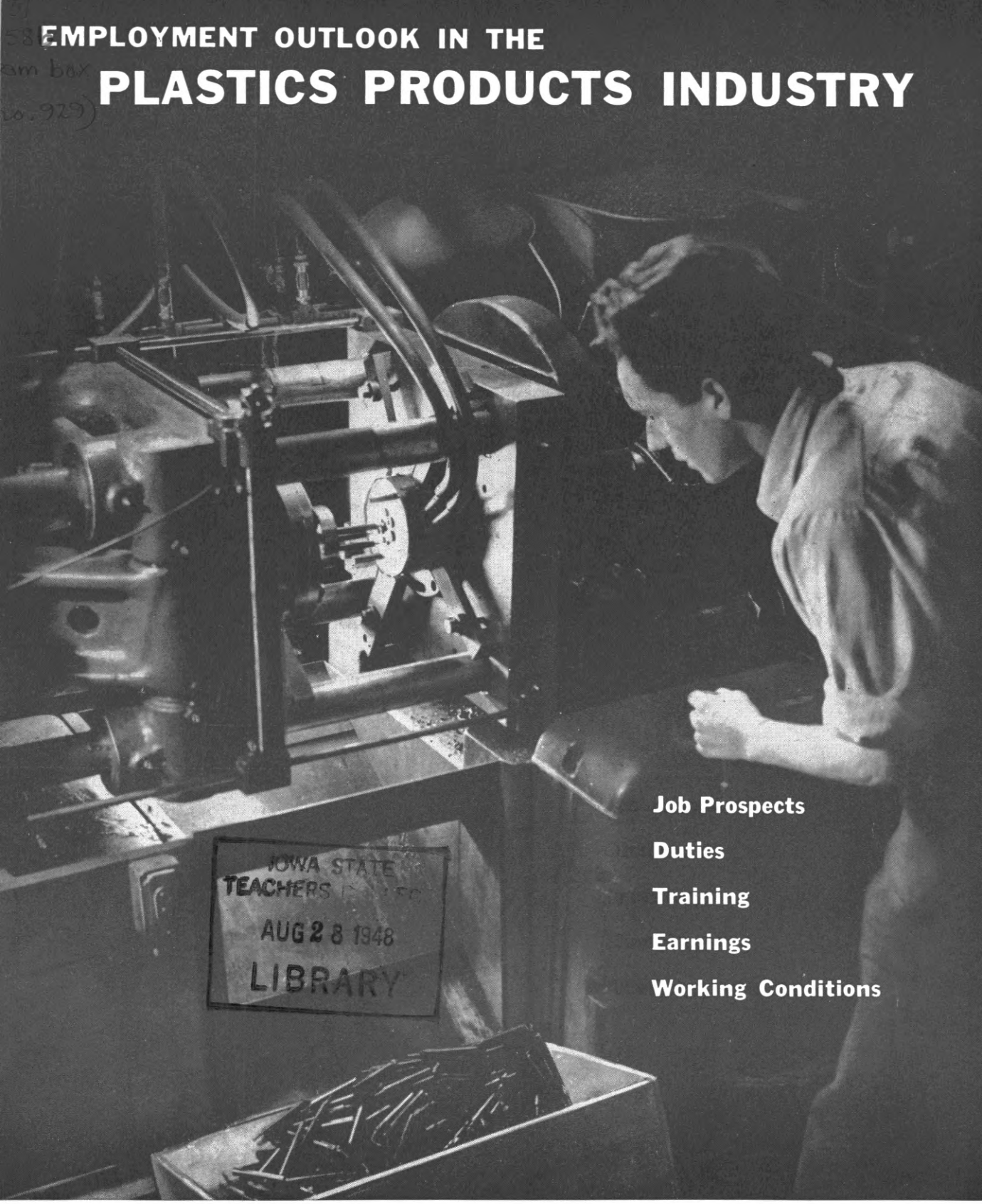
EMPLOYMENT OUTLOOK IN THE PLASTICS PRODUCTS INDUSTRY



Job Prospects

Duties

Training

Earnings

Working Conditions

UNITED STATES DEPARTMENT OF LABOR • BUREAU OF LABOR STATISTICS

OCCUPATIONAL OUTLOOK SERIES • BULLETIN No. 929

Injection molding of fountain pen barrels. This high-speed machine, run by a skilled operator, can turn out hundreds of plastic pieces in an hour.

