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ABSTRACT

"Exploring Careers" is a career education resource program, presented in fifteen separate booklets, for junior high school-age students. It provides information about the world of work and offers its readers a way of learning about themselves and relating that information to career choices. The publications aim to build career awareness by means of occupational narratives, evaluative questions, activities, and career games presented in fourteen occupational clusters. This second of the fifteen booklets, "Industrial Production Occupations," presents an overview of occupations which involve factory production. Narrative accounts focus on a bench assembler, a machinist, and a photocompositor, explaining their training needs and what they do on the job. An exploring section relates the skills needed for these occupations to students' personal characteristics, and suggests activities such as factory trips and reports. A Job Facts section explains nature and places of work, training and qualifications, and other information for thirty-three industrial and production occupations, grouped in occupational clusters of foundry, machining, printing, and other industrial production and related occupations. ("Exploring Careers" is also available as a single volume of fifteen chapters.) (KC)

Exploring Careers

Industrial Production Occupations

U.S. Department of Labor
Ray Marshall, Secretary

Bureau of Labor Statistics
Janet L. Norwood, Commissioner
1979

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Exploring Careers is available either as a single volume of 15 chapters or as separate chapters, as follows:

The World of Work and You
Industrial Production Occupations
Office Occupations
Service Occupations
Education Occupations
Sales Occupations
Construction Occupations
Transportation Occupations
Scientific and Technical Occupations
Mechanics and Repairers
Health Occupations
Social Scientists
Social Service Occupations
Performing Arts, Design, and Communications Occupations
Agriculture, Forestry, and Fishery Occupations

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Government Sources

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Preface

Exploring Careers is a career education resource for youngsters of junior high school age. It provides the kind of information about the world of work that young people need to prepare for a well-informed career choice. At the same time, it offers readers a way of learning more about themselves. The publication aims to build career awareness by means of occupational narratives, evaluative questions, activities, and career games presented in 14 occupational clusters. *Exploring Careers* emphasizes what people do on the job and how they feel about it and stresses the importance of "knowing yourself" when considering a career. It is designed for use in middle school/junior high classrooms, career resource centers, and youth programs run by community, religious, and business organizations.

This is 1 of 15 chapters. A list of all the chapter titles appears inside the front cover.

Exploring Careers was prepared in the Bureau's Division of Occupational Outlook under the supervision of Russell B. Flanders and Neal H. Rosenthal. Max L. Carey provided general direction. Anne Kahl supervised the planning and preparation of the publication. Members of the Division's staff who contributed sections were Lisa S. Dillich, David B. Herst, H. Philip Howard, Chester Curtis Levine Thomas Nardone, Debra E. Rothstein, and Kathy Wilson. Gloria D. Blue, Brenda Marshall, and Beverly A. Williams assisted.

The Bureau gratefully acknowledges the cooperation of all the workers who agreed to be interviewed and photographed, the teachers and students who field tested a sample chapter, and all who shared their ideas with BLS. Many people in the counseling community offered encouragement and support. Special thanks for her generous assistance go to Cathy Cockrill, Career Education Curriculum Specialist, Fairfax County Public Schools, Fairfax, Virginia.

Although they are based on interviews with actual workers, the occupational narratives are largely fictitious.

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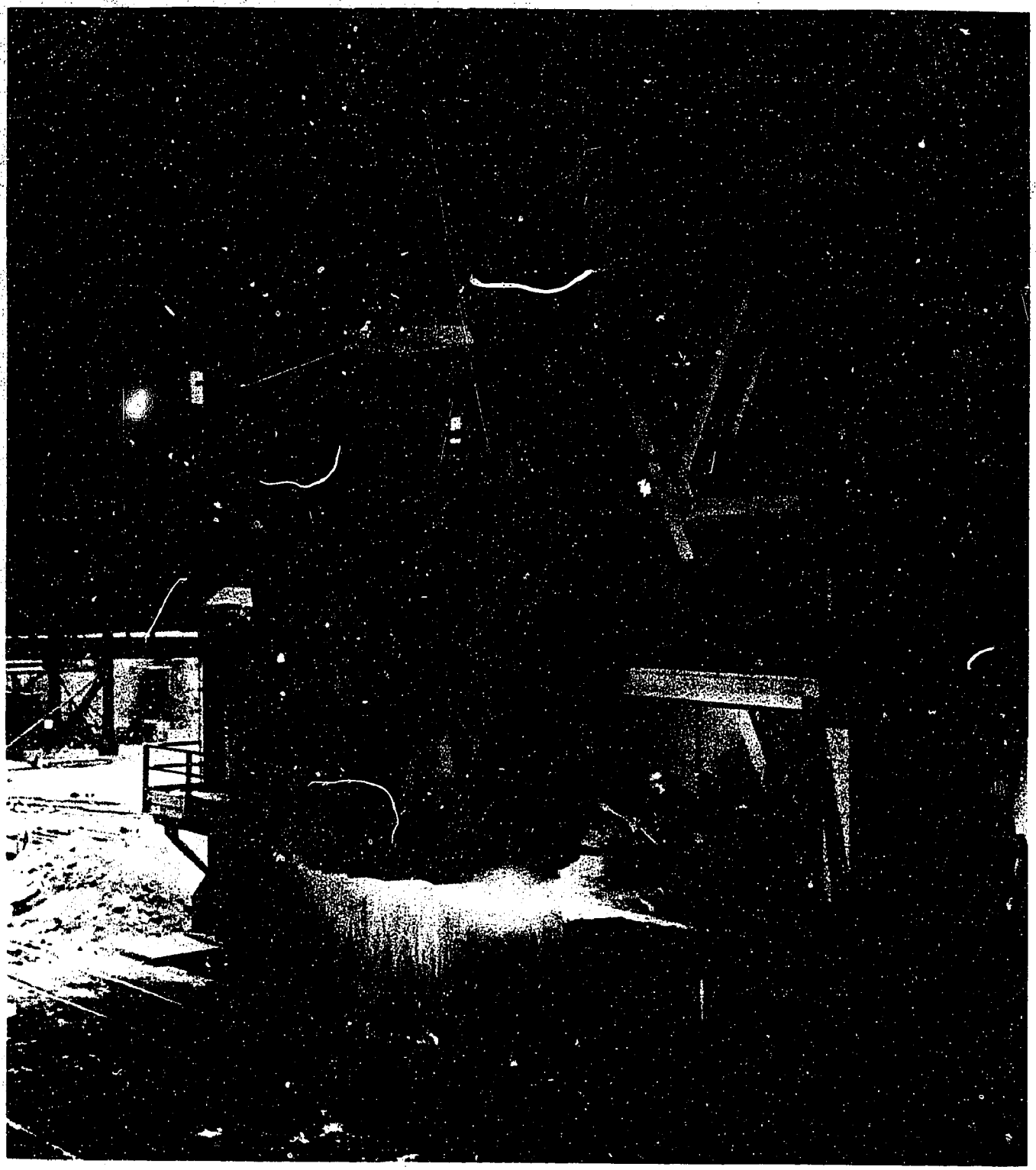
Industrial Production Occupations



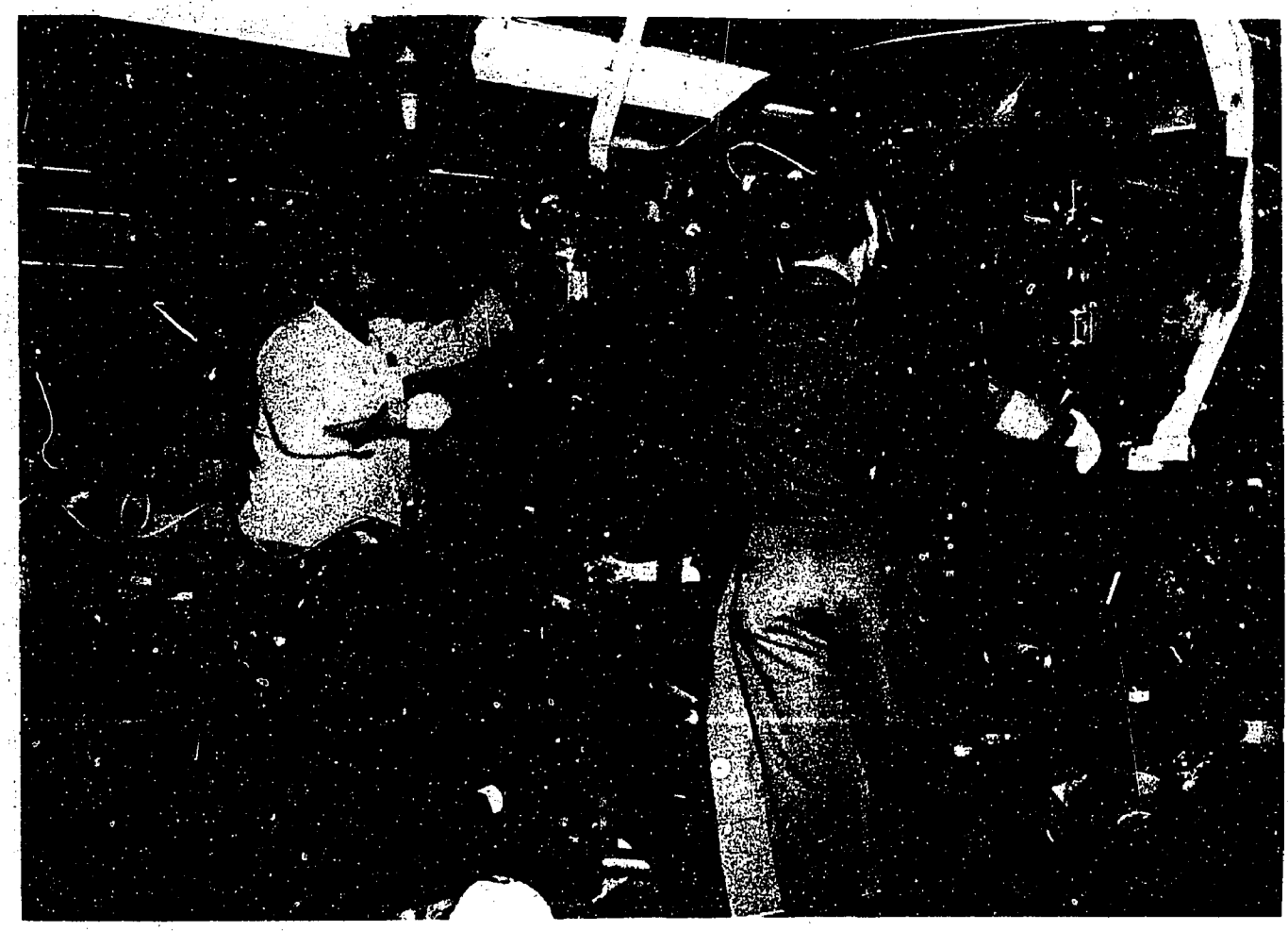
Industrial production workers deal with things more than they do with people or ideas.

Annie Bergdahl walked down the corridor, wide-eyed. From the moment she first walked through the massive brass doors of the main entrance, the Museum of Science and Industry held her in a spell. The old airplanes hanging from the ceiling, the mummies, the space capsules—everywhere she turned, Annie found wonderful things to explore. She wanted to see it all, read every word, push every button. But the museum was so big!

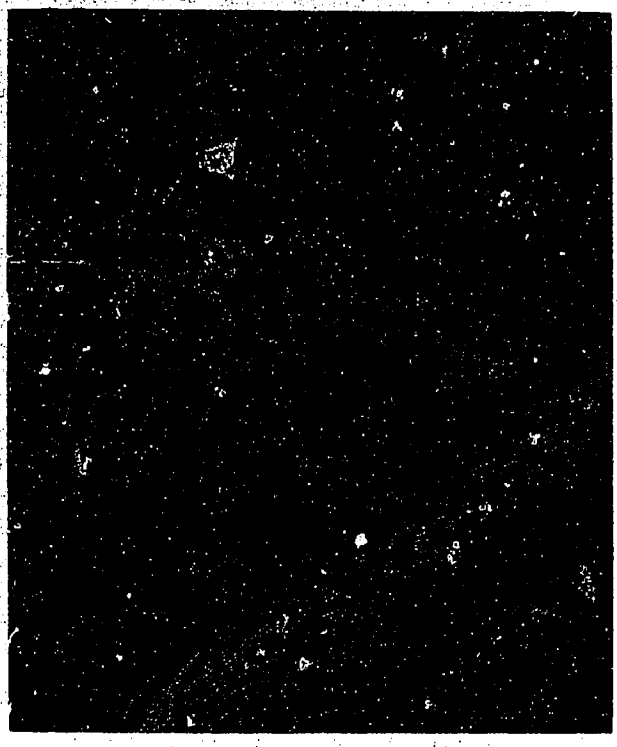
Most of the other youngsters on the field trip also wanted to run off and spend more time at some exhibit they had spotted. But Mr. Borden, their teacher at Middlesex Junior High, kept them together in a group. There were certain exhibits he wanted them to see, exhibits that should liven up the unit they were doing right now in his social studies class.

The unit on industry had begun last week, and Mr. Borden was teaching the class how factories produce goods. Some of the students were obviously bored. But not all of them ... and certainly not Annie. Annie had enjoyed the film about an automobile assembly line. It fascinated her to watch the metal frames grow, almost magically, into complete cars as they moved along. And she couldn't believe how many workers—*assemblers,* Mr. Borden had called them—it took to build a car. Each assembler performed a single task over and over while the seemingly endless parade of unfinished automobiles marched on. As the engines glided down from above, two or three workers would bolt each one to a frame. Others attached the seats; still others added doors or side panels or wheels or a hood, over and over. Mr. Borden had said that not all assemblers work on an assembly line. Many work at benches or on shop floors and set their own pace. Nevertheless, Annie had decided that assembly work wasn't her cup of tea.

Now, at the museum, she walked with the group toward a tall archway crowned with a large sign in shiny brass letters: HALL OF INDUSTRY. Mr. Borden led the students through the archway into a large room. All



It takes many assemblers, each performing a different task, to produce an automobile.



America's industrial plants produce everything from paper clips to rocket ships.

This inspector looks carefully at every television set.

around them they saw exhibits and more doorways. Ushering the group to one side of the room, Mr. Borden sat them on the carpet and introduced them to a casually dressed young man who awaited them there.

"This is Mr. Novacello, class. He works here at the museum, and he's going to tell us about the exhibits in this hall. Now, what are we studying in class these days?"

"Industrial production!" shouted half the group in unison.

"Right!" said Mr. Borden. "And who can tell me what that means?" A sudden attack of shyness paralyzed the group. There was silence until Annie raised her hand.

"Production means making things. Industrial production means making things in factories and plants."

"Very good, Annie," said Mr. Borden, smiling. "Now, let's let Mr. Novacello tell us more about it and demonstrate how some things are made."

Mr. Novacello flashed a smile and greeted the group. After telling them a bit about the museum and himself, he returned to the subject at hand. "Who can tell me why it's important to learn about industrial production?" he asked.

Silence.

"Well, then, who can name some industrial products?"

One by one, the children began to name things made in factories: Cars and trucks, trains and airplanes, books and newspapers, pencils and pens, refrigerators and radios, television sets and telephones, window glass and wallpaper, lampshades and lightbulbs, canned soups and candybars.

"The list is quite long, as you can see," said Mr. Novacello. "Industrial plants produce everything from paper clips to rocket ships. And they produce these things much more quickly, efficiently, and cheaply than was possible years ago. Today, almost every American family has a TV or an automobile or a refrigerator. Without modern industrial production, all these things would have to be built by hand, and most of us could never afford them. Modern industry makes our lifestyle possible, and so we should know something about it.

"There's another reason, too. All those products didn't appear by magic. They were made by millions of workers in a great variety of jobs. When you start thinking about the kind of job you might like when you grow up, it'll help to know about these.

"We have exhibits here that illustrate a dozen different kinds of industrial processes. I want to show you four or five that I think will interest you, and tell you a little about the work and the workers in each. Come with me to the first exhibit and we'll have a look."

Foundry Occupations

The youngsters followed Mr. Novacello over to the far wall and gathered around him before a large darkened window. Curious to know what was about to happen, they listened to him closely.

"This exhibit shows an industrial plant called a foundry. The workers there make metal parts for many different things." As he spoke, Mr. Novacello pushed a button on the wall near the glass panel. Spotlights suddenly illuminated the scene behind the glass, in which a dozen mechanical people came to life. All dressed in overalls and hard shoes, they acted out the different kinds of foundry work. At the same time, a clear, deep voice spoke from a wall speaker.

"The process used to make metal parts in a foundry is called casting," began the voice, "and it resembles the way you would mold a ring or some other shape out of gelatin in your kitchen. Workers heat the metal until it liquifies, then pour it into a mold. When it has cooled and hardened, the metal has the desired shape and is taken from the mold.

"Casting is used to make metal objects that must be very strong, such as engine blocks and axles for cars. In order to cast the desired shape, foundry workers create the molds themselves. First, the *patternmaker* creates an exact model, or pattern, of the part out of metal, wood, or perhaps plaster. Patternmakers are highly skilled workers. They make a model from a set of drawings called blueprints that give the exact measurements of the part. And since the quality of the product depends upon the quality of the pattern, patternmakers work very carefully and deliberately.

"When the pattern is finished, the *molder* uses it to make a mold. Molders pack special sand around the pattern in a box called a flask. After pressing the sand very tightly with mallets or powered rammers, they carefully remove the pattern, leaving a space in the sand exactly the shape of the final piece. This is the mold

"Some castings have hollow sections," continued the voice. "They are formed when the liquid metal flows around a "core" that the *coremaker* creates. Coremakers start with a wood or metal block with a space hollowed out in the proper shape. After packing sand into the hollow, they bake it or dry it by some other method. Once dry, the sand core is hard enough to remove and use in casting."

Fascinated by the mechanical figures, the children stared for another minute or so while the voice described other aspects of a foundry. Then the display went dark and the speaker silent. Mr. Novacello's voice broke the trance.

Steel workers may have to wear special clothing for protection.

Foundry workers make metal objects that must be very strong. Here the worker is pouring liquified metal into a mold.

"If you'll follow me over to the next display, we'll see some other kinds of workers who make things out of metal."

Other Metalworking Occupations

Leading the children to a large floor-to-ceiling display case, he pointed to the first of several life-sized figures posing behind the glass. "Now," he began, "who can tell me the occupation of this man standing at the anvil with a big hammer in his hand?"

"Blacksmith!" answered the class in unison.

"Right!" said Mr. Novacello. "And what do blacksmiths do?"

"They put shoes on horses," answered a few voices.

The guide smiled. "That's partly correct. Many blacksmiths specialize in shoeing horses and are called *farriers.* But blacksmiths also make or mend metal objects for many other purposes. The process they use is called forging. First, they soften a piece of metal, usually iron, by heating it in a fireplace called a forge. Next, holding it on the anvil with a pair of tongs, they strengthen and shape the metal by hammering and chiseling it. Then they cool it in water.

"This blacksmith is forging metal in essentially the same way that his predecessor did a hundred years ago. Even his tools are similar. In a modern *forge shop,* you would find workers who look like these next figures in the case. They heat the metal in a furnace and use large power hammers and presses to pound and squeeze it into the desired shape. With their equipment they can produce objects such as keys, wrenches, drill bits, or huge parts for heavy machinery. And they can do it much faster than a blacksmith.

"Now this occupation," continued Mr. Novacello, indicating the next figure, "may be harder to figure out. As you can see, this woman is placing a metal object in a vat of liquid. An electrical wire is connected to the object, and another runs into the liquid. Can anyone tell me what she's doing?"

