators can work for an annual salary, or for an hourly wage. The amount a plastics fabricator can earn varies by region, type of work, or level of experience. Some earn entry-level wages and gradually increase their pay over time as they learn additional skills and advance within their companies. Those who start out by getting a college degree can expect higher pay, often taking salaried positions throughout the manufacturing industry. Apprenticeship programs allow students to earn an entry-level hourly wage while they study. Working with a union or firm also provides great hands-on experience.

What will I get paid?

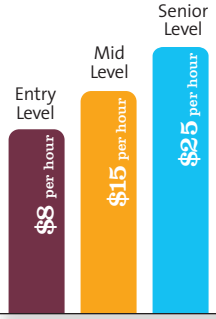


CHART SOURCE: U.S. DEPT. OF LABOR, BLS

PHOTO BY TOM BRIGLIA/PHOTOGRAPHICS

Q&A

Josh Williams, 28

The Board Factory, Melbourne, Fla.

Surfboard Maker/Entrepreneur

Q: What is your job?

A. I am the co-owner of The Board Factory. We make surfboards from expanded polystyrene foam, coat them with fiberglass cloth and epoxy resin, decorate them with artwork, then sell them. We just opened our business, but and it's going really well. As the co-owner, I am also involved in running the business and hiring workers.

Q: Where did you get your training?

A. I learned by working with other surfboard shapers and gradually mastered the process. I also worked for a guy who built racing boats out of composite materials and learned about the different materials involved in plastic fabrication. I've brought a lot of what I learned there into my work as a surfboard maker.

Q: Why did you choose your job?

A. I love surfing and I wanted to learn how to make my own surfboards. I learned the skills I needed over time and began making my own boards. My friend Ed Sixberry and I decided to go into business together and see if we could make it work. For me, doing a job related to surfing is ideal because there is always a beautiful ocean nearby.

Q: What are your goals for the future?

A. I want to continue developing this business and see how far we can take it. I have also developed my own board design using a fiberglass composite material that I learned about from the racing boat technology, and I want to continue to develop that.

Electromechanical Equipment Technician

What will I do?

Electromechanical equipment technicians install, maintain, troubleshoot, and repair a wide range of computer-driven manufacturing or automatic control equipment.

They must understand basic electronics and computer operating systems in order to work with a wide variety of equipment, systems, and manufacturing processes.

They use computerized equipment to calibrate or get data from electrical meters to diagnose problems. They may also help install and maintain power line equipment and systems. The main part of the job is assessing problems with electromechanical relays.

Sometimes, they need to disassemble the relay system to determine what needs to be repaired. Once the electromechanical relay is repaired, they will have to reassemble it.

> Electromechanical equipment technicians must understand basic electronics and computer operating systems in order to work with a wide variety of equipments, systems, and manufacturing processes.

What training will I need?

Most companies require a minimum two-year college degree. Related work experience is also very helpful.

How can I get the required training?

Many community colleges offer programs that combine classroom instruction with necessary hands-on experience. Basic skills learned in high school technical classes also help provide a foundation for learning the required skills. Courses in industrial automation, computer programming languages, and electrical principles, among others, are especially helpful. Once hired, many companies provide additional on-the-job training.

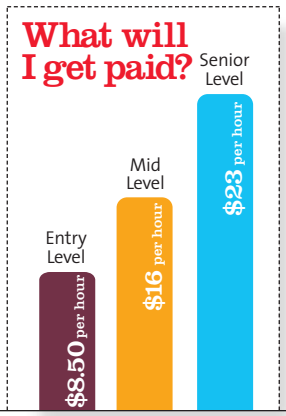


CHART SOURCE: U.S. DEPT. OF LABOR, BLS

Q&A

Adam Lowther, 22

American Electric Power, Tulsa, Okla.

Electromechanical Equipment Technician

Q: How did you decide to become an Electromechanical Equipment Technician?

A. I have always found electricity fascinating. I started out by studying networking, but after taking a class in electronics, I liked it so much that I switched my major.

Q: How did you get your current job?

A. I graduated from Texas State Technical College with a degree in Automation Robotics Technology. I took courses in electrical principles, solid state devices, industrial automation, and various programming languages. I learned how to use lathes, mills, and other equipment. Most of my classes involved lab work, which really helped me understand the lessons. My classes in relays and how to set them up to form a logic circuit as well as courses on using hand tools were also very helpful.

Q: What do you do in your job?

A. I perform daily functional tests of relays on electromechanical equipment. The relays are tested periodically as part of a preventive maintenance schedule. Sometimes the relays fail in service and I have to troubleshoot the relaying scheme to identify the problem. I also clean, perform tests, and calibrate different types of electromechanical relays. These tasks require knowledge of assembling machines, systems, and devices.

Q: Why do you like your job?

A. My job is very diverse and I get to do different things each day. I may be testing relays one day, and installing a new relaying scheme another. I like troubleshooting relaying schemes and using my knowledge of basic electrical principles and reading electrical diagrams. I like to study the logic and find out why something is malfunctioning. I enjoy the feeling of identifying a problem and correcting it. It gives me a rush!

Health & Safety Engineer

What will I do?

Health and safety engineers make sure that a workplace is safe. They inspect manufacturing plants, machinery and equipment to prevent injuries or accidents. For a company that deals with big machinery such as printing presses or oil rigs, they ensure that workers aren't put at risk on their job and that environmental standards are followed. They also coordinate worker training to guarantee that safety laws and regulations are followed, and review safety programs. Health and safety engineers also investigate accidents to determine cause and prevention.

> Health and safety engineers inspect manufacturing plants, machinery and equipment to prevent injuries or accidents.

What training will I need?

Health and safety engineers need to have a working knowledge of safety and environmental laws. They must be able to communicate problems and solutions to workers and employers. They must also be creative, pay attention to details, possess good leadership skills and have concern for others. Most jobs in this area require a four-year college degree. Some do not.

How can I get it?

You can study safety, industrial or general engineering at a four-year university and earn a bachelor's degree. You should also consider an internship. Once you are hired, you can expect on-the-job training from experienced engineers to help prepare you for your work.

How much will I earn?

In 2002, the median salaries received by health and safety engineers were $58,010 annually. The middle 50% received salaries, which lay between $46,580 and $71,980. The lowest 10% earned below $37,230 while the highest 10% earned above $87,250.

What will I get paid?

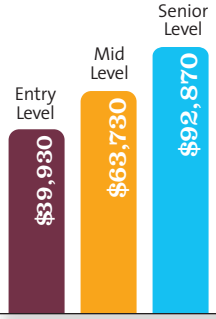


CHART SOURCE: U.S. DEPT. OF LABOR, BLS

Q&A

Brandon Farrison, 32

Pitney Bowes Management Services, Shelton, Conn.