Employment Outlook in the Plastics Products Industry

Bulletin No. 929

UNITED STATES DEPARTMENT OF LABOR
L. B. Schwellenbach, *Secretary*

BUREAU OF LABOR STATISTICS
Ewan Clague, *Commissioner*

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Letter of Transmittal

UNITED STATES DEPARTMENT OF LABOR,
BUREAU OF LABOR STATISTICS,
Washington, D. C., April 15, 1948.

The SECRETARY OF LABOR:

I have the honor to transmit a report on the employment outlook in the plastics products industry. This is one of a series of occupational and industry studies prepared in the Bureau's Occupational Outlook Division for use in vocational counseling of veterans, young people in schools, and others considering the choice of an occupation. The study was prepared by Sol Swerdloff and Calman R. Winegarden. The Bureau wishes to acknowledge the cooperation received from other Government agencies and from officials of trade associations, unions, trade periodicals, and companies in the plastics field. The Bureau, however, takes full responsibility for the interpretations and conclusions in this report.

EWAN CLAGUE, *Commissioner.*

Hon. L. B. SCHWELLENBACH,
Secretary of Labor.

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Employment Outlook in the Plastics Products Industry

Introduction

Plastics are now commonly found in hundreds of uses—in industry, in automobiles and airplanes, in homes—and new uses are rapidly appearing. Stories of spectacular future growth, of a coming "plastics age," have been widely circulated. It is no wonder, that many veterans, young people in schools, and others interested in choosing a field of work are looking to the growing plastics products industry for new and promising job opportunities.

At the end of 1946, the number of jobs in the plastics products industry was higher than the wartime peak, and nearly three times the employment in 1939. Prospects are for a relatively large increase in employment in the industry during the next year or two and for steady growth thereafter. Most of the openings, however, will be for semiskilled and unskilled production workers.

This study discusses job prospects in the industry and describes the duties, training, earnings, and working conditions of its employees.

What is the Plastics Products Industry?

What are Plastics?

Plastics are synthetic organic materials which, through application of pressure or heat or both, may be formed into almost any desired shape. They are man-made from substances like coal, petroleum, wood, and cotton. Although not entirely of recent origin, plastics are mainly products of modern research.

Not only are plastics easy to shape, but they have many other useful properties. Generally they are light, resistant to corrosion, easy to color, odorless, and tasteless. Some are noted for toughness, electrical insulating qualities, transparency, resistance to water, or flexibility. Plastics products constitute parts of electrical appliances, automobiles, airplanes, and industrial equipment of various kinds, and are seen in daily use as radio cabinets, toys, novelties, bottle tops, and telephone hand-sets as well as in hundreds of other forms. The tabulation on the following page shows some typical plastic materials, their properties, illustrations of their uses, and common trade names.

What Is Meant by the "Plastics Products Industry"?

The term "plastics products industry" refers to plants which make molded and laminated plastics articles and parts for sale. This is the largest and most distinctive of the three main divisions of what has been popularly called the field of plastics. The other divisions are plastic materials manufacturing and plastics fabricating.

Plastic materials manufacturers—part of the chemical industry—supply molders and extruders with molding compounds in powder, granular, or flake form, and furnish laminators with impregnating resins. They also furnish sheets, rods, and tubes to fabricating plants. Molders, laminators, and fabricators make the so-called "rigid" plastics products that the public sees and readily recognizes. Less than half of the plastics materials, however, go into these products. The rest are consumed in the making of such other products as paints and coatings, adhesives, brake linings, and grinding wheels. There are about 30,000 workers employed in the plants which manufacture plastic materials, in jobs similar to those found in many other chemical processes.