Mr. Novacello looked out across a sea of blank faces. "Do you all give up? This woman is an *electroplater.* She puts a metal layer, or plating, on an object. She does this by passing an electric current between the plating material, which can be silver, chromium, or some other metal, and the object. She covers those parts of the object that aren't to be plated, and she carefully controls the strength and duration of the current. Then she checks the plating to make sure it was applied evenly and in the right thickness. In this display she is putting chrome plating on an automobile bumper, but she could be plating any of the shiny, silvery parts of a car.

"The next occupation might be a bit easier. Two people wearing face masks are standing over a metal object, while one holds a torch to it. What do you think they're doing?"

Silence.

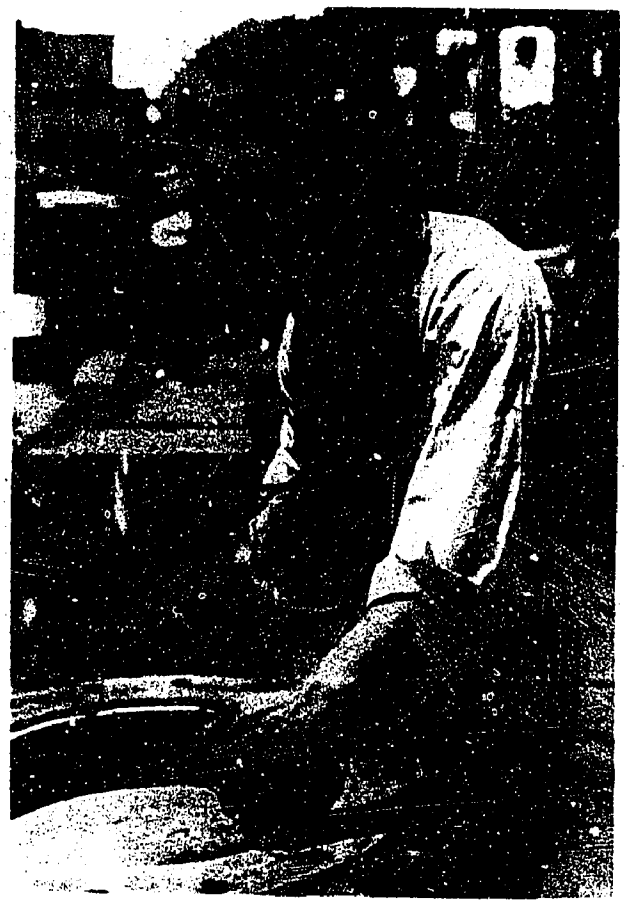
"I thought you'd guess this one," said the guide. "These are *welders.* They use heat from gas or electric

This welder is using heat from an acetylene torch to join pieces of metal.

An artificial limb doesn't prevent this worker from pursuing his trade as a welder.

torches to join pieces of metal together. These two work in a plant where bulldozers are made. They're joining two pieces of the bulldozer frame together. Welders also work in factories that make trucks, boilers, and all kinds of heavy machinery. But you see welders at work just about everywhere, not just in factories. They work on bridges, roads, pipelines, and construction sites, joining the metal beams and steel reinforcing rods that make those structures so strong. And they work on ships. Ship welders have to be highly skilled and they have to do their jobs very carefully indeed, to be sure that the ship doesn't break apart in rough seas. But that's enough for today about welders!

"Now let's look at these last workers in the display. They are demonstrating three different steps in *boilermaking*. The first worker measures and cuts all the pieces from metal, according to the blueprints. These measurements must be precise, because it may be impossible to correct a bad cut. The next worker joins the pieces together temporarily to see if they fit properly. It may be necessary to grind or cut in places to make a good fit.



Boilermakers need mechanical aptitude and manual dexterity.

Then the last worker assembles the boiler by welding or riveting the pieces together. Small boilers, like the one shown here, may be assembled in the shop, but large ones, such as those that supply steam to drive turbines in electric power plants and in ships, must be put together in place. Any questions?"

Several in the group raised questions, which Mr. Novacello answered as best he could. Then he led them to another corner of the hall.

"So far we've seen occupations related to metal products. Now let's look at workers who make something entirely different, something you all use every day in school—books."

Printing Occupations

"Most people in this country today read and own books," continued Mr. Novacello. "But hundreds of years ago books were handwritten, and only the very rich could afford them. And of course in those days, ordinary people didn't know how to read. With the invention of the printing press and movable type, books became much easier and cheaper to print. More people bought them and learned to read them. So those of you who love reading can be grateful to the people who invented the processes we're about to see!"

Following their guide through a wide doorway, the children found themselves on a long balcony overlooking a huge factory in miniature. When they had spread themselves out along the railing to get a better view, Mr. Novacello continued his talk.

"If you could remove the roof of a printing plant and look inside, this is what you might see. The printing process begins in that far room, called the composing room. There, the *compositors* set a written text, or manuscript, in type.

"In the old days, they had to choose type by hand from a large case, one letter at a time. And since all the letters were backwards, it was easy to make mistakes—especially with letters that look alike. Compositors had to take a good look at each letter to be sure they had the right one. That's where the saying "Mind your p's and q's" comes from. Today setting type by hand in this traditional way is done only for very special printing jobs.

"These days, compositors use machines with keyboards on which they type the text. These machines set type much faster than is possible by hand. Until fairly recently, the most common typesetting machines were the Monotype and Linotype machines—both of which force hot molten metal into rows of type. "Hot metal" typesetting is on the way out, however, and is being

replaced by machines that use paper and chemicals to set the type.

"After all the type is set, the columns of text must be arranged into pages. Usually the compositors print the text on paper which is then cut up and pasted onto mounting boards. The completed boards, looking just like the pages of the finished book, then go through a printing process. There are many different ways of printing, including such old standbys as linoleum and woodblock printing. For commercial purposes, however, a process called lithography is very important."

Mr. Novacello pointed to another room in the model. "You can see the lithographic process over here. *Lithographers* photograph the boards with large cameras and make negatives. They lay the negatives over metal plates that have been treated with a special light-sensitive chemical. When a plate is exposed to light, the chemical eats into the metal only in the places where the negative lets the light through, until . . . Presto! The plate has the image from the negative etched into it. And so a printing plate is created. Have I confused you all yet?"

Annie raised her hand. "How do the compositors make type for the pictures in a book?" she asked.

"Good question!" answered Mr. Novacello, smiling. "The answer is that they don't. When they paste up a board, they leave blank spaces where the pictures will appear. Meanwhile, other workers enlarge or reduce each picture to the desired size and insert it in its intended space. Then the lithographer makes a plate of the entire page, pictures as well as words.

"The next step is the actual printing. But first, let me give you a little math problem. If it takes 4 days to print a book using one printing press, and you want to print it in only 2 days, how would you do it?"

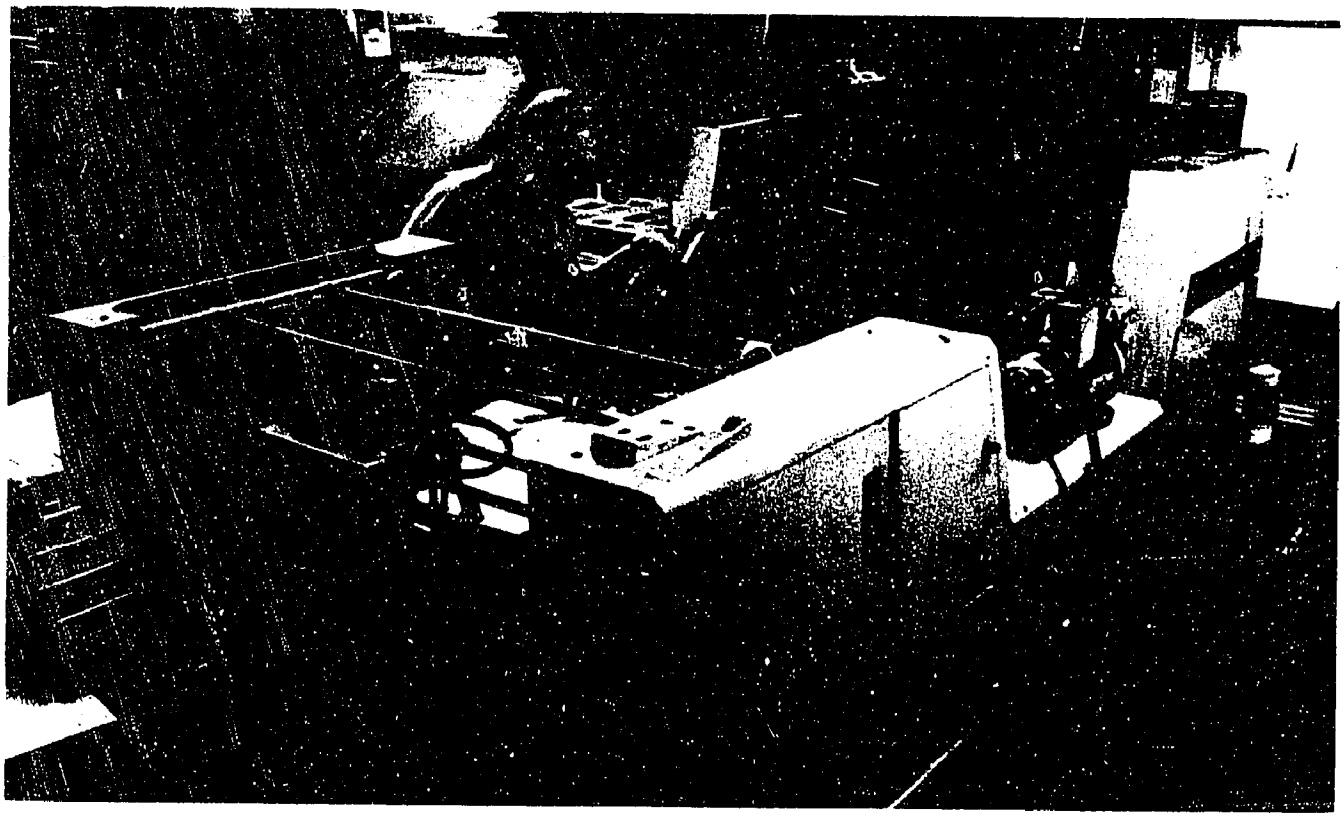
"Use two presses!" shouted several of the children.

"Excellent!" replied Mr. Novacello. "Now, here's the hard part. If each press requires its own set of printing plates, but all of your typesetting and lithography has produced only one set, what do you do?"

"Make another set!" shouted the same voices.

"You're all too smart!" said the guide. "And that's exactly why a print shop employs *electrotypers.* They make a wax or plastic mold of the printing plate. Then they form a metal shell in the mold, in the same way that the worker we saw earlier put a chrome layer on the car bumper—by electroplating. That metal shell, with a lead backing, becomes a duplicate plate.

"When all the plates are ready, they go the pressroom, this large area nearest us. There, the *press operators* set up the printing presses. They insert and adjust the plates,



Many printing press operators learn their trade through apprenticeship programs.

check the supplies of paper and ink, and run the presses. These presses print on both sides of paper that comes from a large roll, and then cut the paper into sheets of several book-pages each.

"These sheets go to the *bookbinders,* who fold them and assemble them into books. Using stitching and glue, they bind the books and attach the covers. After some final touches, the books are ready to be sold. And, if you have no questions, we are ready to move on."

Mr. Novacello led the group back through the main hall and into an adjoining room. The major exhibit was a large scale model, similar to that of the printing plant. Scattered around the edge of the room were life-sized figures standing at various machines. The children's curious gazes wandered every which way until the guide began to speak.

"I want to show you a few more metalworking occupations," he began, "but first I have a question. Who can tell me what a tool is?"

After a conspicuous silence, one brave boy raised his hand. "A tool is something you use to help you do something."

"Excellent," said Mr. Novacello. "And what are some examples of tools?"

Hammer, saw, screwdriver, pliers, chisel, all were mentioned in turn.

"Very good," commented the guide. "You have all given examples of handtools. What you see in this room are examples of *machine* tools. Some are about the size of a person; others, as you can see in the scale model, fill an entire room. Some perform only one kind of operation; others carry out a whole sequence of tasks automatically. But they all use power to cut, grind, drill, or shape metal.

"Machine tools are an important part of industry because they can produce metal parts quickly with a high degree of precision. They make it possible to build complex machines, like automobiles, in large numbers. And those machines have interchangeable parts. For example, if your family's car has a worn-out gear, you can buy a new gear that will be virtually identical to the original one. If the gears were made with handtools, this wouldn't be possible. But with machine tools, we can mass produce automobiles, electric motors, airplanes, and hundreds of other everyday products.

"The people who work with machine tools have different kinds of jobs. *Machine tool operators* have the least complicated jobs and need the least training. They run a machine and watch for problems after *set-up workers* have performed the more demanding job of adjusting the machine and preparing it for use. Set-up workers and operators usually stick to one kind of tool, such as a drill press or a grinder.

"*All-round machinists* have much more training and skill than machine-tool operators. They can operate many different kinds of machine tools, instead of just one kind. With their knowledge of materials and tools, they can do everything necessary to turn a block of metal into an intricate part."

Mr. Novacello walked over to one of the machines. "Take a close look at a machine tool," he said. "On each one you'll find a jig or fixture to hold the metal. You'll also see the "tool" portion of the machine that actually cuts, drills, grinds, or presses the metal. Very often, in order to make a particular part, a special jig or tool is needed. If so, a *tool-and-die maker* produces it. Tool-and-die makers are not only highly skilled machinists, but creative workers, too.

Tool-and-die makers need mechanical ability.

"And speaking of creativity, the most creative machine work of all is that of *instrument makers.* They are a bit like inventors—they take someone's idea and translate it into a piece of experimental or custom-built equipment. And instrument makers work without the benefit of a detailed set of blueprints. Often, there's only a rough sketch or idea to work from. They use their skill and imagination to fill in the details of the design and then carry it out."

After pausing to take a breath, Mr. Novacello called for questions. Annie, who was fascinated by the size of

some of the machines, raised her hand. "How do they put these machines in the factories?" she inquired.

"I'm glad you asked that!" replied Mr. Novacello. "Installing industrial equipment is the job of *millwrights.* They may have to dismantle the old machinery, lay a foundation, move the new equipment in, and assemble it. All of this takes a great degree of skill. Any other questions?"

There were no further questions.

"Well then," announced the guide, glancing at his watch, "so much for machining occupations. I'm going to take you now to another part of the museum. There we will closely examine the nature of one last production occupation. Follow me, if you will, as we set off to explore the production of hot dog lunches by the cafeteria cooks!"

Millwrights use ropes and other rigging devices to help them move machinery.

Personal Characteristics

The day after the field trip, Mr. Borden had his social studies class review what they had learned at the museum. Walking up to the chalkboard and picking up a piece of chalk, he said, "Let's start by brainstorming for a few minutes. We learned a lot yesterday about the different kinds of jobs there are in industry. What can we say about these jobs? What are they like? What do they have in common? And what sort of person would be good at this work?"

There were a few moments of silence. Then Dave raised his hand and answered, "Making things is what their jobs are all about. So you could say that industrial production workers deal with *things.* They have a lot more to do with things than they do with people or ideas."

"They *work with things,*" Mr. Borden wrote on the board. "Very good. Is there anything to add to that?"

Dave continued, "Well, yes. The things these workers deal with could be raw materials ... machines ... tools ... equipment ... the final product itself. But whatever it is, it's an object of some kind. Something you can touch or feel or handle."

"Fine,' said Mr. Borden. "Now, does everyone agree with what Dave has said?"

Phil spoke up. "I agree that all industrial production workers deal mainly with things, but beyond that, their jobs aren't the same at all! Just think about the different levels of skill they need. You have the set-up worker who gets a drill press ready to use, makes all those calculations and adjustments and so forth.... And then you have the drill press operator who just runs the machine! That operator's job seems pretty straightforward to me. It's just a matter of starting and stopping the machine and watching it while it's running.

"And don't forget the machinist," Phil continued, warming to his subject. "The machinists do highly skilled work. They have to know a lot to be able to set up and operate a lathe to make a part for a motor, for example. So even though industrial production workers' jobs have some similarities, they aren't all alike. They range from routine and simple to very complex."

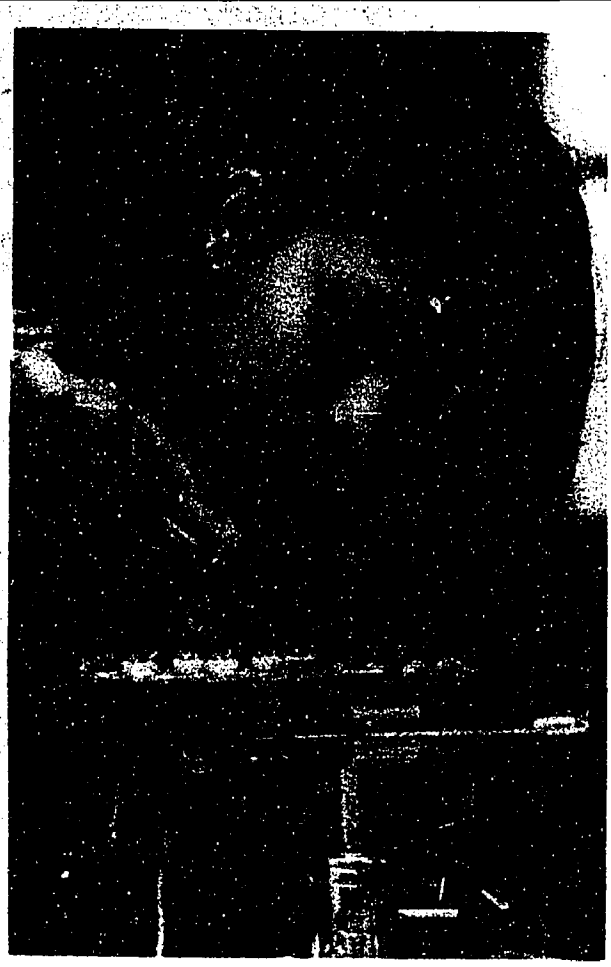
"Industrial production work involves *varying degrees of skill,*" wrote Mr. Borden. "Thanks, Phil. Now, what else?"

"These workers work mostly with their hands," suggested Barbara.

"That's right," said the teacher. "They do *manual work.* They have to be good at doing things with their hands in order to work with handtools or operate machines. It takes coordination and dexterity ... the same kind involved in making a model or repairing a lawn mower, for example. Anything more?"

Annie had something to say. "These workers have to use their heads. They read blueprints, measure things, and make calculations."

"You're right," answered Mr. Borden. "Some of the industrial production workers we've learned about need what's called *spatial ability* to work from diagrams and



Working with handtools takes concentration.

blueprints. Spatial ability means they can look at a flat drawing of a three-dimensional object and picture the object in their mind. They also have to have good *form perception* to notice details and detect slight flaws in shapes and surfaces. And, like just about all workers, they have to be able to understand instructions, reason, and use common sense. As Phil has just told us, reasoning ability is much more important for some industrial production workers than for others. I think we were all impressed with the problem-solving skills it takes to be an instrument maker."

Pat spoke up. "Some of the jobs seem boring to me. Workers like assemblers do the same thing over and over again."

"Yes, that's right," agreed Mr. Borden. "Some industrial production jobs involve repetitive tasks. Jobs like that are just right, though, for people who like *repetitive, concrete, organized* activities. Now, what else can we say about these workers and their jobs?"