Health and Safety Team Leader

Q: What does your company do?

A. We handle several large customers who do the same things we do, print and insert mail. We do their jobs for them in case of an emergency or a natural disaster. For example, we handled a lot of printing for the Federal Emergency Management Agency during the Hurricane Katrina disaster. Many people needed help after the hurricane so we printed and mailed millions of loan applications and letters of solicitation.

Q: What do you do as a safety team leader?

A. I'm the chair of our safety committee, and my main responsibility is to coordinate ways to make sure that our safety policies are followed. We have print, insertion and warehouse teams. We have to make sure that the manufacturing equipment that our operators use is safe. I keep a record, daily or weekly logs, of all our inspections.

Q: How did you enter this career path?

A. I started as a paper cutter nine years ago, and from there I worked my way up into network operations. It didn't happen overnight. I don't have a college degree but that hasn't been a detriment. I stayed focused and I learned continuously.

Q: What's the best part of your job?

A. I love that my job is diverse. My primary responsibility is to operate our printing equipment but I am also responsible for safety. I really like multi-tasking!

Process Control Technician

What will I do?

Process control technicians make sure that products are manufactured consistently and according to their original design. They ensure that there is no variability from one part to the next on the assembly line. They install, set up, and service the electronic and computerized equipment that control machines and production processes in manufacturing plants. There are many industries, such as clothing, transportation, paper products, chemical, and electronic device manufacturing, that need process control technicians.

> Process control technicians need to have a technical understanding of how things are manufactured.

What training do I need?

Process control technicians need to have a technical understanding of how things are manufactured. They also should be good at math and science, enjoy working with electronics and computers, have a knack for repairing things and like to solve problems. They need to be able to work well with others, and be able to multi-task.

How can I get it?

Requirements for becoming a process control technician vary depending on the industry. In many cases, you will need a high school diploma or a GED, and a two-year certificate from a college or technical school with a focus in manufacturing processes. For very technical fields, you will need a Bachelor of Science degree from a four-year university.

What will I get paid?

The average starting wages for an entry-level job as a process control technician can range from $20,000 to $30,000 per year. With more experience, process control technicians can earn in excess of $50,000 per year.

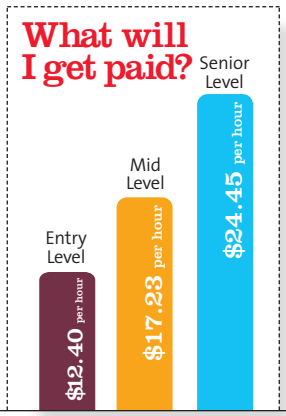


CHART SOURCE: U.S. DEPT. OF LABOR, BLS

Q&A

Qimei He, 26

Cels Enterprises, Inc., Los Angeles, Calif.

Footwear Line Builder

Q: What do you do as a footwear line builder?

A. I design and assist in developing and manufacturing lines of shoes for Chinese Laundry, which is a brand of fashion footwear for young women. It's my job to help design shoes and then make sure they're manufactured according to the design.

Q: How involved are you with the manufacturing process?

A. I research colors and materials for new lines of footwear, and meet with salespeople and buyers in the industry. I do technical sketching of the shoes, and define the details so that prototypes can be made. I also work with the manufacturing staff to make sure that the prototype shoes match the original design. I spend part of the year traveling overseas for my job.

Q: What is the best part about your job?

A. The best part has to be traveling to different countries, meeting new people, and checking out new fashion trends. More importantly, it's amazing to see my designs being produced, worn by famous celebrities, and published in magazines.

PHOTO: SANG PARK

Fixture Designer

What will I do?

Fixture designers create parts and models using an automated process called rapid prototyping. Rapid prototyping is a type of computer-aided manufacturing that takes a 3D graphic image and turns it into an identical physical model, which is usually made out of plastic. Many industries use rapid prototyping to make sure that a finished product will work for a design. For example, a fixture designer working on a truck will need to use rapid prototyping to create power train and transmission controls to make sure that they actually fit in the vehicle. Fixture designers work in many fields including aerospace, automotive, medical, and industrial.

> Rapid prototyping is a type of computer-aided manufacturing that takes a 3D graphic image and turns it into an identical physical model, which is usually made out of plastic.

What training will I need?

Fixture designers need good problem solving, communication, and teamwork skills. Software and machine knowledge and a good understanding of various materials is also important. High school students interested in a career in rapid prototyping and fixture design should take classes in math, science, and English.

How can I get it?

Some positions might require a Bachelor of Science degree in engineering or a related discipline. Others might require an associate degree from a two-year college or technical school. Rapid prototyping software, such as CAD/CAM, can be learned at school or through on-the-job training. It is also useful to have a career-related experience, such as an internship, to help you land your first job.

What will I get paid?

Salary in this position varies depending on the specific field, job, and education level.

What will I get paid?

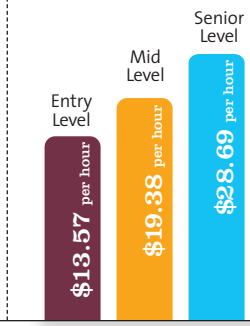


CHART SOURCE: U.S. DEPT. OF LABOR, BLS

PHOTO: ANDY GOODWIN

Q&A

Samantha Hoxie, 25

Hanger Orthopedic, Oakbrook Terrace, Ill.

Prosthetist

Q: What do you do as a prosthetist?

A. I fabricate, fit, and clinically manage prosthetics for amputees. I scan the patient and create a socket mold (or prototype), which is then sent to a technician for fabrication. I then fit the prosthetic to the patient.

Q: Why did you want to pursue this career?

A. When I was in the eighth grade, I went to the Paralympics. I knew I wanted to go into the medical field, so when I saw the athletes being fitted for their prosthetics, it really sparked my interest. From there, I studied kinesiology in college, completed a few internships, and then got my prosthetic certification. I love my job at Hanger Orthopedic.

Q: What sort of skills do you use on the job?

A. I work with many tools throughout the day and use my hands quite a bit too. I also use 3D computer programs, such as CAD/CAM, to design the socket mold. I need to learn how to use different materials because heat and cold will affect the prosthetic.

Q: What do you love about your work?

A. As a prosthetist, I get to help people walk again. I work with a lot of people who have lost their legs because of a vascular disease, such as diabetes. I also work with people who have lost their arms in traumatic accidents. I'm giving them back a way of life that they need, deserve, and should have. Everyday I leave my work thinking, "wow, I've really helped someone."

Food Inspector

What will I do?

Every industry employs its own types of inspectors. Inspectors in the food and beverage industry make sure that products such as soft drinks, candy, and French fries meet required quality standards and are safe for people to consume. They are often employed by food processing plants that use large machines to process and produce huge quantities of food and beverage for our consumption.