Plastics Have Many Different Properties and Uses

Some Typical Plastic Materials and Their Products

Material	Manufactured from—	Outstanding properties	Typical uses	Common trade names
Thermosetting materials				
Phenolics	Phenol [1]	Light, resistant to heat and water, good surface appearance, strong, and hard	Electric switch parts, bottle tops, radio cabinets, gears, bearings, table tops, camera cases.	Bakelite, Durite, Durez, Makalot, Indur, Resinox.
Urea	Ammonia and carbon dioxide.[1]	Unlimited color range, odorless, tasteless, very light, rigid, hard surfaced.	Cosmetic containers, machine housings, automobile hardware, clock cases, buttons.	Beetle, Bakelite Urea, Plaskon, Sylplast.
Melamine	Calcium cyanamid [1]	Heat resistant, electrical insulating, resistant to moisture, hard surfaced.	Light reflectors, tableware, buttons, telephone handsets, circuit breakers.	Melmac, Plaskon, Resimene.
Thermoplastic materials				
Cellulose acetate	Cotton linters, acetic acid, acetic anhydride, sulphuric acid.	Water resistant, dimensionally stable, electrical insulating, easy to color.	Toys, novelties, cultery handles, automobile knobs and handles, brushes and combs, fountain pens.	Bakelite C. A., Kodapak Lumarith, Nexonite, Tenite I, Chemaco, Fibestos.
Ethyl cellulose	Cotton linters, caustic soda, ethyl chloride.	Exceptionally tough, resistant to moisture, electrical insulating.	Flashlight cases, steering wheels, instrument panels, vacuum cleaner parts.	Ethocel, Celcon, Nexonite E. C., Ethofoil.
Acrylics	Propylene, acetone, methyl alcohol.	Transparent, light, shatter resistant, easily formed, resistant to chemicals.	Medical instruments, lenses, dials, toilet articles, novelties, furniture, dentures.	Plexiglas, Lucite.
Polystyrene	Benzene and ethyl chloride.	Electrical insulating, relatively waterproof, dimensionally stable, odorless, tasteless, color fast.	Refrigerator parts, instrument panels, bottle caps, cosmetic containers, bathroom and kitchen tile.	Bakelite Polystyrene, Polyflex, Styramic, Styron, Lustron, Loalin.
Vinyls	Acetylene reacted with acetic acid or hydrogen chloride.	Flexible, hard, chemical resistant, electrical insulating.	Phonograph records, instrument housings, chemical tubing and pipe, furniture, toys.	Saran, Vinylite, Butacite, Koroseal, Gelva, Chemaco, Geon, Velon.

[1] Formaldehyde is usually added in making molding compounds from these materials.

in other chemical processes.

Plastics fabricators—also make plastics products, but unlike molding and laminating plants, are not considered part of the plastics products industry. Their production methods are basically the same as those used in woodworking and metalworking. Plastics fabricators buy plastic forms, such as sheets, rods, and tubes, from the materials producers and turn them into finished articles or parts. As many as 2,000 plants fabricate plastics, including some which also work other materials, such as wood or light metals. They range in size from one-man shops making novelties in basements and garages to a few plants with more than 100 employees. The equipment used ranges from simple hand tools, such as files, to power machines of the kind employed in machining metal or wood. Although there are many fabricating shops, the number of jobs is much lower than in the plastics products industry.

Plants in the *plastics products industry* are engaged mainly in molding or laminating plastics articles for sale. Most of the industry's output consists of plastics parts made to order for firms in other industries, such as the electrical machinery, automobile, radio, aircraft, and fountain pen industries. Other plastics products are sold in finished form, such as novelties, toys, combs, and container tops. Some plants in other industries, such as automobiles and radios, have plastics

departments of their own, instead of purchasing plastics parts from independent molders or laminators.

At the end of 1946, there were over 1,000 plants in the plastics products industry, with a total of about 50,000 employees. In the 200 to 300 plastics departments of plants in other industries, an additional 12,000 to 15,000 were employed. The jobs in these plastics departments correspond to those in the plastics products industry.