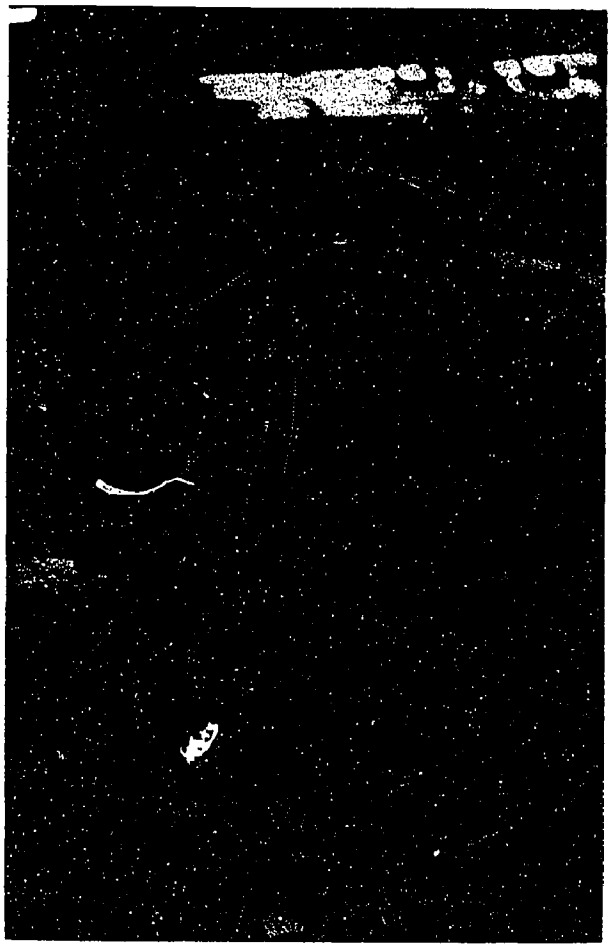
Emily raised her hand. "It seems to me that people who have what it takes to learn a skilled trade are people with some sort of mechanical interest. So many of the jobs we learned about at the museum involved machines and mechanical principles. The workers were applying mechanical principles to practical situations."

"*Mechanical interest* is important," Mr. Borden wrote. "And . . . ?"

There was silence.

"Well, I can think of several things," continued the teacher. "Industrial workplaces can be noisy and dirty. Industrial workers have to be able to do their jobs in places that may be *uncomfortable* or *unpleasant.* Some of the jobs are strenuous, and require both *strength* and *stamina.* Not all industrial production workers have to lift and carry heavy things, of course, but some do. And workers like assemblers and machine-tool operators may be on their feet all day long. That's tiring, too."

Mr. Borden glanced around the room. "Does anyone have anything to add? No? Well, then, let's go on. The other day we saw a film about an automobile factory. . . ."



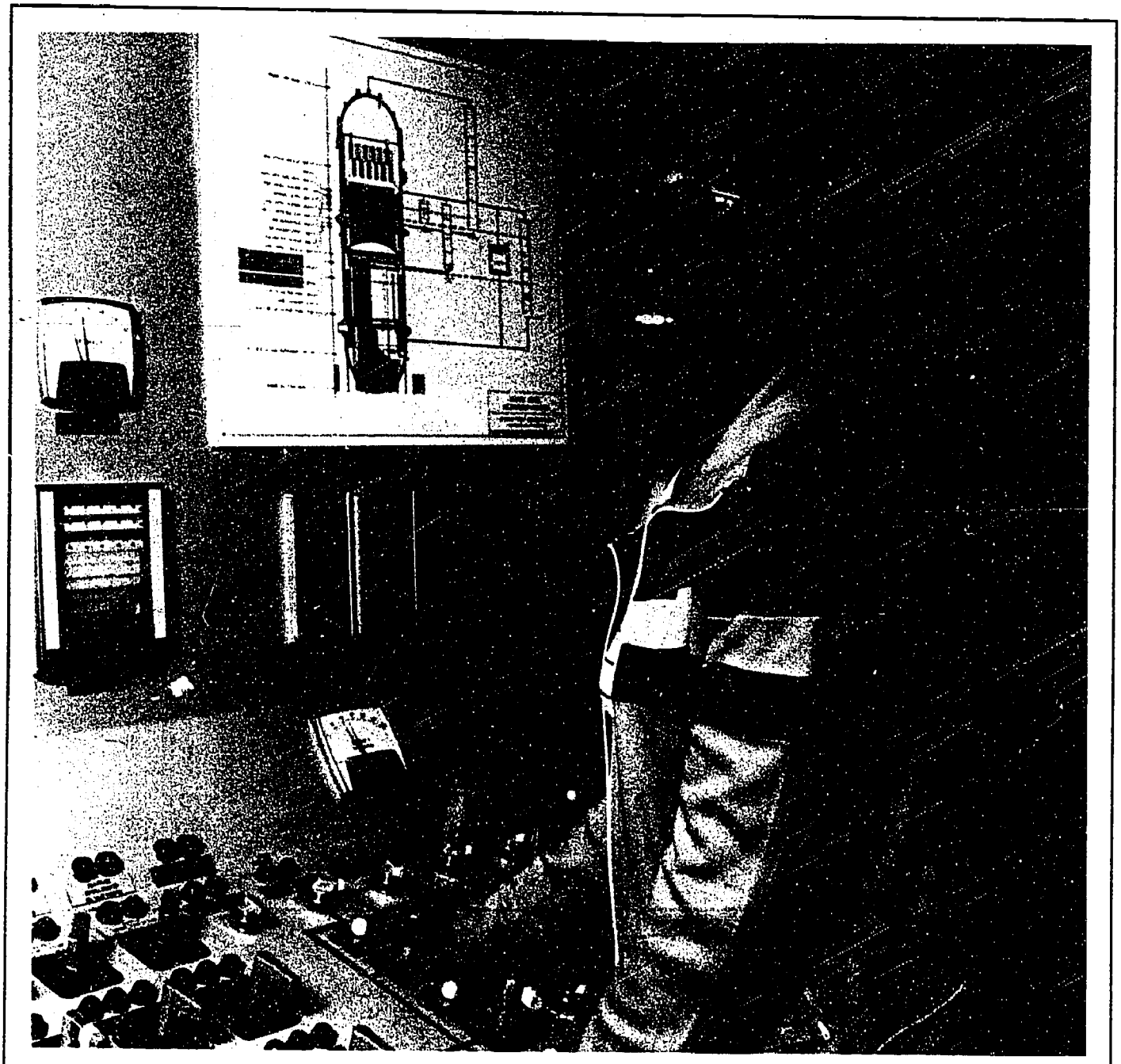
This automobile worker enjoys his job.

Training

A week after the museum trip, Annie gave an oral report in Mr. Borden's social studies class.

"If you wanted to be a lawyer," she began, "you would go to law school. To become a dentist, you'd attend a school of dentistry. But where would you go to learn an industrial trade? For less difficult occupations, such as machine tool operator or assembler, you could train right on the job. But how would you break into a skilled occupation? Would you enroll at the State College of Boilermaking? Tool-and-Die Graduate School? Welding University? That would be one way.

"Trade schools and technical institutes offer programs in the skilled trades—welding, printing, and tool-and-die making, for example. These programs provide theoretical instruction and the practical skills you'd need right away on the job. Vocational training is given in both public and private schools. You're probably familiar with the vocational education courses given here in



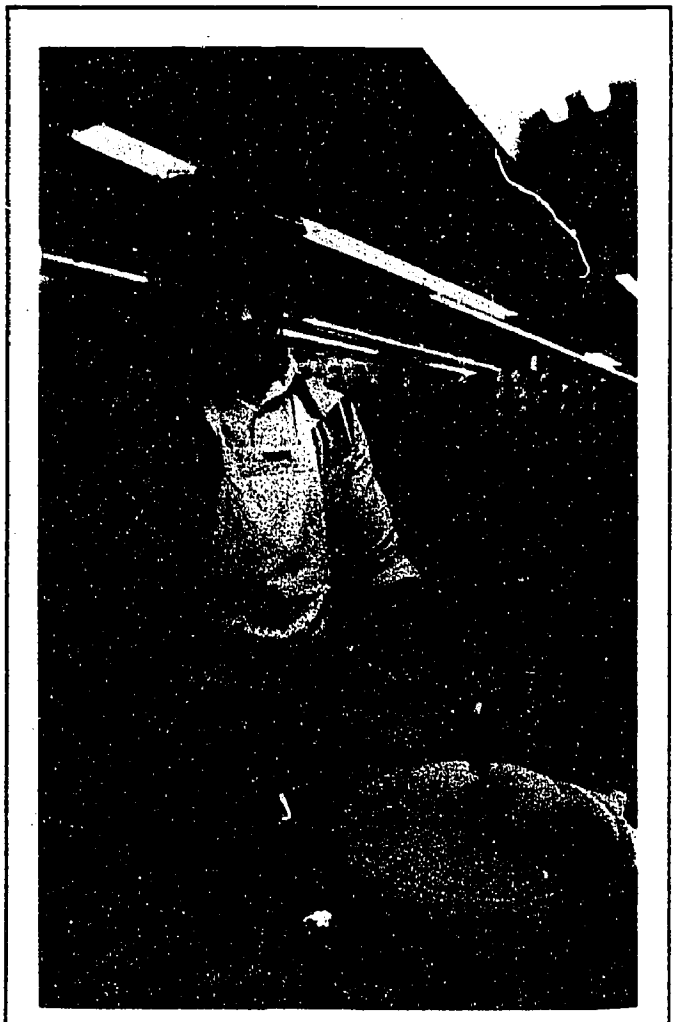
This woman is training for a job as an electric power plant operator.

our school system. There are, in addition, thousands of private schools that teach the skills you'd need for a job in industry.

"There are other ways to train for industrial production occupations, too. Often, the best route is through an apprenticeship. Consisting of planned classroom and on-the-job instruction, apprenticeships normally last about 4 years, although they range from 1 to 6 years. It all depends on the occupation. Apprenticeships are arranged by unions and employers.

"Here's how they work. Let's say you are an apprentice machinist with the Wonderful Widget Company. As an apprentice, you train for 4 years on the job, learning every aspect of a machinist's work. You also go to class to learn blueprint reading, shop mathematics, and other subjects. After completing all the requirements for the program, you receive a certificate that proves you have all the skills of a journeyworker machinist.

"Many workers do learn their skills without apprenticing. Quite a few get their training on the job by watching experienced workers, asking questions, and having someone guide them as they try the job themselves. While some of these workers have attended a vocational high school or a trade school, others begin with no previous exposure to the occupation. And then there are workers who "pick up the trade" on their own by watching, imitating, and experimenting whenever they can."



Many workers learn their skills on the job.

Employers generally prefer to hire people who have finished high school.

More About Training

The Job Facts at the end of this chapter summarize the training requirements for each of 33 industrial production occupations. If one interests you, you can begin preparing in high school. Math, science, drafting, shop, and other industrial arts courses will help. You can join a chapter of VICA (Vocational Industrial Clubs of America), if your school has one. VICA chapters plan projects, take field trips, and hold competitions in such skill areas as welding, machining, and printing.

One final tip: Plan to finish high school. Employers do hire people who haven't finished high school, but they prefer those who have. They know that high school gives you basic skills you'll need for the job. And the diploma shows them that you're willing to finish something once you've started it.

Assembler

Karen says, "You don't need a great deal of education and experience to do what I do, but you have to be good with your hands."

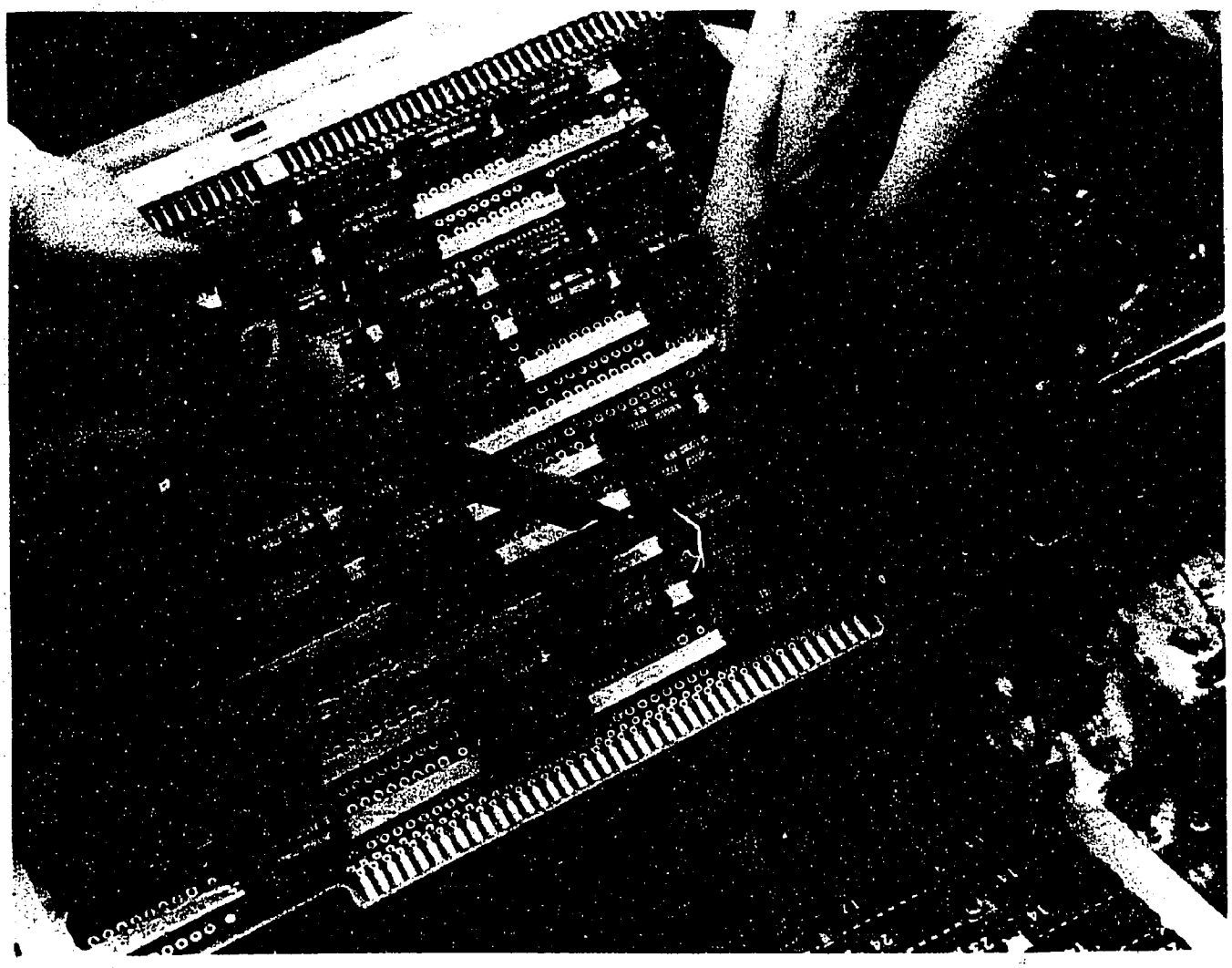
The traditional Fourth of July picnic in Elks Gap last weekend had been a big affair; everyone in town had been there. Under the trees the fire department had set up grills to barbeque the chickens that would be eaten long before the fireworks began. There, Karen ran into her new neighbor, Sarah Green. Sarah and her husband had moved to Elks Gap just a few weeks before, and she and Karen had quickly gotten to be friends.

Over barbequed chicken, Sarah had told Karen that she was thinking about looking for a job. Karen told her about Astro Electronics, the plant where she worked.

"Why don't you come out and apply for a job like mine?" she had suggested. "You don't need a great deal of education or experience to do what I do. But you do need to be good with your hands. You need patience, too, and have to be able to concentrate on very small tasks."

Karen is a bench assembler. She assembles circuit boards for television sets and other electronic equipment, and works at a bench rather than on a moving assembly line. Putting together complete circuit boards means installing all the components: Capacitors, resistors, diodes, transistors, and meds. It means soldering these components into place, and installing connecting wires where necessary. Karen usually works from a diagram or blueprint that shows her where to insert each component. Sometimes, however, Karen uses a "sample board"—an exact model of the board she is constructing.

Karen's job as a bench assembler is more complex and involved than that of an assembly line worker. Karen assembles the circuit boards from start to finish, instead of just inserting one or two components, which is what she might be doing if she were working on an assembly line. On an assembly line she would repeat the same task



Assembling electronic components is very delicate, detailed work that requires concentration.

over and over again, rather than complete all the steps of the circuit board assembly process herself.

Karen didn't need any special training to get her job at Astro Electronics. The company put her through a training course the first day she went to work there, and since then she's been learning and gaining speed through practice.

"It's a bit like putting together a puzzle or a model airplane," she had told Sarah. "It's very delicate, detailed work that requires a lot of concentration. I have to use a magnifying glass sometimes, when I'm working on very tiny boards. It can be hard on the eyes. But I enjoy the work. It's not boring at all, because I put together many different kinds of circuit boards, and the variety makes it interesting."

Karen uses a magnifying glass to put together very small parts.

Karen had been excited and enthusiastic when she talked to Sarah about her job. But now the holiday is over and Karen is back at work. She has to make an effort to concentrate on the work in front of her.

Tools are scattered around Karen's workbench—wire strippers, wire cutters, pliers, lacing cord, a soldering iron. There's cleaning fluid on the workbench, and several trays of electrical components, too. Karen picks up an electrical component and plugs it into some holes in the circuit board. She turns the board over and uses her wire cutters to clip the wire that is sticking out of the circuit board in the back. Then she picks up her soldering iron and solders some metal onto the bottom of the component that's sticking through the circuit board. The melted metal, as it dries, holds the component securely in place. Karen picks up another electrical component and repeats the process.

The "bench" that Karen is sitting at is actually a row of long tables, like the kind used in a school cafeteria. There are lots of benches—row after row. The benches fill up the large warehouse-like building where Karen works. The work area is clean and the temperature is comfortable. Karen likes being able to sit down all day rather than stand, as she'd probably have to do on an assembly line. Sometimes her neck and back get sore from bending over her bench, but it's better than standing all day, in her opinion.

All of the people working at Karen's bench are assembling the same kind of circuit board that Karen is. They work quietly, each concentrating on the work at hand. It's easy to become involved in the work when there's so much detail.

"How's everything down on this end?" The question startles Karen, but she recognizes the voice. It's her supervisor, Betty.

Karen smiles and replies, "All right, I guess, but I'm going to need some more resistors soon."

Betty nods. "I'll go bring some over. Does anyone else need anything?" The man next to Karen asks for some more wire. Betty nods again and then hurries off.

"She's always rushing around," Karen thinks to herself. "But then I guess supervising 30 workers is a pretty demanding job."

Before long Betty is back with the materials. "Oh, Karen," she says, "we have a new worker. She'll be coming out of training after lunch. I thought I'd place her next to you, so that you can help her if she has any problems."

"All right," Karen replies quietly.

"By the way," says Betty, "it's your friend Sarah." Karen looks up with a surprised smile.

Exploring

Assemblers need to be good at working with their hands.

- Are you good at fixing things?
- Are you handy with tools?
- Can you repair your bicycle?
- Do you enjoy leisure activities that involve working with your hands, such as sewing, macrame, stringing beads, model building, or furniture refinishing?

Assembly work usually involves a lot of repetition. Assemblers must be willing to perform repetitious tasks.

- Do you enjoy needlework such as knitting, crocheting, or quilting?
- Can you put up with the repetition involved in mowing grass, shoveling snow, painting a house, or putting down tile?

Speed can be important in assembly work.

- Are you good at activities that require finger dexterity such as slapjack, jacks, or shuffling and dealing cards?

Assembly work requires attention to detail and the ability to follow diagrams and written directions.