The federal government wants to make sure that the food is safe, and federal employees routinely inspect food processing plants. Companies have similar quality control standards in place to make sure that food processing guidelines are being followed. To do this, companies hire inspectors to check food as it travels through the assembly line. Inspectors look for any problems and work with managers to make sure contaminated food doesn't end up on grocery store shelves.

> Food Inspectors are often employed by food processing plants that use large machines to process and produce huge quantities of food and beverage.

What training will I need and how can I get it?

Food inspectors need to know all the various types of contamination to look for. And the inspections will be different, depending on what is being manufactured. For instance, food inspectors dealing with perishable items such as meat and milk products will have to test the temperature to make sure the food hasn't spoiled. In other food processing plants, inspectors check for cleanliness and overall quality. Food processing plants are usually large and use lots of machinery. Sometimes, wood fibers or other contaminants fall into the food. Food inspectors need to make sure that contaminated food is disposed of properly rather than packaged and sold. The majority of inspectors training occurs through company on-the-job programs.

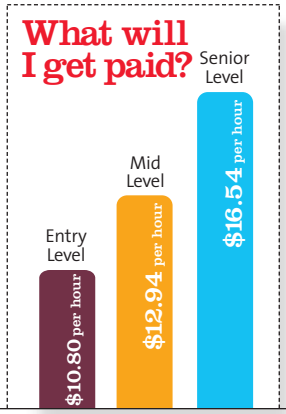


CHART SOURCE: U.S. DEPT. OF LABOR, BLS

Q&A

Jessica Rodriguez, 19

J.R. Simplot Co., Nampa, Idaho

Food Packer/Inspector

Q: How did you decide to become a food packer and inspector?

A. I was working as a customer service representative at a recycled clothing company but I wanted a job that offered better pay and more opportunities for promotions. So, I started looking for a position in the manufacturing industry. I was hired at J. R. Simplot about a year ago and for two weeks I trained with a mentor to learn my job. Since then, I have been working on my own.

Q: What do you do in your job?

A. I work packing and inspecting. Part of my day is spent in the packaging area where I package different foods, such as French fries. I also work as an inspector. I check the food for anything that accidentally gets in, such as wood fibers or pieces of plastic.

Q: What do you like about your job?

A. I like that I have a role in helping keep people safe. It's ultimately my responsibility to make sure that the food isn't dirty, spoiled, or otherwise contaminated. I like that I have a job where I can learn new skills that help me grow and provide promotion opportunities. I also like the fact that I get to move around between stations.

Something for EVERYONE

Metal Fabricator

What will I do?

You can thank metal fabricators for creating many of the things we use in our daily lives. They are the people who cut, form, and shape metals to make parts for automobiles, household appliances, or things we use for work and play. Many metal fabricators work in plants or shops and use different kinds of high-tech and computerized machines to mass produce practically every kind of manufactured metal product. They fabricate and fit parts of metal structures, such as frameworks or shells for machinery, and metal parts for buildings and bridges. They use lathes, presses, and drills to produce a variety of metal tools and appliances. Some metal fabricators work independently and manually create custom parts for a variety of uses.

> Metal Fabricators cut, form, and shape metals to make parts for automobiles, household appliances, or things we use for work and play.

What kind of training do I need and where can I get it?

Community colleges, universities, and apprenticeship programs are all good places to start a career in metal fabrication. Schools offer degrees in metal working and industrial arts, while apprenticeship programs combine academic study with hands-on work experience at manufacturing plants. Education levels can range from a four-year college degree in manufacturing, or a four-year apprenticeship at a trade union or private shop, to an Associate degree in metal technology at a community college. Metal fabricators can also get on-the-job training at manufacturing plants, learning the trade while they work.

What will I earn?

Most metal fabricators work for an hourly wage, which can vary by region, type of work, or level of experience. While many start at entry-level wages and work their way up the ladder others start with some type of college degree.

What will I get paid?

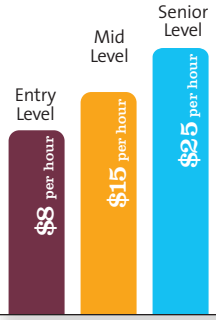


CHART SOURCE: U.S. DEPT. OF LABOR, BLS

Q&A

Daniel McGee, 21

E.J. Ajax Co., Fridley. Minn.

Metal Fabrication Intern

Q: What is your job?

A. I work in a metal fabrication shop as an intern making metal parts. Right now, we are fabricating handcuffs, hinges, and metal framing. I use a lot of different tools, such as punch presses, forming presses, drilling and tapping tools, and lathes.

Q: Where did you get your training?

A. I am enrolled in the machine tool technology program at Minneapolis Community and Technical College, where we learn how to use many different types of metal-working machines. We also learn metallurgy, geometric tolerances, and a lot of math like algebra and trigonometry.

Q: Why did you choose this job?

A. When I started looking for jobs, I knew I didn't want to work in an office. Working in a metal shop is real hands-on stuff and I really like that. There is a perception that people do blue collar jobs because it's all they can do, but I disagree with that. This is the only kind of work I want to do. The best part is that I am always working on something different.

Q: What are your goals for the future?

A. I want to become more experienced in all the different metal fabrication fields and learn everything there is to know about this job. I may go on to college next year and earn a bachelor's degree in industrial technology.

PHOTO BY STEPHANIE RAU

Machine Tool Tester

What will I do?

Machine Tool Testers are responsible for ensuring that machine tools and parts meet required industry quality standards. Sometimes, manufacturing tools can malfunction, which leads to the production of defective parts. To prevent that from happening, machine tool testers inspect parts as they come off the assembly line. Many testing devices and machines are used. Some devices might test the density, dimension, or function of a tool. Machine tool testers are responsible for completing these tests and alerting managers if the tools fail to meet the desired standard. They often monitor several different types of parts and tools daily to ensure that they all meet top-quality standards.

> You will need good math skills and experience in using several types of measuring tools.

What training will I need?

You will need a high school diploma or a GED to qualify for most machine tool tester jobs. Once hired, the company will usually train you to do your specific job. Most companies also provide related classes at work or at a nearby community college. Mechanical aptitude, communication skills, and good hand-eye coordination and vision are very also very helpful for this position. Training for new inspectors may cover the use of special meters and gauges, quality-control techniques, blueprint reading, and safety requirements. Also, since inspection equipment is becoming more automated and the test results are recorded electronically, computer skills are important.

How can I get it?

Some of these skills can be learned by taking math and technical classes in high school. Community colleges and apprenticeship programs offered by companies or trade unions are other possible sources. For those looking to advance to more senior positions, training in statistical process control, new automation, or quality assurance policies are required.