In 1945, the total output of molded and laminated plastics products (including products made outside of the plastics products industry) was valued at 330 million dollars, compared with approximately 76 million dollars in 1939.

Location of Plastics Products Plants

Plastics products plants are located principally in the more important industrial regions of the country, near the main users of their products. At the end of 1946 there were plants in 35 States, but over four-fifths of the workers in the industry were employed in 7 States: Massachusetts, New York, Illinois, New Jersey, Ohio, Connecticut, and California.

Size of Plants in the Industry

Plants in this industry are usually small. One factor is the relative newness of the industry; another is the fact that it is possible to operate fairly small molding plants efficiently. Plants range in size from those which are run by their owners without help to a few large establishments with over 1,000 employees. In 1939 more than half of all plants had less than 50 employees. During World War II and thereafter, the older established companies tended to become much larger. On the other hand, most of the new plants which have opened up within the last few years are still comparatively small.

How Plastics Products Are Made

Plastics products are made primarily by machines. Hand work comes in mainly in the finishing and inspection of the products. In a particular plant, one or more processes may be used, each having its special type of machine. These machines are largely automatic in their operation.

Quantity production is the rule, even in the smaller plants. Typically, large numbers of each item are turned out; for example, a plant may have an order for many thousands of identical bottle caps or fountain-pen barrels. It is usually not economical to make plastics products in small quantities, because of the high cost of the individual molds used in their manufacture. Without mechanization and quantity production, the cost of plastics articles would be prohibitively high and their widespread use impossible.

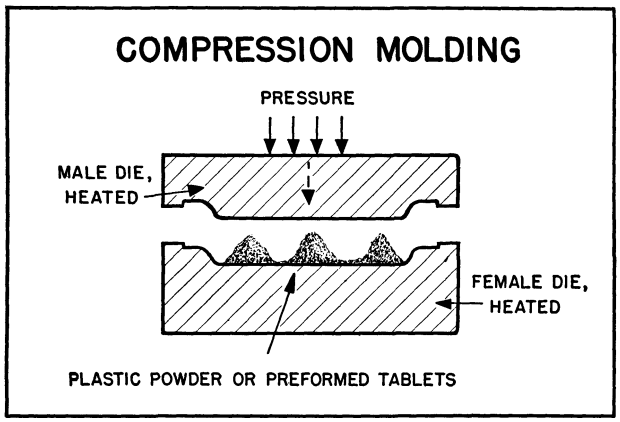
The principal methods of shaping plastics are by molding and laminating. There are four main ways of molding plastics—compression, transfer, injection, and extrusion. Choice of method is based on the shape of the piece to be molded and the kind of plastic materials used. In laminating, pressure is used to bond together plastic impregnated sheets of paper or fabric.

Plastics fall into two main classes: thermosetting and thermoplastic. Thermosetting materials undergo chemical change under heat and pressure, whereas thermoplastic materials do not. After molding, thermoplastics can be reheated and used over again, whereas thermosetting materials cannot be reused. Some of the most commonly used thermosetting compounds are phenol formaldehyde and melamine. Typical thermoplastic compounds include cellulose acetate, ethyl cellulose, polystyrene, acrylics, and the vinyl resins.

Compression Molding

More than half of all molded plastics, including such products as container tops, knobs and handles, instrument housings, electrical fuse boxes, and radio cabinets, are made by the compression method. A carefully measured amount of thermosetting material, either in powder form or in preheated pellets, is loaded directly into the heated cavities of the steel mold, as the simplified diagram [1] shows. The mold closes and pressure is

[1] Data for diagrams adapted from *Product Engineering* (New York, N. Y.).