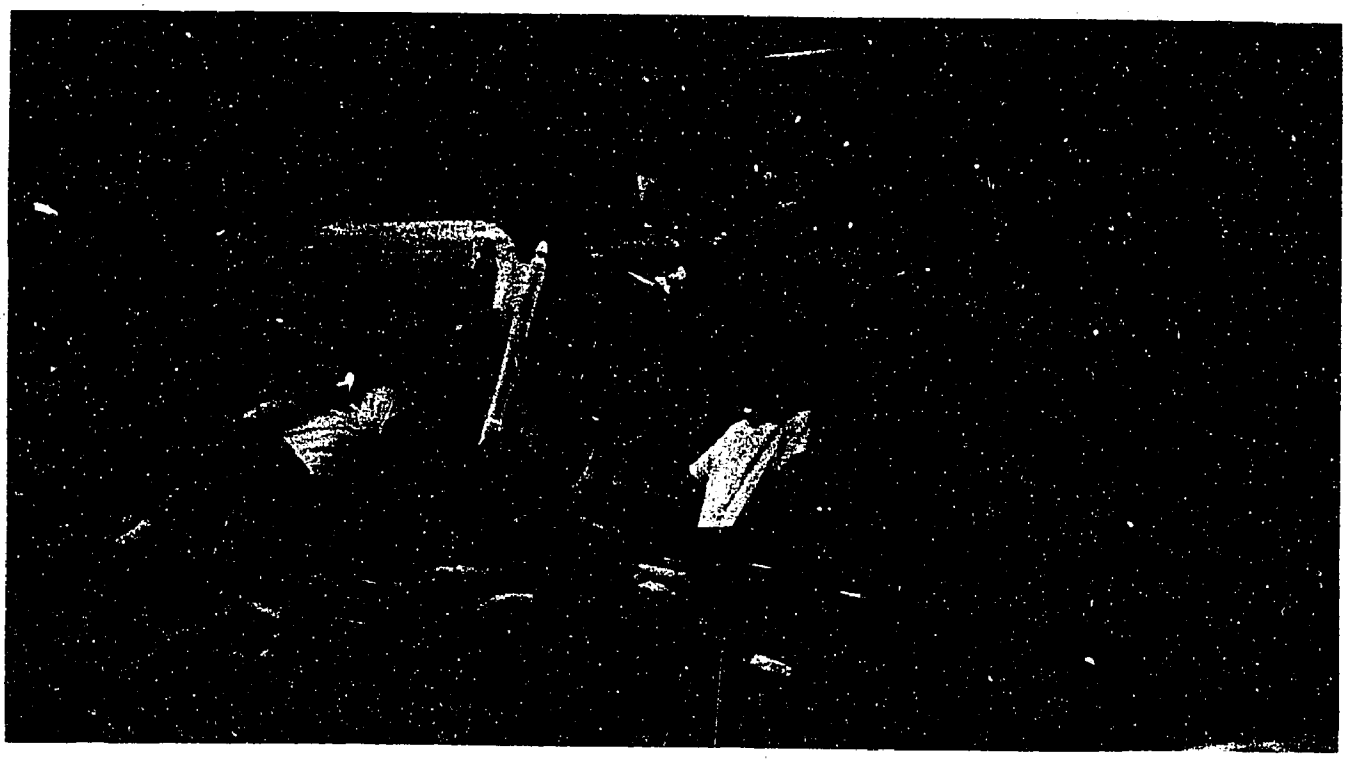
- Are you good at following a recipe, sewing or doing needlepoint from a pattern, building a model from written instructions, assembling a radio from a kit, or painting by numbers?
- Are you good at reading maps?
- Do you understand football plays when they're written out?

Assemblers work indoors. They stay in a small work area while they do their jobs.

- Can you sit still through your classes?
- Can you concentrate without feeling the need to move around all the time?

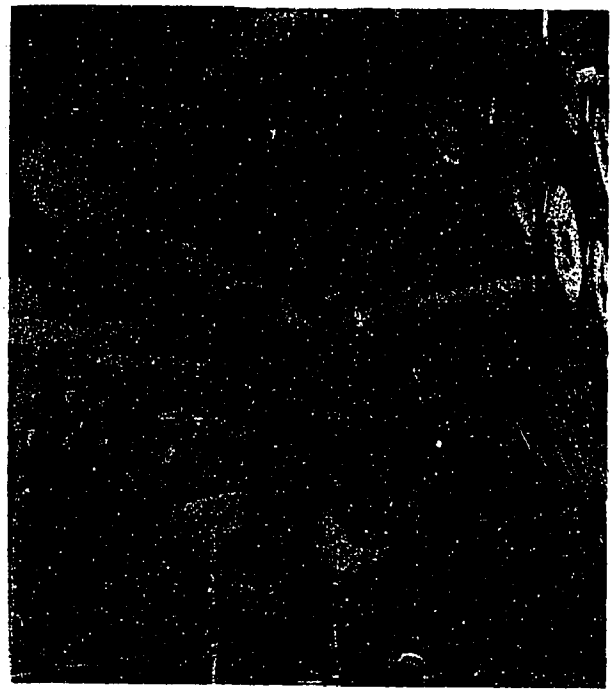
Suggested Activities

Ask your teacher to arrange a plant tour if there is a factory in your community. Prepare questions in advance on the types of production jobs there. Ask about the education and training needed to get a job, starting pay, and opportunities for advancement.



Factory workers relaxing in the products they make.

This worker is filling capsules with medicine.



These strands are being twisted to make tire cord.

Prepare a report on Henry Ford and the assembly line for your English or social studies class. Explain how this method of organizing work has affected the manufacturing process. How has it affected the workers?

Use *Working* by Studs Terkel as the subject for a book report in your English class. (New York: Pantheon Books, 1974.)

Related Occupations

Assemblers aren't the only workers with factory jobs. Using the descriptions below, unscramble the letters to find the names of other production workers.

1. GIEWSN NAEMCIH TOAPRORE. I use a sewing machine to join, gather, hem, reinforce, or decorate such articles as carpets, gloves, hats, bags, and upholstery.

2. YAPSR NEITRAP. I use a spray gun to spray the surfaces of machines, manufactured products, or working areas with paint, enamel, glaze, gelcoat, or lacquer. Before painting something, I often clean grease and dirt from it; sometimes I fill cavities and dents with putty.

3. HAMNICE TURTEC. I cut fabric into parts for such articles as canvas goods, house furnishings, garments, hats, stuffed toys, and upholstered furniture, using a portable electric cutter. I generally cut many layers of fabric at a time.

4. CITAAMOUT NIRTP EPELOVERD. I tend several machines that automatically develop, fix, wash, and dry photographic prints.

5. CIAMNEH GAPARECK. I tend machines that perform packaging functions, such as filling, marking, labelling, tying, packing, or wrapping containers.

6. NARY DWENRI. I tend machines that wind strands of yarn into packages for further processing, shipment, or storage.

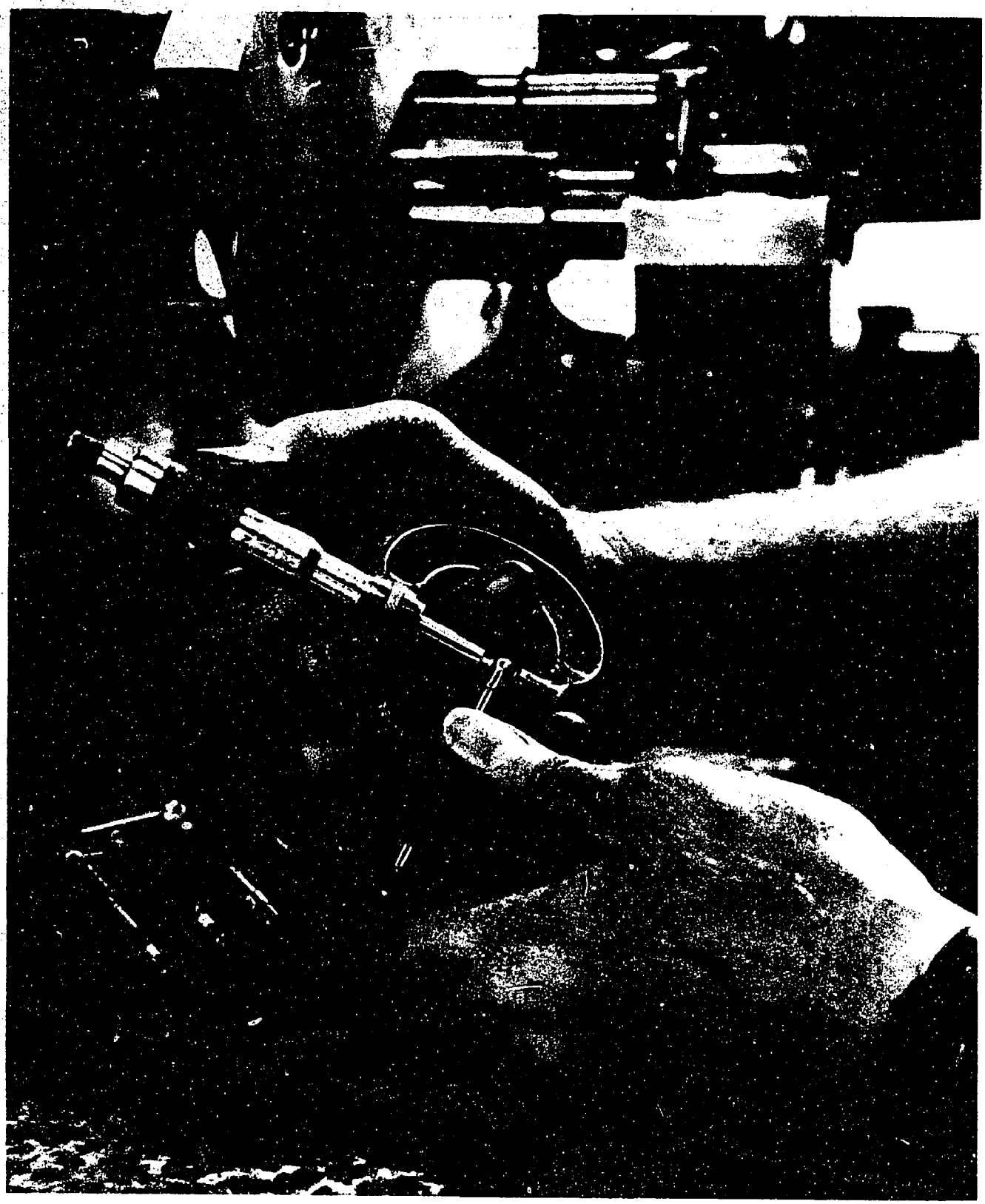
7. PLUMAOE RELFLI. I tend a machine that fills small glass containers known as ampoules with measured doses of liquid drug products.

8. ENARCYN KEWROR. I put fruits, vegetables, meat, cheese, and other food products into processing equipment—washing, peeling, refrigerating, coring, pitting, trimming, grinding, dicing, cooking, or slicing machines. The work I do is used in canning, freezing, preserving, or packaging food products.

9. GTNTKINI HICANEM TROPAEOR. I tend several machines that knit fabrics, garment parts, or other articles from yarn.

See answers at end of chapter.

Machinist



Machinists do very precise work.

Joe rolled over and opened his eyes. Through the dense grey haze he could make out small lights twinkling like stars.

"Strange, it wasn't foggy out," he thought, trying to make some sense of the haze that had swallowed him up. Images swirled through his mind: A quiet summer night, the street leading to his house, unfamiliar lights behind a hedge, a blinding flash, and....

Joe realized with a start that he was no longer outside his house. In fact he had no idea where he was. Alarmed, he jumped to his feet, but lost his footing and fell backwards. As Joe struggled to his feet, he saw that the surface underneath him was as clear as glass. He knew already that it was as slick as ice.

Joe made an effort to focus on his surroundings despite the grey haze that made it difficult to see. He seemed to be in the middle of a large round room. He stood and cautiously took a step toward the lights.

"Who are you?" boomed a loud, authoritative voice. Joe froze.

"Who are you?" repeated the voice impatiently. Joe saw the spheres of light blink as the voice spoke. He felt compelled to answer.

"I'm Joe Von Braun. Where am I?"

No answer. Joe thought about making a break for it, but remembered how slippery the floor was.

"I must be dreaming," he thought. "Of course, this is only a dream. I'll wake up any minute."

"Please, don't run," said another voice, a soft and soothing one this time. The sound frightened him even more, because this voice was closer and undeniably real.

As Joe turned in the direction of the voice, the haze grew lighter. Only a few yards in front of him a sphere of light was suspended in midair. In the haze it looked like the sun on a cloudy day.

"Please, sir, don't run," repeated the gentle voice. The light blinked as the words were spoken. Joe still was too frightened to speak.

"We know our first voice disturbed you, but we mean no harm. We are visitors to your world and we wish to know more about you. We have talked to many of you, but there is still so much to learn. Please tell us about yourself."

The voice was calm and reassuring. Encouraged, Joe began to speak. He spoke haltingly at first, then more confidently.

"I don't know where to begin...."

"Tell us anything."

"Well, my name is Von Braun. I'm 35. Have a wife. What else? I'm a machinist...."

"That's interesting. We've never talked to a machinist before. What is it?"

"A machinist is...that is...I make things."

"What things?" asked the voice, quietly.

"Parts for machines, usually. I work in a machine shop that makes replacement parts for water pumps, electric generators, sometimes cars...well, anything, really. We'll make almost anything from metal."

"What is metal?"

"What is metal?" repeated Joe, puzzled. "Everyone knows what metal is."

"We're sorry, but we don't," replied the voice. "Please explain metal to us."

"Metal is a...well, it's steel, iron, brass...I don't know the scientific definition. How can I explain? Wait, I'll show you."

Joe searched his pockets and found the 6-inch steel ruler he used at work. He held the ruler in front of him and said, "This is metal. This is steel...."

A white light streaked from above, touched Joe's hand and instantly disappeared. The ruler was gone. Joe fell to his knees. He was almost in tears.

"We do know metal. We have seen it before. Tell us more about how you work with metal."

"Please don't hurt me," cried Joe.

"Don't be afraid," responded the voice, as the sphere of light blinked rapidly. "We would never hurt you. We only want to understand. We have seen metal before, but we have nothing like it where we live. We are eager to learn about it. How do you make things from metal?"

Joe hesitated, then began talking again. He did not know what else to do.

"Usually I work from a blueprint the boss gives me. I start...."

"What is a blueprint?" interrupted the voice.

"A blueprint is a drawing of the part I have to make. By looking at it I know what the final product will look like. The blueprint also has the specifications. They tell me how long and wide to make the part and what kind of metal to use. Usually the specifications also give an estimate of how much time I have to make the part."

"Thank you, we understand what a blueprint is. Please continue," said the voice, as the sphere blinked.

"First I gather the metal stock. I'd better explain that. "Metal stock" is a term for all the different pieces of metal I'll be working with: Steel rods, brass tubing, bars of aluminum, whatever. Then I do the layout. I mark the metal to show where I should cut it, put holes in it, or shape it."

"How do you cut it or shape it? Isn't metal too hard?"

"I use machines," explained Joe. "There are all kinds of machines specially designed to work metal—lathes, milling machines, drill presses, planers, and grinders, for example.

"I use saws to cut metal to the right length; drills to put holes in it; planers to shape it; and grinders to smooth its surface. The milling machine and the lathe are the most versatile of all. They can do almost any job."

"So these machines do all your work," said the voice.

"No, no, no," Joe said hastily. "The machines are useless without me. I have to set them up, so they run properly."

"Oh, excuse us. Please go on."

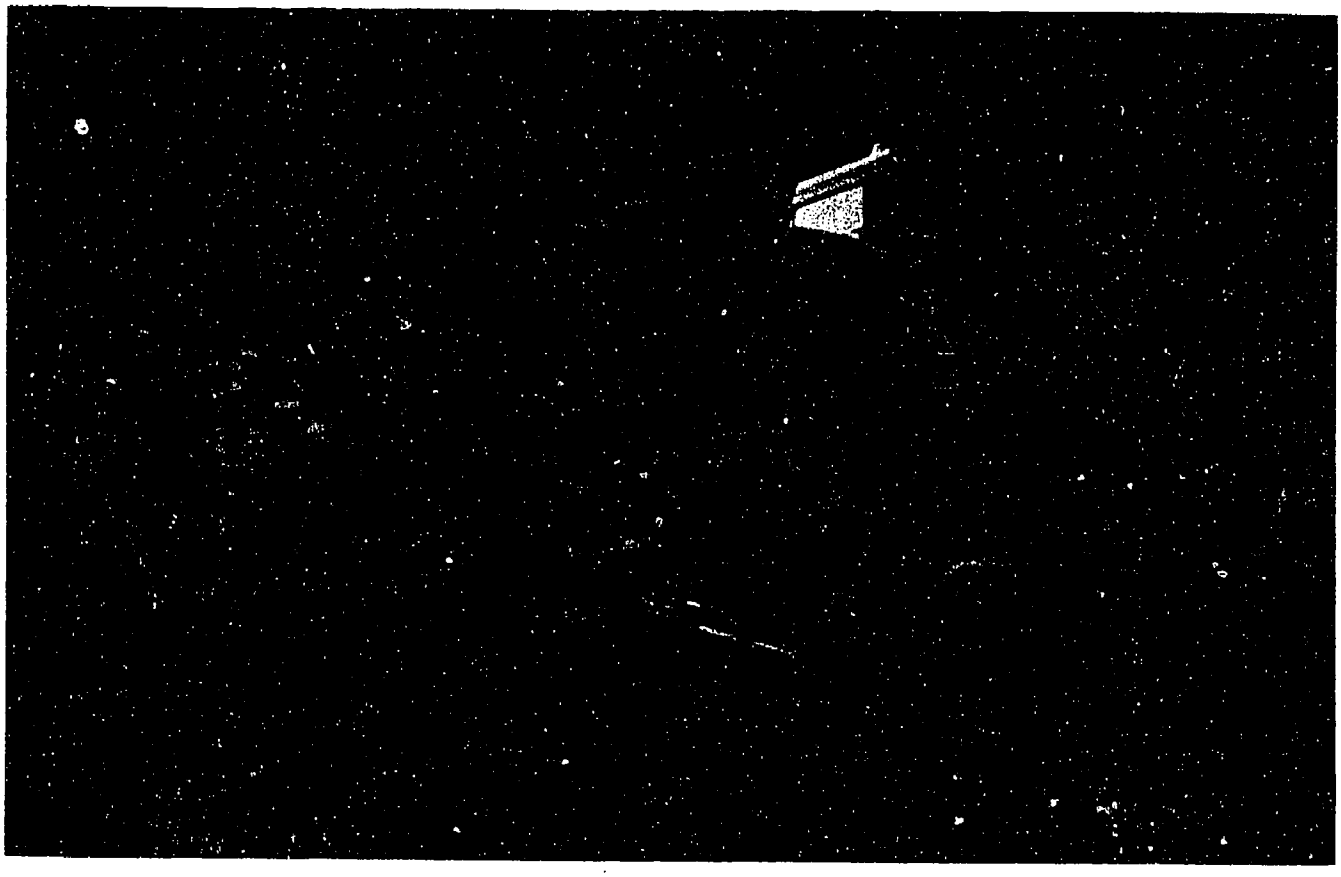
"After I've done the layout, I start using the machines. The first thing I do is decide which machines to use. Usually that depends on what I'm doing. For some jobs I have to use a certain size lathe or a milling machine. For others I can choose how I do the job. Take drilling a hole. I can use a drill press or a milling machine. The drill is a little faster, but the milling machine is more accurate.

"The next step is to set up the machine. The part of the machine that actually cuts the metal I'm working on is called the tool. Tools come in all shapes and sizes. Some are round with teeth like a circular saw. Others look like chisels. Tools are made from different types of metal, usually very hard steel. Before I can cut the metal workpiece, I have to select the tool that's the right shape, size, and hardness to make the cut I need.

"Then I mount the tool on the machine and set the speed that determines how fast the tool will cut the metal. The speed is very important. If I make the cut too fast, the tool will wear out quickly or break. This could ruin the workpiece. Sometimes I set up a hose that sprays liquid on the tool and the metal. The liquid keeps them cool as the cutting is done.