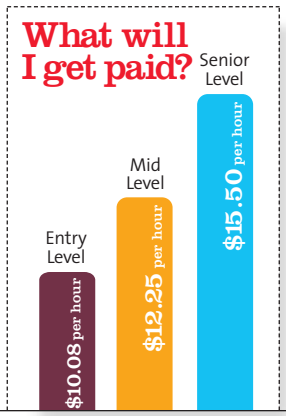


CHART SOURCE: U.S. DEPT. OF LABOR, BLS

Q&A

Shannon Venlet, 22

Trans-Matic Manufacturing Comp. Inc., Holland, Mich.

Machine Tool Tester

Q: How did you decide to become a machine tool tester?

A. After high school, I started working for ManPower Inc.—a company that supplies temporary workers to other companies. That allowed me to try out different jobs for short periods of time.

Q: How did you get your current job?

A. After working for four months as a temporary employee for Trans-Matic in the sort-and-pack area, I heard about an opening as a machine tool tester. I applied for the position and got it. Once I was hired, I trained one-on-one with another machine tool tester for about two months. I also took several classes in safety, quality production assurance, and other subjects that were offered by Trans-Matic.

Q: What do you do in your job?

A. My main job is to check the parts coming off the different presses. I am responsible for up to six machines making various types of metal products. All parts coming off the machines are inspected visually first for any defects and then go through further inspections in the company laboratory.

Q: Why do you like your job?

A. I am the first line of defense against defects for my company's products. Work hours fly by when you are racing between six different presses and checking all types of parts—automotive, plumbing, compressors, etc. And, that is fun and challenging!

How NANOTECHNOLOGY Is Changing Manufacturing

By Otis Port

Advanced manufacturing provides a platform to make new discoveries and push technology to higher levels. More than 60% of all U.S. research and development is aimed at manufacturing, according to the National Association of Manufacturers.

One exciting area is plastics. Ordinary plastics are insulators, which is why extension cords are coated in them. But by changing their conductive property, researchers envision creating paper-thin films that can turn entire walls into video screens. It could also create folding computer displays that could be stuffed into a purse or shirt pocket. Conductive-plastic coatings could also turn roofs into solar-power generators. And clothes with conductive textile fibers could generate juice for cell phones, iPods, and similar gadgets!

The promise is so huge that researchers and scientists at most major chemical companies are racing to develop conductive plastics. One firm, Konarka Technologies Inc., in Lowell, Mass., has already produced prototype roofing materials and fabric for Army tents that make electricity from sunlight.

When might we see wall-size, paper-thin displays? Perhaps next year, but more likely in 2008. "It's now only a question of when, not if," says Richard D. McCullough, co-founder of Plextronics, Inc., Pittsburgh, and dean of Carnegie Mellon University's College of Science.

Materials science covers more than plastics. Everywhere you look, a revolution is brewing. By 2025 or so, the silicon chips in today's computers could be replaced by materials with phenomenal properties that could cram the punch of a supercomputer into a box the size of an iPod!

Recently, a research team at Emory University uncorked a new form of platinum. This metal is used in catalytic converters to absorb pollution from car exhausts. The new compound may help extract hydrogen from water. Cars that run on hydrogen instead of gasoline do not produce air pollution.

The key to these advanced materials is nanotechnology—the ability to tinker with materials at the molecular level. "Nano" comes from "nanometer." That's one-billionth of a meter (a meter is 39.4 inches). How tiny is that? Well, if a strand of your hair were as wide as the lower 48 U.S. states, one nanometer would be shorter than a football field!

With nanotech tools, researchers can precisely tailor the properties of materials for specific jobs. They can create "magic molecules" that do "crazy things," according to Harold W. Kroto, a professor at Britain's University of Sussex. He shared the 1966 Nobel Prize in chemistry as a co-discoverer of Buckminsterfullerene. Better known as the buckyball, this is a carbon molecule that looks like a nanometer-size soccer ball.

Here are a few of the amazing things that are happening in the nano world:

GOLD: changes color, becoming an intense red when shrunk to 30-nanometer particles. A wire made from nano nuggets is 20 times stronger than the gold in a wedding ring.

GALLIUM: a metal used in light-emitting diodes (LEDs), melts at 86ºF. When whittled down to a nano clump of only 39 or 40 atoms, gallium won't melt below 530ºF. Smaller 17-atom clusters remain solid up to 980ºF.

CARBON: the soft stuff in pencils becomes 100 times stronger than steel when formed into nanotubes. These hollow nano-size straws weigh only one-sixth as much as steel.

> As nanotech moves from research into manufacturing, it will unleash a host of outstanding products.

As nanotech moves from research into manufacturing, it will unleash a host of astounding products, predicts Kroto. Cars with engines, bodies, and tires made from nanotube mixtures might be so light that they could go 400 miles on a gallon of fuel.

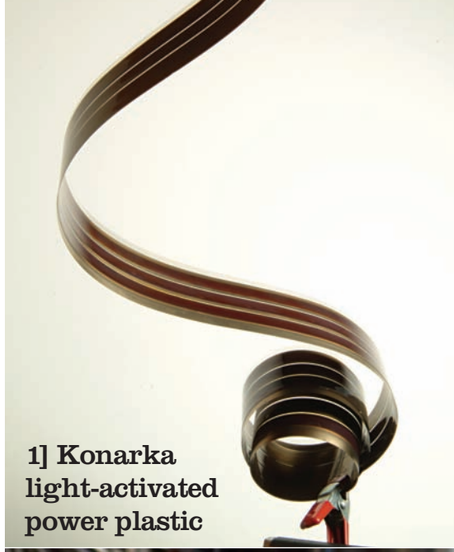
Computer makers are developing chips with nanotube wires to boost performance as much as 1,000 times.

Drug manufacturers are stuffing medicine inside buckyballs. They are also placing sensors on the outside so they will hunt down and attack the cells or viruses responsible for illness.

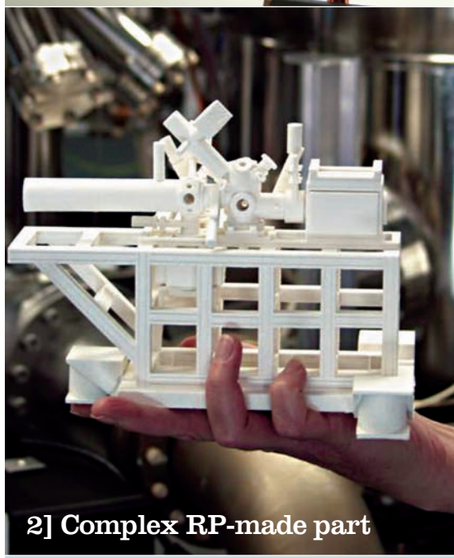
Therics, Inc., Princeton, N.J., already prints porous-ceramic implants for fixing damaged bones. The pores are just the right size for natural bone to grow into and complete the repair. It's a brave new nano world!