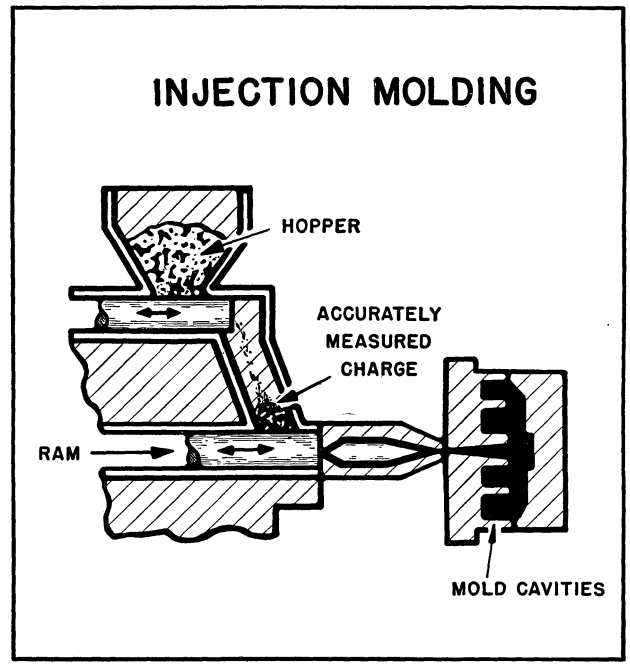
applied. Inside the mold, the material softens under heat and pressure, flows into the shape of the mold, and fuses and hardens permanently. The pressure is released, the press is opened, and the molded piece is removed.

Transfer Molding

This method is employed for molding many thermosetting plastics objects difficult to produce by conventional compression molding—especially those in which metal parts are inserted, as, for example, many electrical devices. Transfer molding is a variation of compression molding, differing from it in that the plastic materials, instead of being loaded directly into the mold cavity, are first placed in a transfer chamber, where they are softened by heat. The material is then forced by means of a plunger into the closed mold, where it is held under pressure for the period required to harden or "cure" the piece being molded.

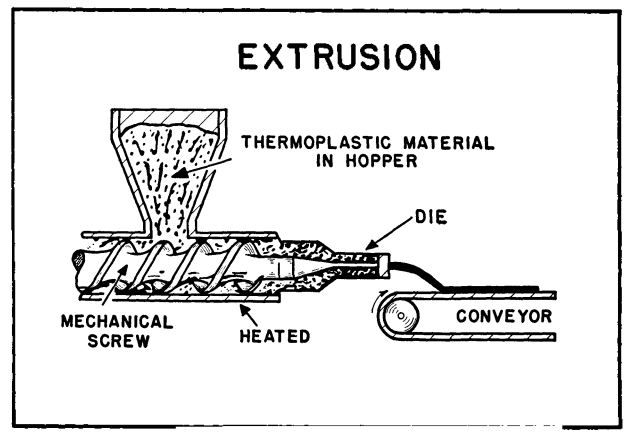
Injection Molding

Most of the molding of thermoplastic materials is done by the injection method, which produces such articles as combs, eyeglass frames, flashlight cases, tooth-brush handles, vacuum-cleaner attachments, instrument panels and costume jewelry. This process is usually done by semiautomatic machines and with the use of multicavity molds, which produce many items at the same time. The diagram [1] shows the basic features of injection molding. The plastic material is loaded into a hopper, which feeds into a cylinder. A ram forces the material into a heating chamber, where it is softened. The plastic material in a semiliquid form is then forced by pressure into a cool, closed mold, and here the material hardens by cooling, and the plastics part is ejected. The entire cycle (the whole operation of changing the heated material into the finished piece) can be completed in as little time as 20 seconds.



Molding by Extrusion

This method is used to produce continuous cross sections (strips) from thermoplastic materials for such products as flexible tubing and wall moldings. Plastic material is fed into the extrusion machine, which, as the diagram [1] indicates, operates much