"All of this may be hard to understand. Let me give you some examples. Say I had a bar of metal an inch in diameter and I wanted to make it thinner—just half an inch in diameter. I would put the bar on a lathe. The bar lies in the machine horizontally and spins very fast. A tool that looks like a chisel would be held in a clamp on the side of the machine. By moving handles and gears at the base of the lathe I can position the tool against the spinning bar, to cut it to the right size.

"If I wanted to put a hole in the same bar, I would use the milling machine. The bar would be clamped on a flat table that moves up and down and sideways. The tool—in this case a drill—is held in an arm above the table. The tool spins and the bar is positioned under it.



Machinists are among the most highly skilled manual workers.

"You're doing fine," said the voice. The lights blinked several times. "What do you do after you have cut the metal with the machines?"

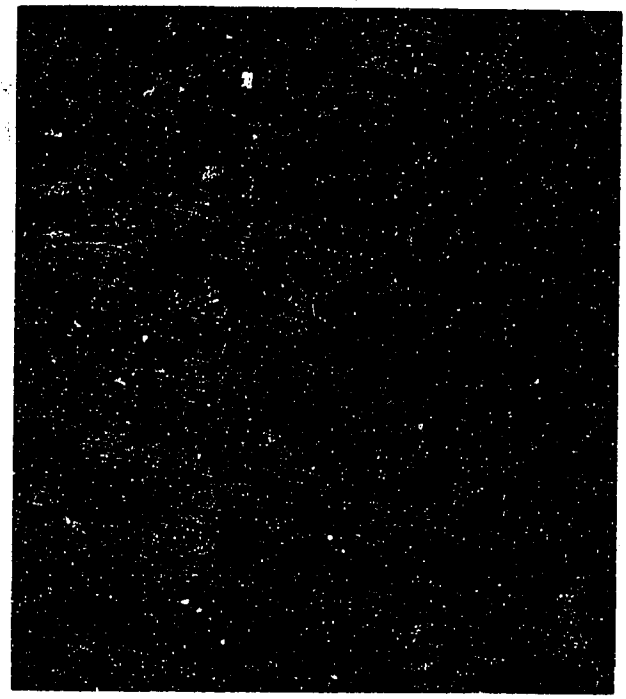
"Well, after I've cut the metal, I measure it to make sure it meets the specifications. Sometimes I can do it with a ruler, that thing I showed you before. Most jobs require more precision. A workpiece may have to be between 5.999 and 6.001 inches long. I use a micrometer to make really precise measurements. The precision is necessary because the part I make usually goes into a larger machine. I have to make it just the right size, so it fits.

"When I'm sure all the pieces are acceptable, I can assemble the part. That means a lot of hand work with files, hammers, and screwdrivers—and more measuring. And that's it," concluded Joe.

"Do all machinists do the same things you do?" asked the voice.

"No, not at all. It depends on where you work. Some machinists make the same part over and over again. Others make many different kinds of parts; that's what I do. And some machinists work in factories repairing production machinery. Well, is there anything else you want to know?" sighed Joe.

"Are you tired? You have been very helpful."



Machining requires concentration.

on your feet most of the day, and it's not just physical work. You have to be able to plan. You have to be good at math to calculate the measurements, machine speeds, and such. You have to be able to concentrate and have the patience to do really precise work. Besides all that you need a bit of imagination. Not everyone can make a three-dimensional object from a flat drawing."

"You are very proud of your skills."

"I always have been—ever since my apprenticeship. There's something special about taking a piece of metal and turning it into something useful."

"What is an apprenticeship?"

"It's a traditional way of learning a craft or trade. You learn by working with experienced workers. And by studying. After I graduated from high school I was accepted in an apprenticeship program at the Navy Yard. I learned to run the machines on the job and studied math, blueprint reading, and the characteristics of metals in evening classes."

"You have been most helpful," said the voice. "But if we don't return you now, you will be missed."

"Wait a minute," shouted Joe. "Who are you? Don't you think you owe me some explanations?"

"Whatever we tell you, you would forget in a short time. Goodbye and thank you." The sphere vanished.

"Wait! Wait!"

As Joe shouted the grey haze grew more dense. Soon he could not see anything. He felt very warm and the haze was so thick he had trouble breathing. He thrashed wildly with his arms.

A hand firmly gripped his shoulder. "Joe, wake up! Wake up!"

Joe jumped up. He was in his bed and his wife was shaking him.

"That must have been some dream," she said.

"Was it ever!"

"It's over now. Go to sleep."

The next day Joe could not recall any of the details of his dream nor could he find his steel ruler.

Exploring

Machinists make parts for factory machinery, cars, and other metal products.

- Do you like to build things?
- Do you like to work with your hands?
- Do you build models or make jewelry?
- Do you repair bicycles or customize automobiles?
- Do you enjoy woodworking?

Machinists use handtools and such machines as lathes and drill presses.

- Do you use tools or machines for a hobby, for work around the house, for gardening, for farming, or for repairing cars, vans, or trucks?
- Do you like to learn how machines work?
- Do you like to learn how to use tools?
- Is it easy for you to learn how to use a tool you've never used before?

Machinists follow blueprints and diagrams. They use mathematics to make measurements and set up their machines.

- Can you read and understand graphs, diagrams, and charts?
- Can you read road maps?
- Can you look at a drawing and picture the three-dimensional object in your mind?
- Do you like to work with numbers?
- Do you like to solve written math problems?

Machinists must do accurate work.

- If you are fixing or building something, do you try to do it just right?
- Have you ever done any detailed work?
- Do you build complicated models or embroider?
- Can you work on something for a long time without becoming bored or careless?

Machinists usually work with little direct supervision. They must be responsible.

- Do you usually get your school assignments done on time?
- Can you work alone successfully?
- Do you have hobbies in which you work alone?

Suggested Activities

Spend time on hobbies and other activities in which you build or repair things. Build models. Do carpentry. Sculpt. Make metal jewelry. Make repairs around your home. Repair your bicycle.

Volunteer to repair toys for a nursery school or day care center, or for a community organization such as the Salvation Army.

Join a chapter of VICA (Vocational Industrial Clubs of America), if your school has one. VICA chapters plan projects, take field trips, and hold competitions in such skill areas as machine shop and machine drafting.

Join an Auto Mechanic or Skilled Trades Explorer Post, if there is one in your area. Exploring is open to young men and women aged 14 through 20. To find out about Explorer posts in your area, call "Boy Scouts of America" listed in your phone book, and ask for the "Exploring Division."

If your school has a machine shop, ask the instructor to talk to your class. Arrange a tour of the shop.

If you are a Girl Scout, see if your local troop has the From Dreams to Reality program of career exploration. Troops may also offer opportunities to try out careers through internships, service aide and community action projects, and proficiency badges in a number of areas including Handywoman and Metal Arts.

If you are a Boy Scout, try for merit badges in Machinery, Metallurgy, Metalwork, and Model Design and Building.

Investigate the properties of metal for a report for your science class or for a science fair project. Compare the characteristics of several metals. Gold, for example, is relatively soft and easy to shape. Steel is harder and more difficult to work with. The encyclopedia is a good place to start your research. Public and school libraries have books that explain how different metals are made and used.

As a topic for a science or industrial arts class, report on machine tools such as lathes, milling machines, and drill presses. Illustrate your report with pictures and diagrams. The encyclopedia is a good place to get an overview of the topic. Library books will explain in more detail how machine tools work and what they are used for. Write for information to the National Machine Tool Builders Association, 7901 Westpark Drive, McLean, Virginia 22102.

Mathematics is an essential tool for machinists because precision is so important in their work. Machinists may work within tolerances as fine as 1/1,000 of an inch. To achieve this sort of precision, they make measurements and do calculations. See if you can solve the problems below. They are typical of some of the simpler problems machinists deal with every day.

- A machinist must cut the following lengths from 2-meter bars of steel: 156 centimeters, 176 centimeters, 19 centimeters, 42 centimeters, and 117 centimeters. How many 2-meter bars will that take? How much steel will be left over?
- In cutting gears for a piece of machinery, the number of teeth on a gear depends on the diameter of the wheel. A machinist has just made a gear with 50 teeth and a diameter of 10 inches. How many teeth would be on a gear with a diameter of 7 inches?
- A machinist has been assigned to cut a groove in a metal block so that the depth beneath the groove is 2.5983 inches. The block is 2.7482 inches thick. After finishing the job, the machinist measures the groove and finds it is .1498 inches deep. In order to work, the part must have been machined to within a tolerance of 1/10,000 of an inch. Is the part acceptable?

See answers at end of chapter.

Because measurements are very important in machinists' work, the conversion to the metric system will affect their job in a number of ways. Use the topic of metric measurement in metalworking for a report in a mathematics class. You might begin your research by writing for information to the Office of Weights and Measures, National Bureau of Standards, Washington, D.C. 20234. They also will supply a list, by State, of speakers to talk about the metric system.

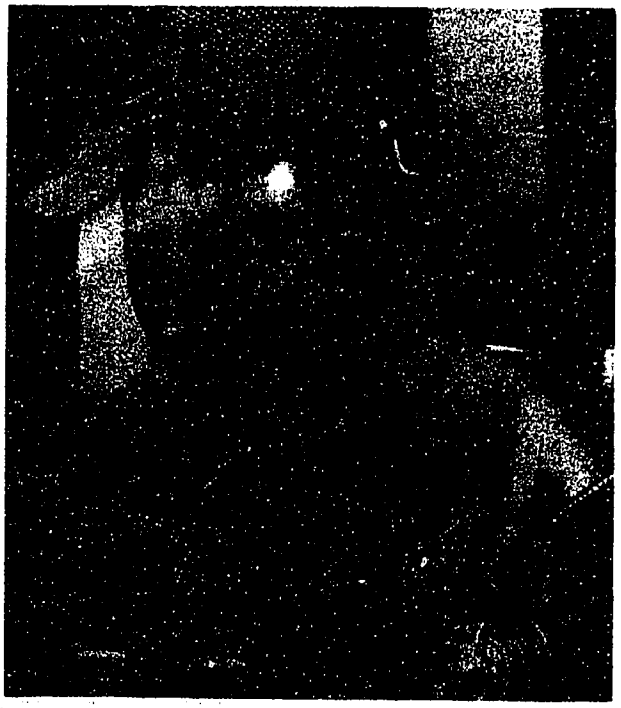
Related Occupations

Machinists are not the only workers who deal with metal and machines. Eight occupations in which the work is similar to a machinist's are listed below. Try to match the workers with their job titles.

a. Machine tool operator
b. Instrument maker
c. Setup worker
d. Tool-and-die maker
e. Mechanical engineer
f. Industrial machinery repairer
g. Jeweler
h. Watch repairer

1. Dan makes machines that are used for measurement in industrial production and research. He has all the skills of a machinist and more.

2. Brenda sets the speed on drill presses used by less skilled workers.



Most machine tool operators learn their skills on the job.

3. George works with precious metals. He can shape gold, silver, or platinum just as a machinist shapes steel or brass.

4. Jim makes or repairs parts for a machine used by almost everyone. He uses a lathe just as a machinist does. The parts in his machine are so small that Jim uses a magnifying glass and tweezers to work with them.

5. Sarah designs machinery. She had to attend college to get her job.

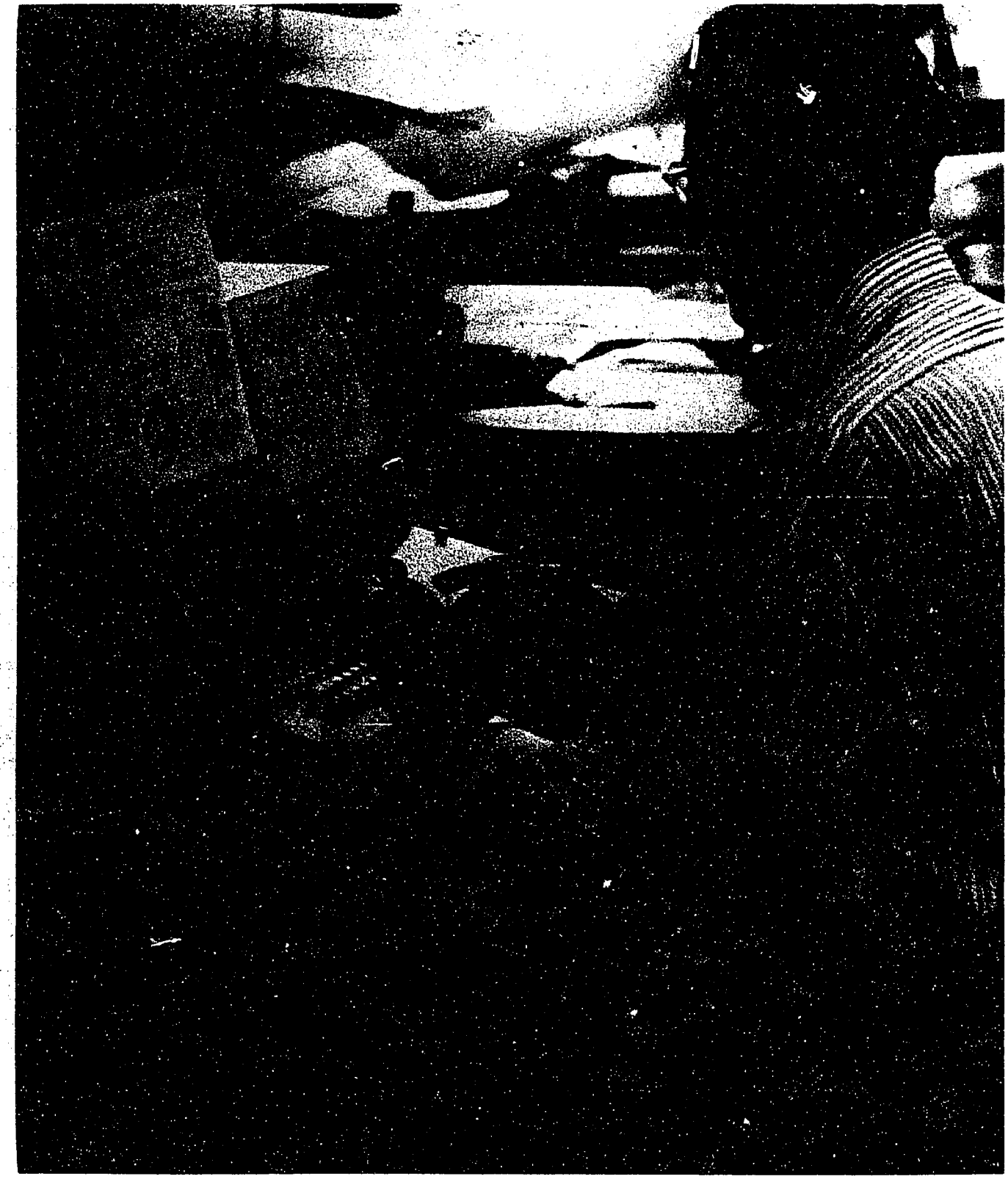
6. Beverly makes the cutting devices used in machine tools. She learned many of her skills as a machinist.

7. Doug operates a drill press and grinding machine. He learned his skills on the job in a few months.

8. Susan repairs and maintains machines used in factories. Sometimes she uses machine tools to make replacement parts. Usually, however, she has the factory's machinist do the work.

See answers at end of chapter.

Photocompositor



Bernard Petrocelli is setting type on a phototypesetter. "This is like using a typewriter," he explains, "but there is a lot more to know."

Bernard Petrocelli pulled into the parking lot of Broadview Elementary School. Before getting out of his car, he glanced in the rear-view mirror to make sure that his tie was on straight. "I'm glad I don't have to put on a suit and tie every morning," he thought to himself.

He checked in at the office, where Ms. Kawasaki, his daughter's sixth grade teacher, was waiting to greet him.

"It certainly is nice to meet you, Mr. Petrocelli. We've all been learning so much from the parents who come and speak to the class about the work they do. I'm sure the children will be fascinated to hear about your job."

"Thank you very much," replied Mr. Petrocelli as the two walked down the hall.

Ms. Kawasaki continued, "I've been doing a bit of research and I'm amazed at the changes that have taken place in the printing industry in the last 20 years. In fact, I just finished reading about a process for storing information called micropublishing. It seems that they are working on some equipment that can record an entire textbook on an area the size of a postage stamp!"

"Yes, there have been some astounding changes in printing technology. And, with the use of computers, things are changing more rapidly than ever. My work in the composing room has come a long way from the days behind a noisy Linotype machine casting hot metal."

The two adults entered Ms. Kawasaki's classroom and took seats in the back of the room, waiting quietly for the music teacher to finish his lesson.

After music was over, Ms. Kawasaki went to the front of the room to speak to the class. "As you all know, we have a guest speaker today who is here to help us learn more about the world of work. He is Mari't's father, Mr. Petrocelli, and he is going to tell us about his job as a photocompositor in a print shop. We already have discussed how important printing is, as a means of both communication and learning, so I think you will all be interested in finding out more about the process. Now, without further delay, I'd like to introduce Mr. Petrocelli."

"Good morning, boys and girls," Mr. Petrocelli began. "It's a pleasure to be here. As your teacher told you, I'm a photocompositor and I work for the Atlas Printing Company—a large shop downtown. We print everything that's fit to be published, including magazines, brochures, advertisements, envelopes, and even labels for cans of food. This morning I'm going to talk to you briefly about the history of printing and then I'll tell you about my job and what I do. Please feel free to ask questions at any time."

A boy who was sitting on the edge of his seat raised his hand and burst out, "Do you print money, too?"

Mr. Petrocelli smiled and replied, "Paper money is printed, but that's one job we don't handle at Atlas. It's illegal for anyone but the Federal Government to print its paper currency. That's done at the U.S. Bureau of Engraving and Printing in Washington, D.C.

"Printing was first practiced by the Chinese over a thousand years ago," Maria's father continued. "They used carved wooden blocks to print. I imagine you've done pretty much the same thing yourselves in art class. Those early Chinese printers carved pictures or words on wooden blocks, inked or painted the blocks, then pressed them against another surface to make a print.

"The wood block method of printing developed by the Chinese was slow and painstaking. Most books and manuscripts were handwritten until the 1400's. About this time, people began experimenting, looking for a way to produce books more quickly and cheaply. Around 1450, a German named Johann Gutenberg invented a process for making movable type out of metal. The process allowed him to use the same type over and over again to print different pages. He also invented the printing press, which he probably adapted from a wine or cheese press, and developed sticky ink to be used with the metal type."

A girl in the front row raised her hand. "We learned that Johann Gutenberg is called the Father of Printing."

Mr. Petrocelli replied, "Yes, he is often referred to as the Father of Printing because his invention of movable type revolutionized the printing process. Printing spread rapidly in Western Europe, and by the early 1500's more than a thousand print shops were operating."

"What has happened since then?" asked a small boy in the back of the room.

"Our story continues," said Mr. Petrocelli. "The first book was printed in America less than 20 years after the Pilgrims landed at Plymouth Rock. The writings of two early printers, Benjamin Franklin and Thomas Paine, strengthened the spirit of unrest in the 1700's that eventually brought about the American Revolution. Their influence kept up the will of the Colonies to win the war.

"Over the years, printers gradually introduced improvements in the typesetting and design of books. Eventually, the job of printing became specialized. That means the printer—who in the days of Benjamin Franklin was also the publisher, editor, type designer, and book seller—no longer performed all those other duties."

"Are you a printer?" a girl in the third row wanted to know.