PHOTO: COURTESY OF BAYER MATERIAL SCIENCE

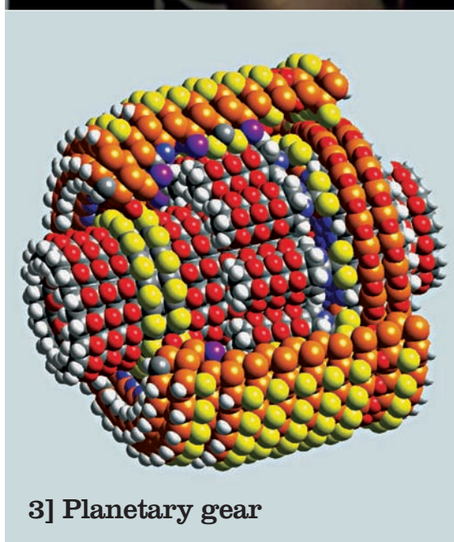
BOTTOM IMAGE COURTESY OF FORESIGHT INSTITUTE, MIDDLE PHOTO COURTESY OF UNIVERSITY OF ALBERTA, TOP PHOTO COURTESY OF KONARKA TECH., INC.



1] Konarka light-activated power plastic



2] Complex RP-made part



3] Planetary gear

Photos from top to bottom:
1) Tiny solar cells printed on plastic by Konarka Technologies generate electricity.
2) 3D model of industrial vacuum system was printed by a Z Corp. inkjet printer.
3) Concept of a futuristic planetary gear assembled from individual atoms.

START-UPS SPELL SUCCESS

By Otis Port

Although manufacturing workers earn nearly 25% more than the average American, some people simply don't want to work for anyone else. If you have this entrepreneurial spirit, advanced manufacturing holds more opportunities than you may suspect.

One reason is that most manufacturing is not done in huge plants with hundreds of workers. In fact, more than 90% of all manufacturers have fewer than 100 employees, and over 50% have less than 10 people. A good example is Silicon Solar Inc., an eight-person producer of solar-energy panels and solar-powered outdoor lighting. Located in Bainbridge, N.Y., the company was founded by Adam Farrell in 1999 when he was 15 years old. Annual sales have grown to $1 million.

Silicon Solar markets its products to the public, but most small manufacturers do not. They sell only to other companies. New United Motor Manufacturing Inc., which has a large factory in Fremont, Calif. builds three vehicles—Toyota's Corolla and Tacoma as well as Pontiac's Vibe. Under those hoods are parts and components from 1,000 suppliers, mostly small, local manufacturers.

Manufacturing alloy steels

PHOTO COURTESY OF THE MANUFACTURING INSTITUTE

More than 90% of all manufacturers have fewer than 100 employees, and over 50% have less than 10 people.

Another reason is that a technological revolution is rippling through advanced manufacturing. Called Nanotechnology, it is the ability to assemble things from individual molecules. Officials at Lux Research Inc., N.Y.C., predict that nanotechnology will transform advanced manufacturing, everything from steel and plastics to pharmaceuticals and cosmetics to computers and semiconductor chips. Nanotech may nurture tomorrow's manufacturing icons, just as electronics gave rise to IBM, Intel, Motorola, and Texas Instruments.

One pioneer is Nanosys Inc., Palo Alto, Calif. This company is only five years old and has fewer than 50 employees. It has raised $125 million from investors and nearly $15 million in federal contracts and grants to help perfect a new type of solar cell. Based on nanotechnology developed by chemists at Harvard University, the solar cells will be printed on thin sheets of plastic. Soon, roofs may sport almost unnoticeable generators that turn sunlight into electricity for a fraction of the cost of today's solar cells.

Nanosys has more nanotech irons in the fire. They include miniature chemical laboratories for drug research and fuel-cell batteries for iPods and cell phones that don't need recharging. Instead, fuel cells release the energy in a liquid fuel such as alcohol so they can be refilled. Nanosys already has big-name collaborators including Intel, DuPont, and Sharp Electronics.

Many nano start-ups are now being showered with investor money, even firms created by students. Timbre Technologies Inc., Santa Clara, Calif., was the brainchild of graduate students at the University of California at Berkeley who devised a better way to spot defects in the ultra-tiny circuit lines on computer chips. They founded Timbre in 1999 and sold it in 2001 to Tokyo Electron Ltd.—for a whopping $138 million!

That's hardly typical, of course. For most manufacturing entrepreneurs, starting a business is a real struggle, and it never ends. "Every day is rough when you own your own business, but for me there's no other way," says Christopher Cole, president of Cole & Co. This Dallas maker of upscale bathroom vanities was launched in 2001. The venture is his first in manufacturing, although he owns two earlier start-ups—an advertising agency and a homebuilding company. Apart from summer and part-time jobs in school, Cole has never worked for anyone else. "Both my parents and my grandparents were entrepreneurs," says Cole, now 38. "It's in my blood."

Cole had the cash to launch Cole & Co. himself, but for entrepreneurs who don't, family and friends are the usual sources of start-up funds. Another is the Band of Angels in California's Silicon Valley. Its members are so-called angel investors—wealthy people who are willing to bet $10,000 to $20,000 on a new company, despite the risk. They know that nine out of ten new ventures fail within five years. When more than $20,000 is needed, several angel investors often chip in.

Most states and some cities have programs to help start new businesses or keep them growing, as does the U.S. Small Business Administration. Once a company gets past the initial start-up phase, venture-capital firms stand ready to invest millions of dollars for part ownership.

If you have an entrepreneurial spirit, advanced manufacturing holds more opportunities than you may suspect.

Finally, despite reports to the contrary, not all American manufacturing is moving to other countries where workers earn lower wages. Japanese, Korean, and European car makers have all built big assembly plants in the U.S. Recently, a little plastics-molding company, 4-Sands Industries Inc. in Lebanon, Ohio, took on a large Chinese competitor and won. "They couldn't deliver parts with the required quality," says Dave Sizemore, who started 4-Sands in 1997.

Still, it's no secret that lots of manufacturing jobs have been lost in recent years. California now has 350,000 fewer factory workers than in 2001. Yet California still has 30,000 manufacturing and high-tech companies, which generate $250 billion a year and employ 1.5 million workers. It's also home to a hugely successful start-up company: Haas Automation Inc., Oxnard, Calif.

Twenty-five years ago, Gene Haas had a five-person manufacturing shop. Last year, his privately-owned firm sold more than 10,000 machine tools and raked in $600 million in revenues. It even exported 500 machines to China.

Advanced manufacturing entrepreneurial hopefuls "should go see Gene," says David Goodreau, chairman of the Small Manufacturers Association of California. "He finances his own equipment, and if he looks at you and sees talent and determination, he'll find a way to get you the equipment you need."