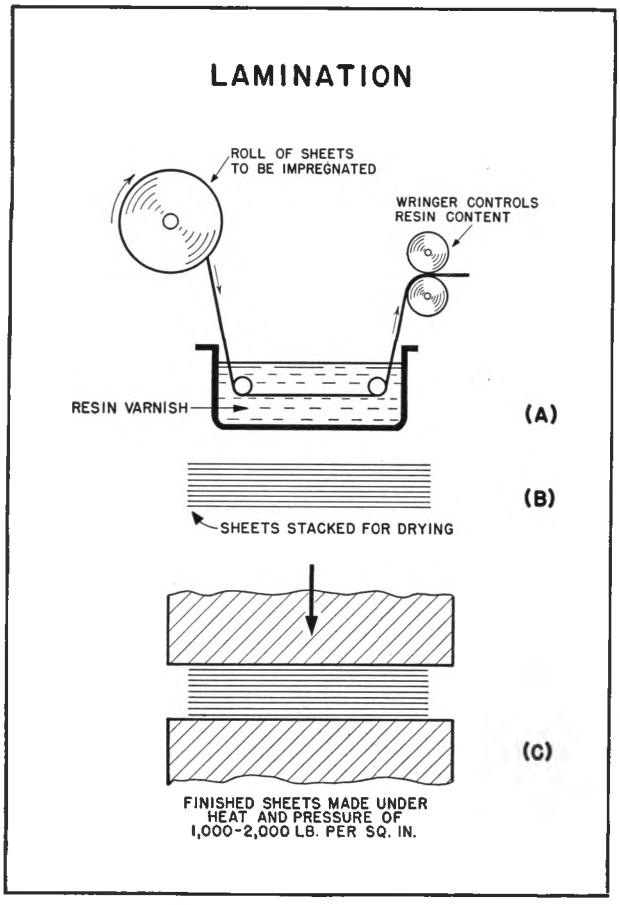


See footnote on page 3.

like a sausage grinder. A continuous screw forces the material into the heating chamber, where it is softened by heat and pressure and then forced, in paste-like form, through the die opening. The strip which emerges takes the form of the die, is carried off on a conveyor, and cooled by blowers or baths. The strips are then cut into the desired lengths or wound on spools.

Laminating

Laminating is used to produce sheets and tubes of high strength and hard finish. Sheets of paper or fabric are soaked in resin solutions and squeezed together under heat and pressure. Lamination may be high pressure, low pressure, or contact, differing according to the type of pressure used. In high pressure laminating, which is shown in the diagram,[1] rolls of paper or fabric are run through a bath of resin, the excess resin is drained off, and these rolls are dried in ovens. Sheets of the material are cut to proper length and placed in stacks between two steel plates. The stacks are then placed between the platens of a hydraulic press, where heat and pressure forms them into laminated sheets. The sheets are cooled and removed from the press. Any type of finish can be obtained, because the finished sheets duplicate the surface of the steel plates.



Inspecting a molded plastics piece for proper size and finish. Very little training is needed for most inspection jobs.

Some typical products machined from laminated sheets or tubes include automobile gears, switchboard panels, bearings, trays, and table tops.

Finishing and Inspection

Before molded plastics products are ready to be shipped to the user, they undergo a series of hand- and machine-finishing operations. Excess material must be removed, surfaces polished, and in many cases holes must be drilled and other machining done on the plastics pieces. Frequently, pieces have to be assembled. Laminated sheets, rods, and tubes may be further shaped by sawing, machining, and punching holes.

Plastics articles are inspected for proper size, finish, color, and other specified qualities required by the user.

See footnote on p. 3.

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As this is a relatively new industry, and one which has added many workers in recent years, most of its employees are young. During World War II, women constituted 40 to 50 percent of the workers in plastics products plants. By 1947 the proportion had dropped to about a third. Most of the women are in the finishing and inspection departments and in office work, although they frequently operate semiautomatic molding machines.

Finishing room worker hand-filing a plastics telephone hand-set. Many of the finishing jobs are held by women.

In 1946 about 5 percent of the workers in the industry were Negroes. Some Negroes are employed in production jobs, but most are employed as janitors and as laborers in the shipping and storage departments.

Kinds of Jobs

Because the production methods of the plastics products industry are largely mechanized, the bulk of the jobs are semiskilled and unskilled. Employment in major departments is shown in chart 1.