"Well, not exactly...I was just getting to the part where I fit in," answered Mr. Petrocelli. "The 20th century has witnessed many changes in printing. Jobs have become much more specialized as the industry has grown. And the printing industry has grown tremendously! Well over a billion books are bought each year in the United States alone. Furthermore, technology has changed the way we do our jobs. Today's world is one

of automation. Machines perform much of the work that used to be done by hand. I think my job in the composing room illustrates some important changes that have taken place in the printing industry over the last 25 years.

"In the composing room, we set the type. We take the "copy"—the material that is to be printed—and from that we prepare pages of type. When I first started as a compositor 27 years ago, I operated a machine called a Linotype. I learned the work right on the job, as an apprentice. To make a line of type, I punched the letters from the keyboard. The machine then made words from a hot metal mixture it had pressed into molds of these letters. This cooled into a solid metal strip—or 'line o'type'." He reached into his pocket and pulled out a silver colored bar. "To give you a better idea, I brought along a line of type."

"Can we pass it around the room? I can't see it," came a voice from the back of the room. "We'll handle it very carefully."

Mr. Petrocelli smiled. "That's a good idea, because the metal is a mixture of lead, tin, and antimony, and it will bend or scratch rather easily. It's not hard like steel or copper."

He continued, "Operating the Linotype was hard work. The machines were hot and noisy and my clothes often got splashed with hot lead."

"Then why did you stay in that job?" a girl asked.

"There were lots of good things about the job," Mr. Petrocelli replied, "For one thing, I've always been proud to work in the printing industry because it's so important to all of us. And a job like mine takes skill. When I was operating the Linotype, I had to space all the words

Computers and electronics are changing printing methods. Hobbies and courses in these areas provide a good background for printing.

properly to fit the column size and decide where to break words at the end of a line when necessary—all those things require judgment.

"After I had been there about 10 years, the company I was working for adopted a new method of setting type. Instead of the machine casting of molten metal, type is set by a photographic process that uses paper and chemicals. Because photography is such an important part of this process, it's called phototypesetting. Sometimes it's called photocomposition.

"To make the change, I had to go through a training program. I wasn't at all pleased about changing over to cold type at first, and complained about it to the union representative. I figured that I had mastered the Linotype and I didn't want to start from the beginning with a new machine. I was pretty upset for a while. But eventually I realized that the Linotype machine really was on the way out, and that I had no choice but to pick up new skills."

"Wasn't it hard to "relearn" your job after all those years?" asked a boy sitting near the windows.

"Becoming a photocompositor did take some getting used to," Mr. Petrocelli replied. "I had to learn to work a whole new machine. The keyboard was completely different, so I had to block the old one from my mind. Also, this machine produced paper prints or film negatives instead of strips of metal."

"Why did the company change from hot metal to phototype?" a girl asked.

"Phototypesetting offers many advantages over casting type from hot metal," answered Maria's father. "It's a fast, flexible, relatively inexpensive method of setting type.

"For example, in phototypesetting, the print will always be clear and perfect, no matter how many copies must be produced. That's because it's photographed. When metal type is used—the kind you're passing around the class right now—the metal letters must be inked to make print. However, the pressure of the metal type against the paper causes "ink squeeze", which tends to make the edges of the printed letters irregular. Also, phototype is very convenient when different type sizes are needed for one job. A simple magnifying lens allows the machine to photograph correctly sized type."

Mr. Petrocelli went on. "My career took one more major twist when I went to work for Atlas about 4 years ago. Being a large company, they had the most modern equipment. Once again I needed more training. . .because Atlas uses computers in their typesetting system."

An enthusiastic student burst out, "Wow, another "new career" for you!"

"In a way, yes," Mr. Petrocelli responded. "In this typesetting operation, I type on a special keyboard just like I did in the other phototype process. The keyboard has many extra keys, however, and I had to learn them all. There are keys, for example, that indicate the size and style of type and the space between letters. There also are keys that give the machine directions such as "delete" or "store in memory". A screen that looks like a television screen has been added to the keyboard so now I can see the characters as I set the manuscript. The screen is called a Visual Display Terminal.

"After the copy has been typed onto the keyboard, my machine produces a tape that later is fed into a computer. The computer's job, basically, is to decide when to hyphenate words and how to space them properly so that the margins will be even. The computer has been programmed with a set of rules so that it knows, for example, that *hearing* should be hyphenated *hear-ing*. It also is instructed that *ring* should not be hyphenated *r-ing*, as that's a one-syllable word. When I handled the Linotype, I made all those decisions myself. The computer produces a tape that "drives" our phototypesetting machine and prints out material much faster than any person could do it. Our system, for example, can print a page of type every 3 or 4 seconds!"

The students clearly were impressed. Maria beamed. Her father then asked for more questions.

One boy hesitated, then asked, "In the beginning, you said you learned your trade by apprenticeship. I'm not sure what that means."

"That's a good question," Mr. Petrocelli replied. "In the apprenticeship training program, I learned my trade on the job—at first by watching others and then picking up skills on my own. At the same time I had classroom instruction in related subjects, such as typography, printing, and English. The program was run jointly by the union I belong to and the company. It lasted 4 years; I gradually gained more responsibility and earned more money."

Another pupil asked Mr. Petrocelli what advice he'd give to students interested in printing.

"First of all, I would recommend that you finish high school. There are courses you can take in school that will give you a good background—typing and English, for example. Don't underestimate English! Grammar is a "must". And learn all you can about electronics, computers, and photography—for that is where the future lies in the printing industry."

Ms. Kawasaki walked up the aisle and joined the speaker at the front of the room. "I'm afraid our time is up, but I'd like you to know how much we enjoyed your talk today."

"It was my pleasure to be here," replied Mr. Petrocelli.

Just then the class broke out in loud and enthusiastic applause.

Exploring

Photocompositors need finger and manual dexterity in order to type copy on the keyboard of a composing machine.

- Do you knit, do needlework, or do macrame?
- Can you thread a needle quickly?
- Can you type?
- Are you good at games like slapjack and jacks?
- Can you shuffle and deal a hand of cards quickly?
- Do you enjoy leisure activities that involve working with your hands, such as making jewelry, building models, or refinishing furniture?

Photocompositors must have an eye for detail. They must follow the copy exactly and detect every single mark on material that comes back for correction.

- Can you read road maps easily? Can you find a place on a road map quickly?
- Do you like to do word-finds and other games where you must find hidden objects in pictures?
- Are you good at following a recipe, sewing or doing needlework from a pattern, building a model from written instructions, assembling a radio from a kit, or painting by numbers?

The work of photocompositors can be repetitious.

- Do you enjoy needlework that involves a lot of repetition, such as knitting, crocheting, or quilting?
- Can you put up with the repetition involved in mowing grass, shoveling snow, painting a house, or putting down tile?

Photocompositors work indoors. They are confined to their work areas for long periods of time.

- Can you sit still in the car during long trips?
- Can you sit still through your classes or an assembly program?

Suggested Activities

Ask your teacher to arrange a field trip to view the printing process at a local printing plant or newspaper.

Invite a compositor to speak to your class about his or her job. Ask the speaker to bring in galley proofs and explain the proofreader's marks.

Try your hand at printing, using one of the inexpensive printing kits you can obtain at hobby shops or department stores.

- Put your name or initials on greeting cards or stationery.
- Make business cards for the staff of your school newspaper or yearbook.
- Print letterhead stationery for a school club.
- Print publicity for a school event such as a career day, concert, science fair, or awards ceremony.
- Volunteer to print flyers, bulletins, and news releases for your church or temple, or for a community organization.

Use the silk-screen process to print a poster, greeting card, or gift enclosure. Design and print holiday wrapping paper.

Set up a printing business as a class project under the Junior Achievement (JA) program. This program

Mr. Petrocelli helps an assistant with layout work.

gives high school students a chance to operate an actual business. JA printing companies typically do job printing or publish local newspapers or magazines. For information, write to Junior Achievement, Inc., 550 Summer Street, Stamford, Connecticut 06901.

Your school system, or a nearby community college or technical institute, may offer courses in printing or graphic arts. If so, invite one of the instructors to speak to your class. Prepare questions in advance on the kinds of printing jobs there are in your community, and the training they require.

Join a chapter of VICA (Vocational Industrial Clubs of America), if your school has one. VICA chapters plan projects, take field trips, and hold competitions in such skill areas as offset printing.

Invite a local representative from the International Typographical Union to speak to your class about apprenticeship opportunities in the printing industry in your community.

If you are a Boy Scout, try for the merit badge in Printing.

Computers and electronics are changing printing methods. Hobbies in these areas provide a good background for a career in the printing industry.

- Do a project on electronics or computers for a science fair.
- Join an Electronics or Computer Explorer Post, if there is one in your area. Exploring is open to young men and women aged 14 through 20. To find out about Explorer posts in your area, call "Boy Scouts of America" listed in your phone book, and ask for the "Exploring Division."

Knowledge of photography is increasingly important in the printing industry.

- Learn how to take pictures with a 35-mm camera.
- Join a Photography Explorer Post, if there is one in your area.
- If you are a Boy Scout, try for a merit badge in Photography.
- If you are a Girl Scout, see if your local troop has the From Dreams to Reality program of career exploration. Troops also offer proficiency badges in a number of areas, including photography.

Artistic ability is necessary for the compositor in a small shop who does layout work. Design a collage or poster for a school activity or a community event.

As a project for an English or art class, set up a display of different types of printed material: Books, magazines, newspapers, flyers, matchbook covers, labels on containers and packages. For each item in your display, identify the type size and typeface. The library has books on typography that will help.

Use the topic of metrics in the graphic arts and printing trades for a report in a mathematics class. You might begin your research by writing for information to the Office of Weights and Measures, National Bureau of Standards, Washington, D.C. 20234. They also will supply a list, by State, of speakers to talk about the metric system.

As a project for an English or social studies class, report on the role of newspapers and the printing industry during the American Revolution.

Write for information on careers in the printing industry to the American Newspaper Publishers Association, The Newspaper Center, Post Office Box 17407, Dulles International Airport, Washington, D.C. 20041 and to the Graphic Arts Technical Foundation, Education Council of the Graphic Arts, 4615 Forbes Avenue, Fittsburgh, Pennsylvania 15213.

Related Occupations

The compositor handles only one step of a printing job. The work of other people in printing and publishing occupations is described below. If you need to, refer to the list of job titles at the end.

1. I run the printing press, inserting print plates into the machine and controlling the ink and paper. I also may have to clean or repair the machine. Who am I?

2. I check the type for all kinds of errors, such as spelling, grammar, punctuation, and margins. Who am I?

3. I make metal printing plates of pictures and other copy that cannot be set in type. Who am I?

4. I make duplicate plates from the forms turned out by the composing room workers. These are used for jobs that demand volume printing, such as books and magazines. Who am I?

5. I operate machinery that folds, sews, staples, and binds printed items. Who am I?

6. I deal with the public, trying to get new business for the printing company. Selling this service requires a knowledge of printing technology and the ability to advise customers about their particular needs. Who am I?

7. I take the manuscript and rough ideas from the client and then plan the design of the job. I prepare the job for the composing room workers. Who am I?

8. I oversee the entire production process, following each job from the planning stage to the delivery to the customer. I must see that we stick to the budget and time schedule set up for every job we do. Who am I?

Bookbinder

Production manager

Electrotyper

Printing press operator

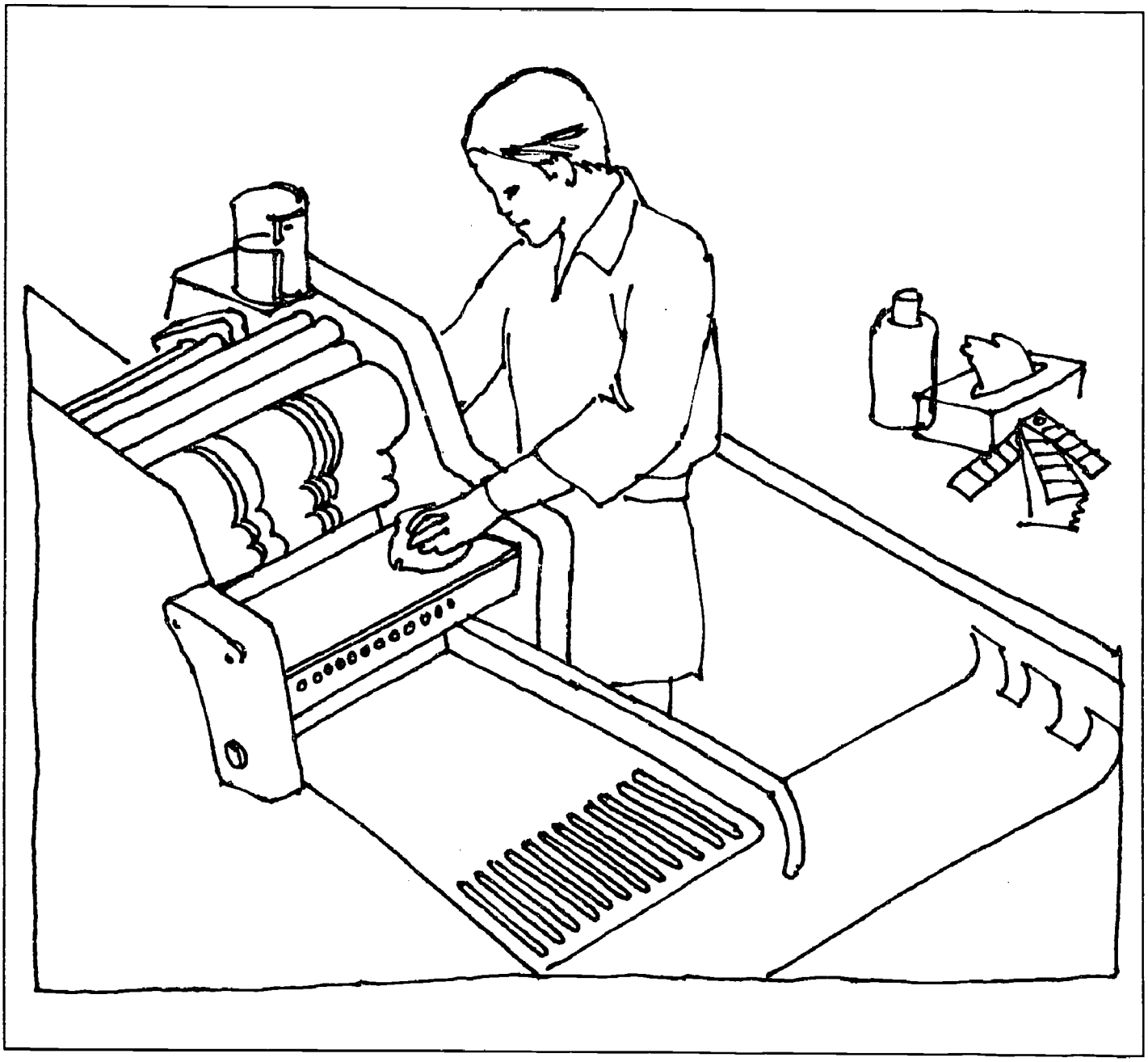
Proofreader

Layout artist

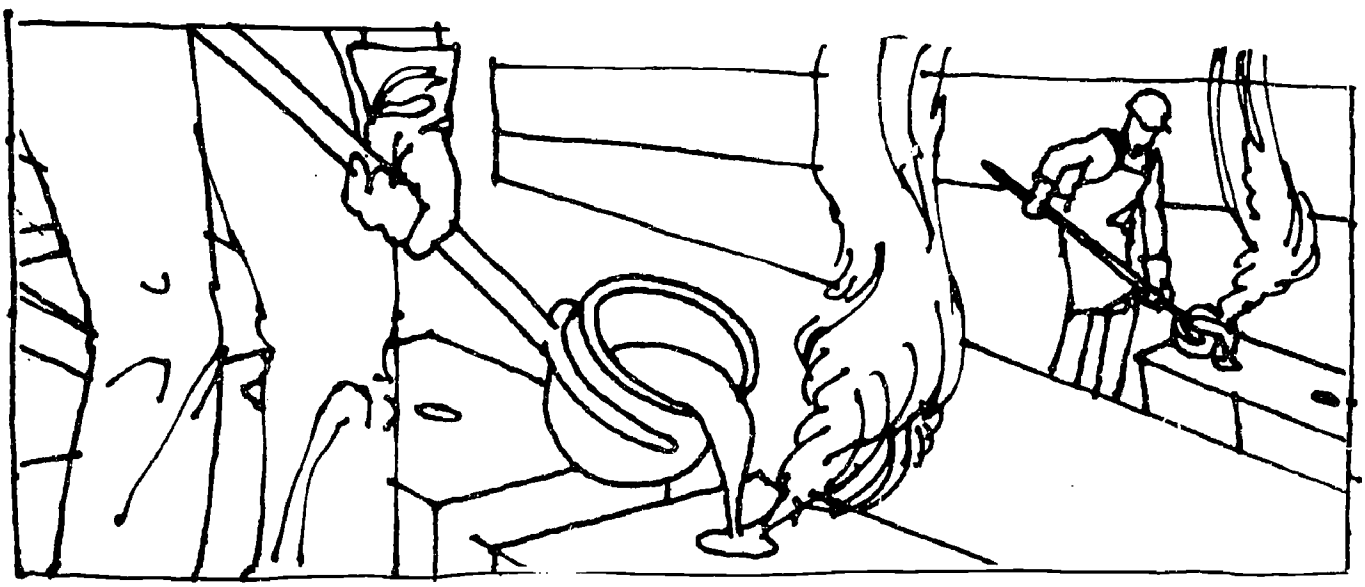
Photoengraver

Printing sales representative

See answers at the end of chapter.



Job Facts



There isn't room in this book for a story about every industrial production occupation. However, you'll find some important facts about 33 of these occupations in the following section. If you want additional information about any of them, you might begin by consulting the Department of Labor's *Occupational Outlook Handbook*, which should be available in your school or public library.

Occupation	*Nature and Places of Work*	*Training and Qualifications*	*Other Information*
FOUNDRY OCCUPATIONS			
Patternmakers	Foundry patternmakers are highly skilled craftworkers. They make the metal or wood patterns that are used in producing industrial and household goods from metal castings. Most patternmakers work in shops that make and sell castings. The rest work in plants that make castings to use in their final products, such as plants operated by manufacturers of automobiles or machinery.	Precision, accuracy, and manual dexterity are very important. Patternmakers work from blueprints and check dimensions with instruments such as micrometers and calipers. To read blueprints, they must be able to visualize objects in three dimensions. Apprenticeship, usually lasting 5 years, is the best way of learning to be a patternmaker. A few apprenticeships last only 3 or 4 years. Although it is difficult to learn the trade on the job, some skilled machinists transfer to metal patternmaking with additional on-the-job training and experience. Employers almost always require apprentices to have a high school education. Vocational and technical school training in patternmaking, metalworking, and machining may be credited toward completion of the apprenticeship.	Patternmakers work indoors in well-lighted, well-ventilated areas and are not exposed to the heat and noise of the foundry floor. Although not strenuous, patternmaking requires considerable standing and moving about. Because patternmakers learn either basic metalworking or woodworking, they are qualified for related jobs—as machinists or cabinetmakers, for example.