Christopher Cole

Fun Facts
About Advanced Manufacturing

1. How long does it take to make jelly beans?

Answer: 7 to 10 days! Once the center of the jelly bean, which contains its flavor is made, it has to be cooled completely before it can get the right color. The jelly beans then go through the "painting" process several times to get their color. After the jelly beans are colored, they are first inspected by machines and then by hand to make sure that they are the right color and size. Finally, the jelly beans can be packaged and shipped.

2. What products are made from recycled plastic soda and juice bottles?

Answer: They are used to make carpets, insulating materials in clothes and sleeping bags, auto parts, paintbrushes, and other things like tennis balls!

3. How are CDs manufactured?

Answer: A Compact Disk, or CD, is a simple piece of injection-molded clear plastic, about 1.2 mm thick. Once the plastic is formed, a thin, reflective aluminum layer is placed onto the disc followed by a thin acrylic layer to protect it. The label is then printed onto the acrylic and the CD is finished. After the manufacturing process is complete, the CDs are ready for music which can be downloaded from any PC.

4. How much paper is used in the U.S. each year?

Answer: Americans use about 187 billion pounds of paper a year.

5. How many 12-ounce soft-drink bottles can be filled in one minute?

Answer: 850 bottles!

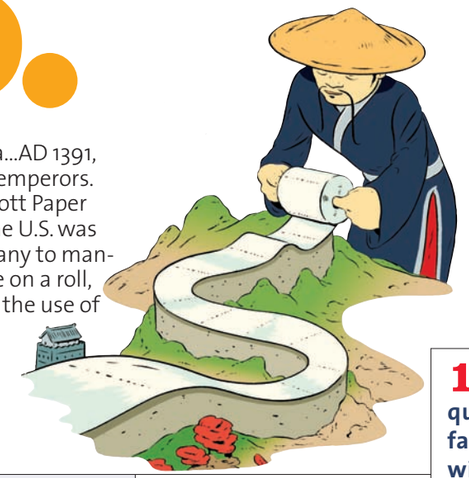
6. What is the largest manufacturing industry in the world?

Answer: The automobile manufacturing industry. There are about 400 million cars and light trucks in the world today.

7. When and where was the first bicycle made?

Answer: The first bicycle was made by Baron von Drais in Germany in 1817 and it was similar to a scooter. It was almost completely made of wood. Riders propelled it by pushing their feet against the ground.

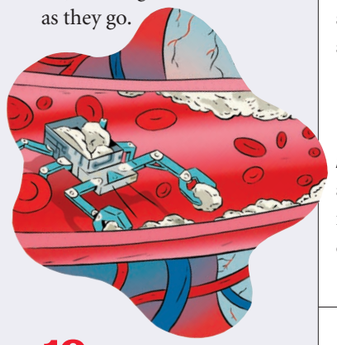
8. When and where was toilet paper first invented?



Answer: China...AD 1391, for use by the emperors. In 1890, The Scott Paper Company in the U.S. was the first company to manufacture tissue on a roll, specifically for the use of toilet paper.

9. What are micro-machines?

Answer: Some micro-machines are 1,000 times smaller than a human hair and can travel through the arteries, cleaning out cholesterol as they go.



10. How does an MRI machine work?

Answer: An MRI machine creates a magnetic field around the patient's body, sends radio waves through the body, and then measures the response with a computer. This creates a picture of the inside of the body so doctors can determine the best diagnosis and treatment.

11. What are nanomaterials?

Answer: Nanomaterials are tiny materials manufactured atom by atom. A nanometer is one billionth of a meter—10 nanometers is 1,000 times smaller than the diameter of a human hair.

12. What are most backpacks made of?

Answer: Many backpacks are made from synthetic fabrics that are derived from coal and oil by-products.

13. What metal frequently used in manufacturing is compatible with human tissue and used as a biomaterial to replace human joints?

Answer: Titanium is light, strong, corrosion resistant, and easily formed. It is also used in airplanes, missiles, and space shuttles.

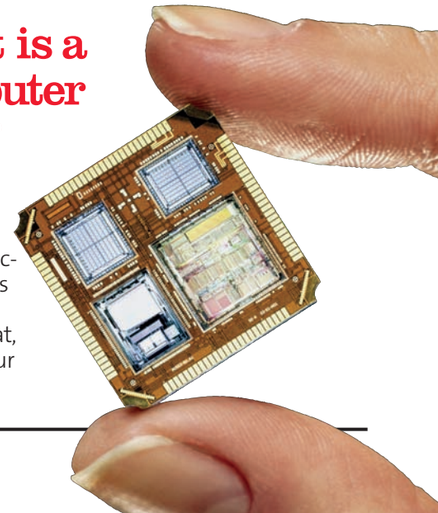
14. How many parts are there in a Boeing 747 airplane?

Answer: 6,000,000 parts, half of which are fasteners. At 31,285 cubic feet, the 747-400 has one of the largest passenger interior volume of any commercial airplane, which is equivalent to more than three houses each measuring 1,500 square feet.

15. What are the largest products manufactured in the world?

Answer: Ships. The Knock Nevis is a supertanker measuring 1,504 feet (over 1/4 of a mile) in length and 226 feet in width, making it the largest item manufactured in the world. If the Eiffel tower was laid on its side, it could easily be carried on the Knock Nevis.

16. What is a computer chip?



Answer: A computer chip, also called a semiconductor, is one of the smallest and most fragile products in the world. Each chip has more than 5.5 million transistors inside it. A speck of dust, a bead of sweat, or a strand of hair on a chip would be like a dinosaur footprint and could easily destroy the chip.

ILLUSTRATIONS BY ASON SCHNEIDER. BICYCLE PHOTO: BICYCLE MUSEUM OF AMERICA, NEW BREMEN, OH.; JELLYBEANS: ISTOCKPHOTO

PHOTOS: COMPUTER CHIP: GETTY IMAGES

Resource Guide

Dozens of professional organizations, government Websites and trade unions exist to help you learn more about advanced manufacturing careers. Here is a sampling of resources to get you started.