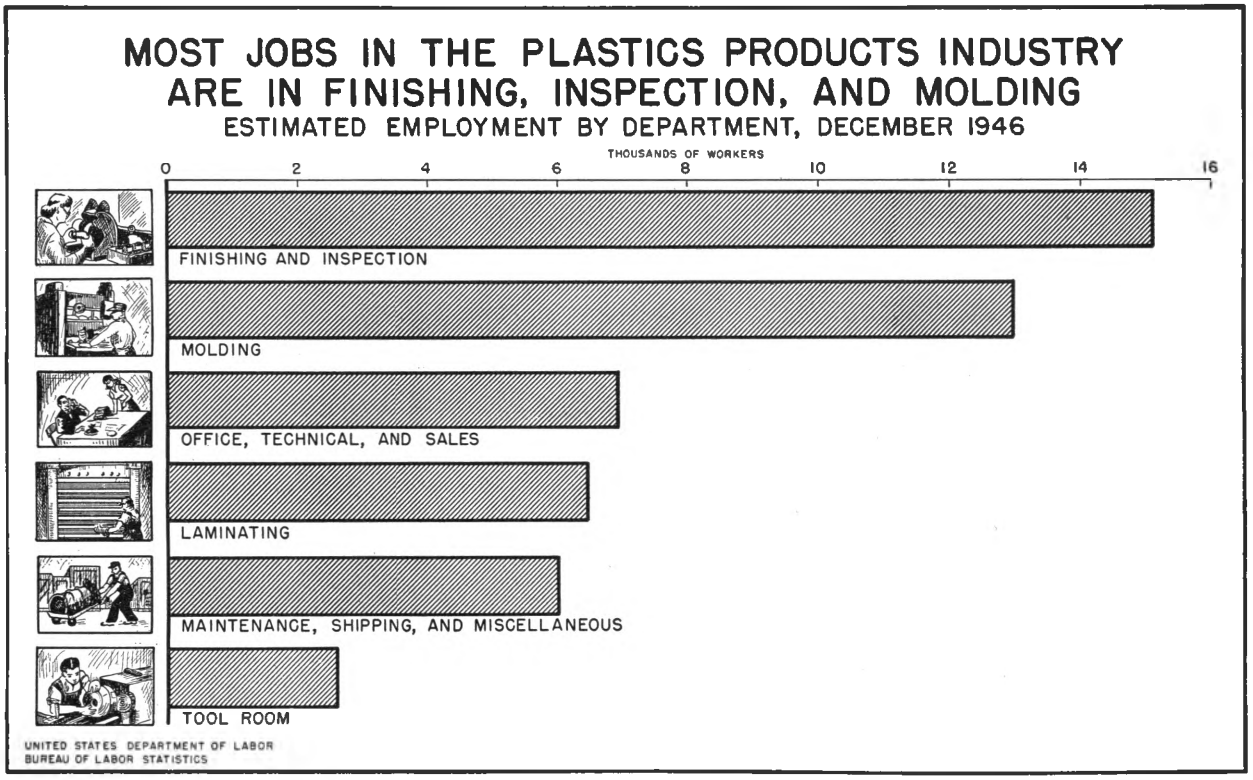


Chart 1.

Over a fourth of the workers are in the molding departments. Almost all molding machine operators learn their duties in a few months of on-the-job training. Hand molders (operators of nonautomatic molding machines), however, are relatively skilled. Operators of fully automatic molding machines may be trained in a few weeks. In the finishing and inspection departments, which have nearly a third of the workers, semiskilled and unskilled employees do the various tumbling, sanding, assembling, and polishing operations. Similarly, much of the inspection is done by workers who need brief training. In laminating departments, as in molding, nearly all the jobs center around machine operation. Plastics products plants also employ a number of men who move materials or perform laboring jobs. These are found in the storage and shipping departments, as well as the various production and maintenance departments.

On the other hand, molding plants which make their own molds have toolrooms where highly skilled tool and die makers and machinists are employed; but toolroom jobs are only a small percentage of employment. There are also a number of workers who maintain the plant and its equipment, among them being some skilled men, such as electricians and mechanics.