Occupation	*Nature and Places of Work*	*Training and Qualifications*	*Other Information*
Molders	Molders make sand molds for use in producing metal castings. Most are machine molders; they operate molding machines that pack and ram the sand mechanically. Others are hand molders, and use manual methods and power tools to construct sand molds. Molders work in shops that make and sell castings, or in plants that make castings to use in their final products.	People become skilled hand molders by completing a 4-year apprenticeship program or learning the work informally through on-the-job training. Less skilled hand molding jobs and most machine molding jobs can be learned with 2 to 6 months of on-the-job training, but employers prefer those with apprenticeship training. While an eighth grade education usually is the minimum requirement for apprenticeship, many employers prefer high school graduates.	Working conditions vary. In older foundries, work is performed in a dusty, noisy, dirty, hot atmosphere. In foundries with improved ventilation and air-conditioning, there is much less heat and dust. The work is physically demanding and may be hazardous at times. Molders must be careful to avoid burns from hot metal.
Coremakers	Coremakers prepare the "cores" that are placed in molds to form the hollow sections in metal castings. Cores are made either by hand or by machine. When hand methods are used, the coremaker uses mallets and other handtools to pack sand into the corebox. Machine coremakers operate machines that pack the sand. Coremakers work in shops that make and sell castings or in plants that make castings to use in their final products.	People become skilled hand coremakers by completing a 4-year apprenticeship program, or learning the work informally through on-the-job training. Apprenticeships also are sometimes required for more difficult machine coremaking jobs. Apprenticeships in coremaking and molding often are combined. While an eighth grade education usually is the minimum requirement for coremaking apprentices, most employers prefer apprentices who are high school graduates.	Coremaking is one of the least hazardous foundry jobs.

Occupation	*Nature and Places of Work*	*Training and Qualifications*	*Other Information*
MACHINING OCCUPATIONS			
All-round Machinists	Machinists are skilled metalworkers. They use metalworking machines of various kinds to make and repair metal parts, tools, and machines. Most machinists work in factories that produce metal products such as automobiles and machinery. Almost every factory using substantial amounts of machinery employs all-round machinists to maintain its mechanical equipment. The Federal Government employs machinists in Navy Yards and other places. Leading areas of employment are Los Angeles, Chicago, New York, Philadelphia, Boston, San Francisco, and Houston.	Precision and accuracy are very important. Machinists consult blueprints before beginning to make a machined product, and check the results with precision instruments such as micrometers. A 4-year formal apprenticeship is the best training, although many machinists learn this trade on the job. A high school or vocational school education is desirable.	All-round machinists can operate most types of machine tools, whereas machine tool operators generally work with one kind only. Machinists must follow strict safety regulations when working around high-speed machine tools. Short-sleeved shirts, safety glasses, and other devices are required to reduce accidents. Opportunities for advancement are good. With additional training, machinists can become tool-and-die makers. Skilled machinists can open their own shops. Many machinists are members of unions.
Instrument Makers (Mechanical)	Instrument makers work with scientists and engineers to translate designs and ideas into experimental or custom-built mechanical equipment. Most of them work for firms that manufacture instruments or for research and development laboratories that make special devices for scientific research. The Federal Government also employs instrument makers. The main centers of instrument making are in and around New York, Chicago, Los Angeles, Boston, Philadelphia, Washington, Detroit, Buffalo, and Cleveland.	Precision and accuracy are important, for instrument makers often work to very fine tolerances. They need spatial and reasoning ability, plus imagination and resourcefulness, for they often work from rough sketches or ideas rather than detailed blueprints. Some instrument makers advance from the ranks of machinists or skilled machine tool operators by completing 1 or 2 years or more of instrument shop experience. Others learn their trade through 4-year apprenticeships. Employers generally prefer high school graduates for apprenticeship programs, and additional technical school training is desirable.	Instrument assembly rooms are sometimes known as "white rooms" because almost sterile conditions are maintained. Serious work accidents are not common, but safety rules require the wearing of certain apparatus and clothing. Many instrument makers are union members.

Occupation	*Nature and Places of Work*	*Training and Qualifications*	*Other Information*
Machine Tool Operators	These workers use machine tools such as lathes, drill presses, milling machines, grinding machines, and punch presses to shape metal. Most work in factories that produce metal products, transportation equipment, and machinery. Skilled machine tool operators also work in production departments, maintenance departments, and toolrooms. Employment is concentrated in major industrial areas including the Great Lakes region, Los Angeles, Philadelphia, St. Louis, and Indianapolis.	Machine tool operators usually learn their skills on the job. Most are semiskilled operators; they perform simple repetitive operations that can be learned in just a few months. Becoming a skilled operator often requires 1 to 2 years of experience and on-the-job training. Some companies have formal training programs for new employees. Although no special education is required, courses in mathematics and blueprint reading are helpful.	Most operators stand a great deal of the time and work in a relatively small space. Machine tool operators have job titles that refer to the machine they operate: Drill press operator, milling machine operator, and the like. Skilled machine tool operators may become all-round machinists, tool-and-die makers, or advance to machine maintenance jobs. Most machine tool operators belong to unions.
Setup Workers (Machine Tools)	These skilled workers, often called machine tool job setters, prepare large complex tools such as a drill press or lathe for use. They consult blueprints, written specifications, or job layouts; select and install proper cutting or other tools; and adjust guides, stops, and other controls. They explain to semiskilled operators how to run the machine. They work in factories that manufacture fabricated metal products, transportation equipment, and machinery. Employment is concentrated in major industrial areas including Los Angeles, Philadelphia, New York, Chicago, Detroit, and Cleveland.	They must meet the same qualifications as all-round machinists. Good judgment is needed to select the sequence of operations so that metal parts will be made according to specifications. The ability to communicate clearly is important in explaining the machinery operations to semiskilled workers. Setup workers may advance to shop supervisor or transfer to other jobs such as parts programmer.	Because they work with high-speed machine tools that have sharp cutting edges, setup workers must follow certain safety practices. Many setup workers are members of unions.

Occupation	*Nature and Places of Work*	*Training and Qualifications*	*Other Information*
Tool-and-Die Makers	These highly skilled, creative workers produce tools, dies, and special guiding and holding devices used by other machining workers to mass-produce metal parts. They have a broad knowledge of machining operations, mathematics, and blueprint reading; use almost every type of machine tool and precision measuring instrument; and do repair work. Most work in plants that produce manufacturing, construction, and farm machinery. Others work in automobile, aircraft, and other transportation equipment industries, small tool-and-die shops, and electrical machinery and fabricated metal industries. About one-fifth work in the Detroit and Flint, Chicago, and Los Angeles areas. Employment also is concentrated in Cleveland, New York, Newark, Dayton, and Buffalo.	Mechanical ability, finger dexterity, an aptitude for precise work, and a good working knowledge of mathematics and physics are important. They obtain their skills in a variety of ways including formal apprenticeship, vocational school, and on-the-job training. A 4-year apprenticeship probably is the best way to learn the trade. Most employers prefer persons with high school or trade school education for apprenticeships. Several years of experience after apprenticeship often are necessary to qualify for more difficult work. Some advance to supervisory and administrative positions in industry; many become tool designers; others open their own shops.	Because of their extensive skills and knowledge, tool-and-die makers are able to change jobs within machining occupations more easily than less skilled workers. As with other machining workers, they wear protective glasses when working around metal-cutting machines. Tool-and-die shops usually are safer than similar operations in production plants. Many are members of unions.
PRINTING OCCUPATIONS			
Compositors	Compositors set type. Nearly all compositors use machines and press keys similar to a typewriter's. Type is set by hand only for very special printing jobs. Most compositors work for newspaper plants, or for commercial printing plants, book and magazine printers, and printing plants. Some work for banks, insurance companies, advertising agencies, manufacturers, and other firms that do their own printing.	Skilled compositors usually learn their trade through a 6-year apprenticeship. This period may be less for apprentices who have already worked in the printing industry. Shorter apprenticeships also are customary for people who have had courses in printing technology. Applicants for apprenticeship generally must be high school graduates. Courses in mathematics and English, especially spelling, are important, and a background in electronics and photography is increasingly useful.	Working conditions vary from plant to plant. Some are hot and noisy. In general, new plants are well-lighted and clean. Many compositors are union members.

Occupation	*Nature and Places of Work*	*Training and Qualifications*	*Other Information*
Lithographers	Lithography, also known as offset printing, is a printing process in which the material to be printed is either drawn or reproduced photographically on a flat metal plate. Then the plate is treated chemically so that the printing areas will attract ink while the nonprinting areas repel it and stay blank. Lithographic workers specialize in different steps of the printing process. Some are camera operators; others are artists, strippers, or platemakers. Lithographers work for commercial printing plants, newspapers, and book and magazine printers. Some work for the U.S. Government Printing Office.	Lithographic craft workers usually must complete a 4- or 5-year apprenticeship program. Apprenticeship applicants usually must be high school graduates and at least 18 years old. Some lithographers learn the craft by taking a 2-year program in printing technology at a technical institute, junior college, or college. High school courses in printing, photography, mathematics, chemistry, physics, and art are helpful.	Although the work is not strenuous, lithographers are on their feet much of the time. They sometimes are under pressure to meet publication deadlines. Many lithographers are union members.
Photoengravers	Photoengravers make metal printing plates of drawings, photographs, and other copy that cannot be set in type. These plates are then printed in the letterpress process. Over half work in shops that make photoengravings for other printing firms. Other employers include newspapers, photoengraver shops, book and magazine printers, and the Federal Government. Some photoengravers have their own shops.	Most learn through a 5-year apprenticeship program. Apprenticeship applicants must be at least 18 years old and generally must have a high school or vocational school education.	Although the work is not strenuous, photoengravers stand up much of the time. Good eyesight is particularly important because of the close work and color discrimination involved. Most photogravers are union members.
Electrotypers and Stereotypers	These workers make duplicate press plates of metal, rubber, and plastic for letterpress printing. Duplicate plates are used when there is a large volume of printing to be done. Electrotypers work mostly in plants that print books and magazines. Most stereotypers work for newspaper plants. Electrotypers and stereotypers also are employed in shops that provide this service for printing firms.	Nearly all complete 5- to 6-year apprenticeships. Electrotyping and stereotyping are separate crafts and relatively few transfers take place between the two. Apprenticeship applicants must be at least 18 years old.	Although operations are highly mechanized, some lifting of heavy press plates occasionally is required. Nearly all electrotypers and stereotypers are union members.

Occupation	*Nature and Places of Work*	*Training and Qualifications*	*Other Information*
Printing Press Operators	These workers set up, adjust, and operate offset, letterpress, and gravure printing presses. Over half work in commercial printing plants or in the printshops of book, newspaper, and magazine publishers. Others work for banks, insurance companies, manufacturers, and other organizations that do their own printing.	Most press operators learn through apprenticeship, while some learn as helpers or press assistants. Others obtain their skills through a combination of work experience and vocational or technical school training. The length of apprenticeship and the content of training depend largely upon the kind of press used in the plant. Apprenticeships in commercial shops generally last 2 years for press assistants and 4 to 5 years for press operators. Mechanical aptitude is important in making press adjustments and repairs. The ability to visualize color is essential for work on color presses. Physical strength and endurance are needed for work on some kinds of presses, where operators lift heavy plates and stand for long periods.	Pressrooms are noisy and workers in some areas wear ear protectors. Press operators are subject to hazards when working near machinery. They sometimes work under pressure to meet deadlines. Many pressroom workers are union members.
Bookbinders and Bindery Workers	Bookbinders glue, sew, or staple the pages and the covers together to produce a book. They operate machines and do some of the work by hand. Many work in shops that specialize in bookbinding. Others work in bindery departments of book publishing firms, commercial printing plants, and large libraries. Some skilled bookbinders work in hand binderies. They design original bindings for a limited number of copies of a large edition, or restore and rebind rare books.	A 4- or 5-year apprenticeship generally is required to qualify as a skilled bookbinder. Apprenticeship applicants usually must have a high school education and be at least 18 years old. Although most bindery workers learn their tasks through on-the-job training lasting from several months to 2 years, many learn through formal apprenticeship. Accuracy, patience, neatness, and good eyesight are qualities needed by bookbinders. Good finger dexterity is necessary for workers who count, insert, paste, and fold.	Bookbinding shops are noisy when machinery is operating. Long periods of standing and constant use of the arms can be tiring. Many bindery workers are union members.

Occupation	*Nature and Places of Work*	*Training and Qualifications*	*Other Information*
OTHER INDUSTRIAL PRODUCTION AND RELATED OCCUPATIONS			
Assemblers	Following instructions or diagrams, assemblers put together the parts of manufactured items using hand and machine tools. Many perform a single operation on an assembly line. Others have more complex jobs: Bench assemblers may make steering columns for automobiles, build rifles, or put together the small components used in radios; floor assemblers put together large machinery or equipment on shop floors; highly skilled assemblers may have to wire tubes for a television set or put together and test a calculator. All work in manufacturing plants, almost two-thirds in plants that make machinery and motor vehicles. Over half work in the heavily industrialized States of California, New York, Michigan, Illinois, Ohio, and Pennsylvania.	Speed and accuracy, manual dexterity, patience, good eyesight, and physical fitness may be important. Assemblers often work with very small parts. Floor assemblers may have to lift and fit heavy objects. Skilled assemblers use precision measuring instruments and must know how to read blueprints and other engineering specifications. Inexperienced people can be trained in a few days or weeks. Longer training is required for skilled assembly jobs. High school graduation usually is not required. However, some employers prefer applicants with mechanical aptitude and vocational school training.	Assembly jobs tend to be more monotonous than other blue-collar jobs. Working conditions differ, depending on the job performed. Some work in clean, well-lighted rooms while others work in noisy, dirty areas. Some are under pressure to keep up with the speed of assembly lines. Work schedules may vary at plants with more than one shift. Many assemblers are members of unions.
Automobile Painters	These skilled workers repaint older vehicles that have lost the luster of their original paint and make body repairs almost invisible. They remove old paint by sanding, fill nicks and scratches with body putty, and mix paints when necessary. Almost two-thirds work in shops that specialize in automobile repairs. Most others work for automobile and truck dealers. Some work for organizations that maintain and repair their own fleets of vehicles, such as trucking companies and buslines. Many experienced painters open their own shops.	Good health, keen eyesight, and a good color sense are very important. Agility also is vital as they often bend and stoop to reach all parts of the car. Most auto painters start as helpers and gain skills by working with experienced painters. Becoming highly skilled requires 3 to 4 years of on-the-job training. A few learn by completing 3-year apprenticeship programs. High school graduation is not required, but may be an advantage since it shows reliability and perseverance. Experienced painters may advance to shop supervisor, while those with the necessary funds open their own shops.	They may wear protective equipment because of fumes. Many painters belong to unions.

Industrial Production Occupations

Occupation	*Nature and Places of Work*	*Training and Qualifications*	*Other Information*
Blacksmiths	Blacksmiths make and repair equipment and other items made of metal. Those who specialize in shoeing horses are called farriers. Almost two-thirds work in factories, railroads, and mines. The remainder work in small shops, and most are self-employed. Most farriers are self-employed and contract their services to horse trainers at racetrack stables and to owners of horses used for private or public recreation.	Good physical conditioning is important because pounding metal and handling heavy tools and parts require strength and stamina. Farriers must have the patience to handle horses. Many beginners enter the occupation by working as helpers. Others complete 3- or 4-year apprenticeship programs that teach blueprint reading, proper use of tools and equipment, heat-treatment of metal, and forging methods. Many farriers learn by assisting experienced workers. Some take courses in horseshoeing at a college or private horseshoeing school. At least 3 to 5 years of experience are required to obtain skills necessary to shoe racehorses. Farriers who wish to work at racetracks must pass a licensing exam.	A blacksmith's job may be hazardous. Blacksmiths are subject to burns from forges and heated metals and cuts and bruises from handling tools. They often wear protective devices. Some farrier jobs are seasonal and may involve long hours, weekend work and much travel. Many blacksmiths belong to unions.
Blue-Collar Worker Supervisors	These workers train new employees, maintain employee and production records, plan and schedule work, and prepare reports on production, cost, personnel, and safety. Over half work in manufacturing, supervising the production of cars, washing machines, or any of thousands of other products. Most of the remainder work in the construction industry, in wholesale and retail trade, and in public utilities.	Most supervisors are promoted through the ranks. Experience, skill, and leadership qualities are vital. Employers place special emphasis on the ability to motivate employees, maintain high morale, command respect, and get along with people. Completion of high school is the minimum educational requirement. A college or technical school background can be helpful, particularly in industries with highly technical production processes.	Supervisors generally work more than 40 hours a week and sometimes do paperwork at home. They may receive overtime pay. Working conditions vary and some are subjected to noisy, dirty conditions. On the other hand, they have more challenging and prestigious jobs than most blue-collar workers.

Occupation	*Nature and Places of Work*	*Training and Qualifications*	*Other Information*
Boilermaking Occupations	Boilermakers assemble, erect, dismantle, and repair boilers and other pressure vessels. They use power tools and devices such as oxyacetylene torches, welding equipment, power shears, and rigging equipment. Layout workers follow blueprints in marking off lines on metal plates and tubes. Fitters see that boiler parts fit together properly before assembly. Boilermakers work in the construction industry, in iron and steel plants, petroleum refineries, railroads, shipyards, and electric powerplants. Some work in Navy shipyards and Federal powerplants. Layout workers and fitters work mainly in plants that make fire-tube and water-tube boilers, heat exchangers, heavy tanks, and similar products.	Physical strength and stamina are required to do the heavy work, and manual dexterity and mechanical aptitude are needed to handle tools. Many people have become boilermakers by working for several years as helpers to experienced boilermakers, but a 4-year apprenticeship is considered the best way to learn this trade. Most layout workers and fitters are hired as helpers to experienced workers, and they take about 2 years to become highly skilled. Employers prefer high school or vocational school graduates as apprentices or helpers.	The work may be hazardous. Boilermakers often work in damp, poorly ventilated, cramped quarters and sometimes at great heights. Workers often wear protective equipment. Most workers belong to unions.
Boiler Tenders	Boiler tenders operate and maintain the steam boilers that power industrial machinery and heat factories, offices, and other buildings. They also may operate waste heat boilers that burn trash and other solid waste. About half work in factories. Plants that manufacture lumber, iron and steel, paper, chemicals, and stone, clay, and glass products are among leading employers. Others work for public utilities and in hospitals, schools, and Federal, State, and local government.	Persons learn through on-the-job training as a helper in a boiler room. Some high school courses are helpful. Applicants for helper jobs should be in good physical condition and have mechanical aptitude and manual dexterity. Some large cities and a few States require boiler tenders to be licensed. Two types of licenses exist—for low pressure and high pressure boilers. Because of regional differences in licensing requirements, one who moves to another city or State may have to pass an exam for a new license.	They have to work in awkward positions and may be exposed to noise, heat, grease, fumes, and smoke. They also are subject to burns, falls, and injury from defective boilers or moving parts. Modern equipment and safety procedures, however, have reduced accidents. Some boiler tenders are union members.

Occupation	*Nature and Places of Work*	*Training and Qualifications*	*Other Information*
Electroplaters	Electroplaters use an electrochemical process to give metal articles such as silverware, jewelry, and jet engine parts a protective surface or an attractive appearance. About half work in shops that specialize in metal plating and polishing. Other platers work in plants that make plumbing fixtures, cooking utensils, household appliances, electronic components, motor vehicles, and metal products.	An eye for detail, patience, manual dexterity, and good eye-hand-arm coordination are important. They must carefully study job specifications for each item to be plated and must examine their work for defects. In addition, good physical condition is important as workers may have to lift and carry heavy objects at times. Most learn by helping experienced workers, and it usually takes at least 3 years to become an all-round plater. A small proportion work for 3 or 4 years as apprentices. Some high school or vocational school courses are helpful, and a few people take a 1- or 2-year electroplating course in a junior college, technical institute, or vocational high school.	The work may be hazardous. They are subject to burns from splashing acids and inhalation of toxic fumes. Humidity and odors also are problems. Workers may wear protective clothing. Some platers are members of unions.
Furniture Upholsterers	Furniture upholsterers repair or replace fabrics, springs, padding, and other parts of furniture that are worn or damaged. They use tack and staple removers, pliers, hammers, hand or power shears, webbing stretchers, upholstery needles, and sewing machines. Over three-fourths own and operate or work in small upholstery shops. Some work in furniture stores and for businesses, such as hotels, that maintain their own furniture.	Manual dexterity, coordination, an eye for detail, good color sense, patience, and a flair for creative work are helpful. Occasional heavy lifting may be required. Most people complete about 3 years of on-the-job training before becoming fully skilled. Vocational or high school courses in upholstery are helpful.	Working conditions vary. Some shops are large and clean while others are small and dusty. Workers stand while they work and do stooping, bending, and some heavy lifting. Some upholsterers are union members.