PROFESSIONAL AND INDUSTRY ORGANIZATIONS

American Academy of Environmental Engineers
(410) 266-3311
www.aaee.net

Accreditation Board for Engineering and Technology
(410) 347-7700
www.abet.org

Accrediting Commission of Career Schools and Colleges of Technology
(703) 247-4212
www.accsct.org

ACE Mentor Program
(203) 323-8550
www.acementor.org

Aerospace Industries Association
(703) 358-1000
www.aia-aerospace.org

American Academy of Environmental Engineers
(410) 266-3311
www.aaee.net

American Chemical Society
(800) 227-5558
www.chemistry.org

American Design Drafting Association
(731) 627-0802
www.adda.org

American Institute of Aeronautics and Astronautics
(703) 264-7500
www.aiaa.org

American Institute of Chemical Engineers
(800) 242-4363
www.aiche.org

American Iron and Steel Institute
202.452.7100
www.steel.org

American Society for Engineering Education
(202) 331-3500
www.engineeringk12.org

American Society for Quality
(800) 248-1946
www.asq.org

American Society of Mechanical Engineers
(800) 843-2763
www.asme.org

American Society of Safety Engineers
(847) 699-2929
www.asse.org

American Welding Society
(800) 443-9353
www.aws.org

ASM International
(440) 338-5151
www.asminternational.org

PHOTO: F64/GETTY IMAGES

Biomedical Engineering Society
(301) 459-1999
www.bmes.org

Board of Certified Safety Professionals
(217) 359-9263
www.bcsp.org

Electronic Industries Alliance
(703) 907-7500
www.eia.org

Federal Aviation Administration
(866) 835-5322
www.faa.gov/education

IEEE Computer Society
(202) 371-0101
www.computer.org

Independent Electrical Contractors
(703) 549-7351
www.ieci.org

Industrial Designers Society of America
(703) 707-6000
www.idsa.org

Institute of Electrical and Electronics Engineers
(212) 419-7900
www.ieee.org

Institute of Industrial Engineers
(770) 449-0460
www.iienet.org

Junior Engineering Technical Society
(703) 548-5387
www.jets.org

Manufacturing Skills Standards Council
(202) 429-2220
www.msscusa.org

Minerals, Metals, & Materials Society
(800) 759-4867
www.tms.org

National Association for Printing Leadership
(800) 642-6275
www.napl.org

National Association of Manufacturers/NAM
(202) 637-3000
www.nam.org
(NAM is the nation's largest industrial trade association, representing small and large manufacturers in every industrial sector and in all 50 states.)

National Center for Integrated Systems Technology
(815) 942-3180
www.ncist.ilstu.edu

National Center for Manufacturing Education
(937) 512-2365
www.ncmeresource.org

National Council for Advanced Manufacturing
(202) 429-2220
www.nacfam.org

National Council of Examiners for Engineering and Surveying
(800) 250-3196
www.ncees.org

National Council of Textile Organizations
(202) 822-8028
www.ncto.org

National Electrical Manufacturers Association
(703) 841-3200
www.nema.org

National Electrical Contractors Association
(301) 657-3110
www.necanet.org

National Institute for Certification in Engineering Technologies
(703) 548-1518
www.nicet.org

National Institute for Metalworking Skills
(703) 352-4971
www.nims-skills.org

National Society of Professional Engineers
(703) 684-2800
www.nspe.org

National Tooling and Machining Association
(800) 248-6862
www.ntma.org

Precision Metalforming Association
(216) 901-8800
www.metalforming.com

Precision Machined Products Association
(440) 526-0300
www.pmpa.org

Printing Industries of America/Graphic Arts Technical Foundation
(800) 910-4283
www.gain.net

Rubber Manufacturers Association
(202) 682-4800
www.rma.org

Semiconductor Industry Association
(408) 436-6600
www.sia-online.org

Society for Mining, Metallurgy, and Exploration
(800) 763-3132
www.smenet.org

Society of Automotive Engineers
(724) 776-4841
www.sae.org

Society of Manufacturing Engineers
(313) 271-1500
www.sme.org

Society of Petroleum Engineers
(800) 456-6863
www.spe.org

Society of Plastics Engineers
(203) 775-0471
info@4spe.org

Society of Plastics Industry
(202) 974-5200
www.plasticsindustry.org

Society of Women Engineers
(312) 596-5223
www.swe.org

Steel Manufacturers Association
(202) 296-1515
www.steelnet.org

Wood Products Manufacturers Association
(978) 874-5445
www.wpma.org

GOVERNMENT AGENCIES

U.S. Department of Labor Employment & Training Administration
www.doleta.gov
www.careervoyages.gov
(877) 872-5627

Occupational Safety and Health Administration
(800) 321-6742
www.osha.gov

MANUFACTURING UNIONS

AFL-CIO
www.aflcio.org
or call your local union

AFL-CIO Working for America Institute
(202) 974-8100
www.workingforamerica.org

Bakery, Confectionery, Tobacco Workers and Grain Millers International Union
(301) 933-8600
www.bctgm.org

United Auto Workers
(313) 926-5000
www.uaw.org

International Association of Machinists & Aerospace Workers
(301) 967-4500
www.iamaw.org

International Brotherhood of Electrical Workers
(202) 833-7000
www.ibew.org

International Brotherhood of Teamsters
(202) 624-6800
www.teamster.org

International Union of Operating Engineers
(202) 429-9100
www.iuoe.org

National Electrical Contractors Association
(301) 657-3110
www.necanet.org

National Joint Apprenticeship Training Committee
www.njatc.org

Sheet Metal Workers' International Association
(202) 783-5880
www.smwia.org

United Food and Commercial Workers
www.ufcw.org

NOTE: Websites and phone numbers change so you may need to do a web search or call Directory Assistance.

Achieving Success

Tips for Counselors, Teachers and Parents Helping Students Understand Advanced Manufacturing Careers

PHOTO: F64/GETTY IMAGES.

Tips for Counselors...

High school students need an expert to help them map out choices for their future. They turn to you as a professional counselor to show them paths they may not have considered. Advanced manufacturing is one of those hidden opportunities. The following suggestions will make it easier for you to steer your students toward this growing and dynamic field.

Showing the Way

You can talk to students realistically about what they can expect based on the amount of time they are willing to spend preparing for a career. Jobs in Manufacturing.com (**www.jobsinmfg.com**), a section of the Jobs in Logistics.com Website lists offerings from lots of cool companies kids will recognize. A great resource for students to compare salaries for different regions and occupations is CompGeo online (**www.compensation-online.com/oconlma.htm**).

Many students are surprised to hear about the great earning potential and variety of occupations in advanced manufacturing. Let students check out options on their own and then invite them to come back and talk about what they need to do to realize that potential.

Testing for Success

Sometimes students need to figure out who they are and what they want to do for themselves. Assessment, personality, and aptitude tests can be a great first step. The Website **www.dreamitdoit.com** includes an aptitude quiz that starts by asking the student to think of the one thing he or she likes to do best. Results are followed by links to resources for jobs, schools and internships.

Anyone who shows aptitudes in the areas of mechanical and analytical reasoning, trouble-shooting and problem-solving, spatial relations, or numerical ability might want to consider a career in manufacturing.

Charting a Course

Regardless of how students pursue a career in advanced manufacturing, you can stress the importance of math and science. If students do well working with their hands and enjoy being creative, steering them toward physics and geometry can give them the tools they need at every level of advanced manufacturing. However, what manufacturers say they need the most are basic employability skills. Teamwork, organization, and logical thinking are critical.

> Teamwork, organization, and logical thinking are critical.

Learning on the Job

You can also help students by setting up internships at local companies. On-the-job training paired with relevant high school classes makes work and school more meaningful. It also helps the employer give feedback to the student and to the school about what is expected.

A great resource for students is the U.S. Department of Labor Job Corps (**www.jobcorps.doleta.gov**). Qualified students learn a trade, earn a high school diploma or GED, and get a job. Also **www.doleta.gov/jobseekers/apprent.cfm** provides excellent information on apprenticeship opportunities.

Earning Certification

In addition to apprenticeship certificates, many secondary and post-secondary technical schools as well as community and technical colleges offer programs that lead to industry certification. This allows students to get started in advanced manufacturing with as little as two years of training.

The Manufacturing Skill Standards Council (MSSC) offers a Production Technician Certification. The foundation curriculum certifies workers against industry-recognized, federally endorsed standards. MSSC's goal is to expand the pool of workers with the foundational skills needed to keep pace with technological changes. This program stresses the importance of basic technical skills as well as foundational knowledge and skills in math, science, reading, writing, communications, IT, analysis, problem-solving, teamwork, organization and planning—all in a manufacturing context.

Community colleges are a great resource for workers looking to upgrade skills. Advanced manufacturing is getting more technical and keeping pace means going back to school. Many community colleges offer courses in the evenings to facilitate work-education balances. Some even offer online courses.

Higher Education

Some manufacturing jobs require advanced degrees. The U.S. Department of Education Prepare for My Future Website (**www.ed.gov/students/prep/college/consumerinfo/index.html**) is a great place to find a college, make sure it is accredited and fits your financial, lifestyle and career goals.

The United States has some of the most advanced four-year public and private institutions in the world. Students interested in engineering, electrical and mechanical systems, hydraulics, pneumatics, nanotechnology or other advanced manufacturing careers have many options. The U.S. Department of Education's Think College Website (**www.ed.gov/students/prep/college/thinkcollege/edlite-index.html**) can help.

TIPS FOR TEACHERS...

Teachers play a vital role in opening the eyes of students to how they can thrive beyond the classroom. When students get tired of hearing you talk about the opportunities, bring the dream to them. Guest speakers can testify to the range of possibilities in their own town and around the world.

Summer internships for teachers can give you real-world experience that will fire kids up about what happens in the world of advanced manufacturing.

Math Camp

A slew of summer math programs can make learning math fun. Check out **www.ams.org/employment/mathcamps.html** and open a world of possibilities for your students.

The same goes for science. Science Service (**www.sciserv.org**) lists science fairs, scholarships and a magazine.

For support outside the classroom, a new public collaborative effort called Workforce3 One (**www.workforce3one.org**) can also help. It contains the latest news and links for training students in technical skills.

Next try exploring the National Association of Manufacturer's (**www.gettech.org**) career page with your students. This Website shows how manufacturing careers are cool!

Another great source for hands-on science lesson plans is **www.teachervision.com**. It provides lessons that make math and science concepts come to life in the hands and heads of students.

For helping kids use teamwork to problem solve go to Odyssey of the Mind Website (**www.odysseyofthemind.com**). Student creations compete with teams from all over the world.

TIPS FOR PARENTS

If your teens had their way, would they play video games all day? That may be a good sign. The technical, spatial and logistical skills required to navigate levels and be successful in the virtual world could be a sign that your teen would enjoy a career in advanced manufacturing.

Enjoy is the key word. The Manufacturing Institute's *Dream It, Do It Career Calculator* puts it this way: "What you're best at plus what you love to do. It's the equation for a perfect job." Isn't that what you want for your teen? Success, happiness, and fulfillment? Those goals will be a lot easier to reach if they look forward to getting up each day and going to work.

Sharing the Dream

The earlier teens start thinking about what kind of career they would enjoy, the better off they'll be. Just because they change aspirations every six months doesn't mean they aren't dedicated. They are trying on different possibilities to find the right fit. Take each one seriously. Explore the options with them by helping them do research and talk to people who hold those jobs. Have them find out what level of education is required? What are the job prospects? What are the salary ranges?

Share your career choices with your teens. Talk about what you do, how you got to where you are and your goals for the future. Answer questions and ask some of your own. What did they like the most? What would they like to avoid when it is time for them to earn a paycheck?

Do you have an interesting career in advanced manufacturing? Volunteer to speak in your teen's classroom or at a career day. Who knows, it just may get you fired up about going to work tomorrow.

Encourage your teens to do the best they can regardless of their educational goals. Whether their future includes college or technical school will depend on the individual student, but make sure they get a high school diploma. Along the way, counsel your student to take as many courses in math and science as possible. That will help them in work and everyday life. Teach them to speak and write effectively. Regardless of their career choice, the ability to communicate is essential in today's world.

> The ability to communicate is essential in today's world.

SURF THE WEB

Parents will find lots of career information at **http://www.careervoyages.com/parents-main.cfm.**

This site provides:

+ different types of careers
+ information on the training and skills needed to enter these careers
+ advice on how to pay for more specialized training

www.careerclusters.org (Once students know what they want to do, The National Association of State Directors of Career Technical Education web site outlines career pathways and gives resources for helping students achieve their career goals.)

A DAY AT THE OFFICE

Ms Foundation's Take Your Daughter and Son to Work Day Website (**www.daughtersandsonstowork.org**) suggests some fun activities listed below to make the trip even more educational.

CONVERSATION CAFÉ:

Children are often asked: "What do you want to be when you grow up?" Instead, ask visitors to imagine what their future workplace will look like. Will you work indoors or outside? What will you have on your desk? Ask them to consider what they want their home lives to be like. Will it be an apartment in the city or a ranch in the suburbs?

ASK THE ADULTS:

Tell students that they are to be reporters, interviewing adults about their dreams, daily life and experiences in managing work and home life.

The program takes place the fourth Thursday of every April. Plan on it.

WE WANT FUTURES.
NOT JUST PAYCHECKS. YOU PROBABLY THINK WE WANT TO SPEND THE REST OF OUR LIVES PLAYING VIDEO GAMES, BUT MAYBE WE'D RATHER MAKE VIDEO GAMES. OR HOW ABOUT FLAT-SCREEN TVS. ACTUALLY, WE WANT TO MAKE GOOD LIVES FOR OURSELVES. HOW DO WE DO THAT? WHATEVER YOU LOVE TO DO, THERE'S A GREAT FUTURE WAITING FOR YOU WITH THOUSANDS OF CAREERS AVAILABLE IN MANUFACTURING.
WWW.DREAMIT-DOIT.COM
Dream!t Do!t™ YOUR FUTURE IS THERE FOR THE MAKING.
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