Occupation	*Nature and Places of Work*	*Training and Qualifications*	*Other Information*
Forge Shop Occupations	Before metal can be shaped, it must be heated in intensely hot furnaces (forges) until it is soft. Forge shop workers place the heated metal between two metal dies that are attached to power-presses or hammers. The hammers or presses pound or squeeze the metal into the desired shape. Hammersmiths direct the operation of open die power hammers; hammer operators manipulate impression die power hammers; press operators control huge presses equipped with dies; upsetters operate machines that shape hot metal; heaters control furnace temperatures; inspectors examine forged pieces for accuracy, size, and quality; die sinkers make impression dies for forging hammers and presses; trimmers, grinders, sandblasters or shot-blasters, picklers, and heat treaters are involved in cleaning and finishing operations. About three-fourths work in shops that make and sell forgings. The remainder work in plants that use forgings in their final products, such as plants operated by manufacturers of automobiles, farm equipment, and handtools. Employment is concentrated in and around Detroit, Chicago, Cleveland, Los Angeles, and Pittsburgh.	Forge shop workers must be strong enough to lift and move heavy forgings and dies. They need the stamina and endurance to work in the heat and noise of a forge shop. Most learn their skills on the job. They generally join hammer or press crews as helpers or heaters, and progress to other jobs as they gain experience. Some forge shops offer 4-year apprenticeship programs for skilled jobs such as die-sinker, heat treater, hammer operator, hammersmith, and press operator. Training requirements for inspectors range from a few weeks to several months of on-the-job training. Employers usually do not require a high school diploma, but graduates may be preferred.	The work is more hazardous than most manufacturing occupations. Workers are subject to noise, vibration, heat, and smoke. Workers may wear protective equipment. Most workers are union members.

Industrial Production Occupations

Occupation	*Nature and Places of Work*	*Training and Qualifications*	*Other Information*
Inspectors (Manufacturing)	Inspectors make certain that products meet specifications. For example, they may taste-test soft drinks, use tools such as gauges and magnifying glasses to make sure airplanes are assembled properly, or examine a jacket for flaws. Two-thirds work in plants that produce durable goods such as machinery, transportation equipment, electronics equipment, and furniture. Others work in plants that produce goods such as textiles, apparel, and leather products. Almost two-thirds work in Ohio, New York, Michigan, Illinois, Pennsylvania, California, New Jersey, North Carolina, and Indiana.	Inspectors generally are trained on the job for a brief period—from a few hours or days to several months, depending on the skill requirements. Preferences of employers vary widely with respect to education, experience, and qualifying aptitudes. Good health and eyesight, accuracy, and the ability to pay attention to detail, work with numbers, and get along with people may be important.	Working conditions vary considerably. Some have well-lighted, air-conditioned workplaces while others are exposed to high temperature, oil, grease, and noise. Many inspectors are members of unions.
Millwrights	Millwrights prepare machinery for use in a plant. This may involve constructing concrete foundations or wooden platforms, dismantling existing equipment, and moving, assembling, and maintaining machinery. Most work for manufacturing companies. The majority are in transportation equipment, metal, paper, lumber, and chemical products industries. Others work for contractors in the construction industry; machinery manufacturers employ a small number. Employment is concentrated in Detroit, Pittsburgh, Cleveland, Buffalo, and the Chicago-Gary area.	Mechanical aptitude is vital because millwrights work with various tools while putting together and taking apart complex machinery. Strength and agility also are important because millwrights do much lifting and climbing. The ability to give and carry out instructions accurately and analyze and solve problems also is important. Some spend 6 to 8 years learning the trade informally on the job as helpers to skilled workers. Others complete 4-year formal apprenticeship programs. Applicants for apprentice or helper jobs must be at least 17 years old. Some employers prefer high school or vocational school graduates.	The work may be hazardous, and workers wear protective devices. In addition to the dangers of being struck by falling objects or machinery or falling from high places, millwrights are subject to the usual hazards of cuts and bruises. Millwrights employed by factories generally work year round. Those employed by some construction companies may experience periods of unemployment. However, they usually earn higher wages. Frequently these millwrights travel. Most millwrights belong to unions.

Occupation	*Nature and Places of Work*	*Training and Qualifications*	*Other Information*
Motion Picture Projectionists	Motion picture projectionists operate and maintain movie projectors and sound equipment. They may inspect film, load and start the machine, adjust light and sound, make the changeover to a second machine at the end of a reel, rewind film, splice film when required, and make repairs. Many of these functions are automated in modern theaters. The majority work for indoor theaters. Most of the remainder work for drive-ins, while some work for large manufacturing companies, colleges, television studios, and Federal, State, and local governments.	Good eyesight and normal color perception, good hearing, manual dexterity, mechanical aptitude, and a temperament for performing routine work alone are important. Most theaters are unionized, and union membership requirements vary considerably among the locals. Applicants often must work for trial periods lasting several weeks or complete union training programs without compensation. They may have to pass a written exam before becoming a union member. Unions prefer high school graduates. In a few cities and States, projectionists must be licensed, often before applying for union membership.	Most work evenings on weekdays, generally 4 to 6 hours, and 10 hours or more on Saturdays or Sundays. Some work at several theaters. In small towns, they usually work only part time because of the small number of shows. Those at drive-ins, particularly in northern States, may be laid off during the winter. The work is not strenuous and is relatively safe, but there is the danger of electrical shock and acid burns from the projector's lamp.
Ophthalmic Laboratory Technicians	Ophthalmic laboratory technicians (also called optical mechanics) make eyeglasses. The two types of technicians are surfacer (lens grinder) and bench technician (finisher). In small laboratories, one person may perform both functions; in large laboratories, these duties may be performed by several people. Most work in ophthalmic laboratories but some work for retail optical dispensaries or other stores that sell prescription lenses. A few work for eye physicians or optometrists who dispense glasses directly to patients.	Because they work with machines and small handtools, finger dexterity, some mechanical ability, patience, and a liking for precision work are important. The vast majority learn their skills on the job, usually taking 3 years to become all-round mechanics. High school graduates may learn by completing 3- to 4-year apprenticeship programs, and most authorities agree that this training leads to more opportunities. Some technicians receive training in the Armed Forces or complete 9-month vocational school programs and then receive on-the-job training. Employers prefer high school graduates. Some States require licenses.	Work surroundings are noisy because of power grinding and polishing machines. Some technicians are members of unions.

Occupation	*Nature and Places of Work*	*Training and Qualifications*	*Other Information*
Photographic Laboratory Occupations	Photographic laboratory workers develop film, make prints and slides, and perform related tasks such as enlarging and retouching photographs. All-round darkroom technicians can perform all the tasks necessary to develop and print film. Color technicians specialize in processing color film. Darkroom technicians are assisted by specialized workers such as developers, printers, and retouchers. Other workers include film numberers, who sort film according to the type of processing needed; film strippers, who unwind rolls of film and place them in developing machines; printer operators, who operate machines that expose rolls of photographic paper to negatives; machine print developers, who operate machines that develop these rolls; chemical mixers, who combine chemicals that make up developing solutions; slide mounters, who operate machines that cut, insert, and seal slides in mounts; and photocheckers and assemblers, who inspect finished slides and prints and package them for customers. Most semiskilled workers are employed by large photofinishing labs that specialize in processing film for amateur photographers. A large proportion of darkroom technicians work in labs operated by portrait and commercial studios, manufacturers, newspaper and magazine publishers, advertising agencies, and other organizations. Some work in commercial labs specializing in processing work of professional photographers.	For many photography laboratory jobs, manual dexterity, good vision, including normal color perception, and good hand-eye coordination are important. Most darkroom technicians learn their skills on the job, taking about 3 years to become fully qualified. Employers prefer high school graduates. Training is offered in high schools, trade schools, and the Armed Forces. A few colleges offer 2-year programs in photographic technology. Semiskilled photolab workers train on the job for a few weeks to several months. Many darkroom technicians eventually become professional photographers.	In some labs, employees may work much overtime during the summer and other peak periods, and temporary workers may be employed during these peaks. In many semiskilled occupations, the work is repetitious and the pace is rapid. Some workers are subject to eye fatigue.

Occupation	*Nature and Places of Work*	*Training and Qualifications*	*Other Information*
Power Truck Operators	Power truck operators drive trucks with lifting mechanisms to move heavy materials. Operators must follow special procedures when using a truck at a plant, warehouse, or construction site. They may manually load and unload, keep records of materials moved, and maintain trucks in good working condition. About three-fourths work in manufacturing industries. Many work in plants that make automobiles, machinery, fabricated metal products, paper, building materials, and iron and steel. Many also work in warehouses, depots, freight and marine terminals, and mines.	Operators need manual dexterity, strength, and stamina to drive the truck and to load and unload goods. They need good eyesight, including good depth perception, to pick up, move, and deposit loads. They often need mechanical ability to perform minor maintenance. Large firms generally require applicants to pass a physical examination. They train on the job for several days, but it usually takes several weeks to reach maximum efficiency.	Work may be hazardous, and operators may be exposed to all kinds of weather. Operators are subject to collisions and falling objects; some transport dirty material. However, working conditions are being improved.
Production Painters	Production painters apply varnish, lacquer, paint, and other finishes to the surface of manufactured items. Most painters use sprayguns while others use automatic equipment such as spraying machines, dipping tanks, and tumbling barrels. They may use masking tape to prevent colors from overlapping, mix paint, and clean equipment. As production lines become more automated, painters must learn to use modern machinery such as electrostatic applicators and powder-type painting systems. About two-thirds work in plants that make automobiles, machinery, furniture and other wood products, or manufactured metal products such as cans, tinware, and handtools.	Production painters need good eyesight to distinguish colors and check for even application of paint. The job also demands a tolerance for repetitious work and good physical condition since painters stand for long periods of time and often work in awkward and cramped positions. No formal apprenticeship or training exists. Workers may spend from a few days to several months acquiring their skills on the job. High school graduation may be needed for advancement. A few painters become supervisors.	The job may be hazardous as painters are exposed to fumes and noises. Workers may wear protective clothing and apparatus. Some painters are union members.

Occupation	*Nature and Places of Work*	*Training and Qualifications*	*Other Information*
Stationary Engineers	Stationary engineers operate boilers, generators, turbines, condensers, and other equipment that provide power, heat, air-conditioning, and light. They regularly inspect equipment, check meters and gauges, and make minor repairs. They may supervise others. Places of employment include power stations, factories, sewage and water treatment plants, offices and apartment buildings, hotels, hospitals, and Federal, State, and local governments.	Good physical condition is important because these workers may crawl inside boilers and work in crouching or kneeling positions. Mechanical aptitude, manual dexterity, and accuracy also are important. Many start as helpers or oilers and acquire their skills on the job. A good background can be obtained in the Navy or Merchant Marine. However, most training authorities recommend a formal 4-year apprenticeship. High school or trade school graduates are preferred for apprenticeship. Many States and localities have licensing requirements. Although licensing requirements differ from place to place, applicants usually must be 18 years old, reside for a specified period in the area in which the exam is given, meet experience requirements, and pass a written exam. One who moves to another area may have to obtain a new license.	Workers may be assigned to any one of three shifts around the clock, and to weekend and holiday work. In many plants, only one engineer works on each shift. The work may be hazardous as workers may be exposed to heat, dust, dirt, oil and grease, and fumes or smoke. They also are subject to burns, electric shock, and injury from moving machinery. Some stationary engineers are union members.
Wastewater Treatment Plant Operators	Wastwater treatment plant operators control and maintain pumps, pipes, and valves that send harmful domestic and industrial waste to treatment facilities. They may read and interpret meters and gauges to check plant equipment; operate chemical feeding devices to remove pollutants; take samples of water for laboratory analysis; and test and adjust the level of chlorine in the water. They keep records and may make minor repairs using a variety of tools. Most work in municipal plants and private industry while some work in Federal installations.	Mechanical aptitude and competence in basic mathematics are important. Operators also must be agile as they must climb ladders and move easily around heavy machinery. Trainees start as helpers and learn their skills on the job. Employers prefer high school graduates and in some States this is a minimum requirement. Some 2-year associate degree programs in wastewater technology are available. In many States, supervisors and certain operators must pass an exam to certify that they are capable of overseeing plant operations. There are different classes of certification for different sizes of plants. These also may entail education and experience requirements.	Many operators in small towns work part time. They work different shifts and may have to work overtime in an emergency. They may be exposed to odors, as well as noise from the operation of electrical motors and pumps.

Occupation	*Nature and Places of Work*	*Training and Qualifications*	*Other Information*
Welders	Welders join two or more pieces of metal by applying intense heat and adding filler materials when necessary. These permanently connected metal parts are then used in the construction of cars, ships, household appliances, and thousands of other products. Jobs vary from those of highly skilled manual welders who can use welding equipment in more than one position and who can plan their work from drawings and other specifications to those of unskilled welding machine tenders who simply press a button to start a machine. Almost two-thirds help manufacture durable goods such as boilers, bulldozers, trucks, ships, and heavy machinery. Most of the remainder repair metal products or help construct bridges, large buildings, and pipelines.	Manual dexterity, good eyesight, and good eye-hand coordination are important. Workers should be able to concentrate on detailed work for long periods, and should be in good physical condition since welders bend, stoop, and work in awkward positions. It takes several years of training to become a skilled welder. Some of the less skilled jobs can be learned in a few months or less. A few companies offer apprenticeship programs. Employers prefer applicants with high school or vocational school training in welding. Some welders may be required to pass certification exams. Welding machine operators may learn skilled welding jobs; skilled welders may be promoted to inspectors, technicians, or supervisors. Experienced workers with college training may become welding engineers, while a few open their own shops.	Welders work in the presence of toxic gases, fumes, rust, grease, and dirt. They wear protective clothing and devices. Many welders are union members.

Answers to Related Occupations

ASSEMBLER

1. Sewing machine operator, 2. Spray painter, 3. Machine cutter, 4. Automatic print developer, 5. Machine packager, 6. Yarn winder, 7. Ampoule filler, 8. Cannery worker, 9. Knitting machine operator.

MACHINIST

1. b, 2. c, 3. g, 4. h, 5. e, 6. d, 7. a, 8. f.

PHOTOCOMPOSITOR

1. Printing press operator, 2. Proofreader, 3. Photoengraver, 4. Electrotyper, 5. Bookbinder, 6. Printing sales representative, 7. Layout artist, 8. Production manager.

Answers to math problems

MACHINIST

1. Three 2-meter bars with 90 centimeters of steel left over. 2. 35 teeth. 3. yes.

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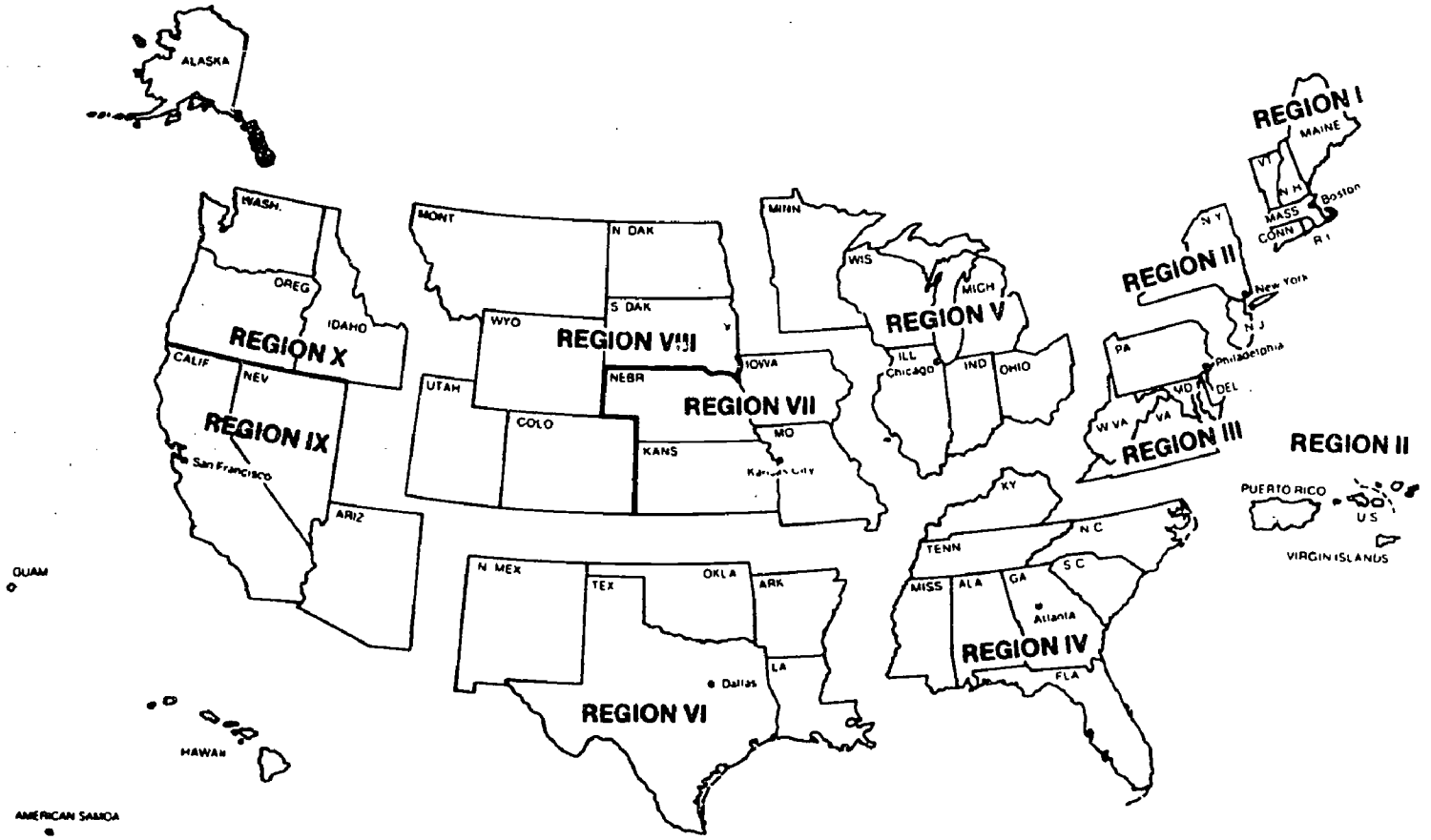
Bureau of Labor Statistics
Regional Offices



Region I
1603 JFK Federal Building
Government Center
Boston, Mass. 02203
Phone: (617) 223-6761

Region II
Suite 3400
1515 Broadway
New York, N.Y. 10036
Phone: (212) 944-3121

Region III
3535 Market Street
P.O. Box 13309
Philadelphia, Pa. 19101
Phone: (215) 596-1154

Region IV
1371 Peachtree Street, N.E.
Atlanta, Ga. 30309
Phone: (404) 881-4418

Region V
9th Floor
Federal Office Building
230 S. Dearborn Street
Chicago, Ill. 60604
Phone: (312) 353-1880

Region VI
Second Floor
555 Griffin Square Building
Dallas, Tex. 75202
Phone: (214) 767-6971

Regions VII and VIII
911 Walnut Street
Kansas City, Mo. 64106
Phone: (816) 374-2481

Regions IX and X
450 Golden Gate Avenue
Box 36017
San Francisco, Calif. 94102
Phone: (415) 556-4678