White-collar workers constitute nearly one-seventh of the industry's total employment. There are, of course, the usual clerical jobs, such as typing, bookkeeping, and filing. Many salesmen are employed in the marketing of plastics products. In the technical fields, there are chemical and electrical engineers, mold and product designers, and draftsmen.

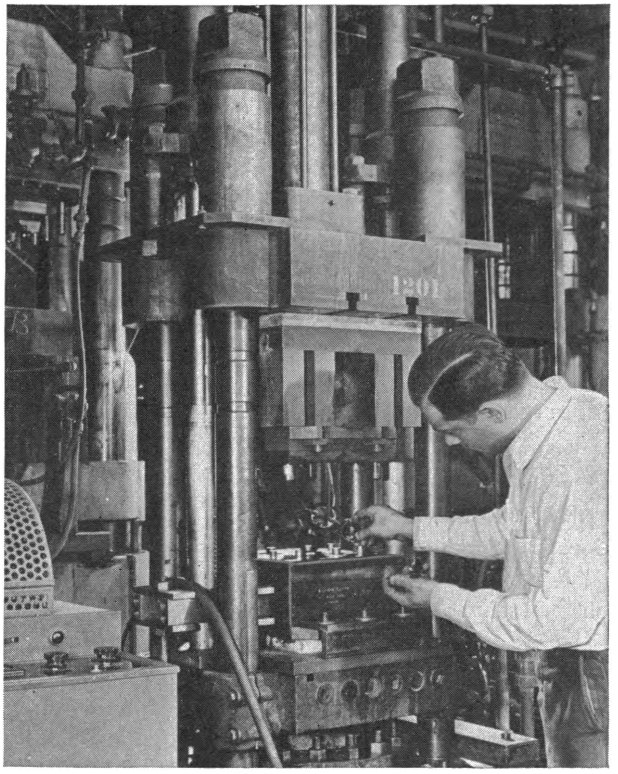
What Are the Earnings?

In early 1948 hourly earnings of plant workers in this industry ranged from an entrance rate of 60 cents an hour for some unskilled finishing jobs to more than $2 an hour for especially skilled tool and die makers. A high percentage of the workers are on incentive pay, with a guaranteed minimum hourly rate. The average hourly earnings of production workers employed in 115 plants reporting to the Bureau of Labor Statistics in December 1947 were about $1.24. On the average, they earned $51.32 a week for 41.4 hours of work. This compares with hourly earnings of $1.28 and weekly earnings of $52.74 for production workers in manufacturing industries as a whole in the same month. These figures include extra pay for overtime, holiday work, and night shifts, and therefore do not show the straight-time pay. Typical straight-time earnings in each of the main occupations of the plastics products industry are given in the subsequent discussion of jobs in the industry.

This industry does not have seasonal ups and downs in production, so that nearly all its employees work the year round.

Working Conditions

Working conditions in plastics products plants are usually good, compared with factory work in general. The buildings are often modern, well-lighted, and adequately ventilated. Molding departments tend to be noisy, and it may be quite hot next to the molding machines. The operators have to wear gloves, since they handle hot plastics pieces. In laminating plants, the odor from the laminating solution may be disagreeable, and heat near the presses may be bothersome.



Transfer molding is a variation of compression molding. The operator is taking out molded telephone parts.

The work in the industry is not particularly dangerous. Accident data for 1946 indicate that in this industry there were about 16.8 disabling injuries for each million employee-hours worked, compared with a rate of 19.9 for all manufacturing industries. The machines used in molding are largely automatic, with numerous safety devices to reduce the hazards. In finishing operations, cutting and stamping machines cause occasional injuries, and the workers may be affected by dust from grinding and polishing.

Most plastics products plants operate more than one shift; three-shift operation is the most common.

About half of the plants in the industry are unionized. Locals of various CIO and AFL unions and some independent unions have organized these plants.

Jobs in Plastics Products Industry—Duties, Training and Qualifications, and Earnings

Thus far a general picture of the industry and its workers has been given. Anyone considering a career in the plastics products industry will want a closer look at the more important occupations in the industry, especially those jobs unique to plastics.

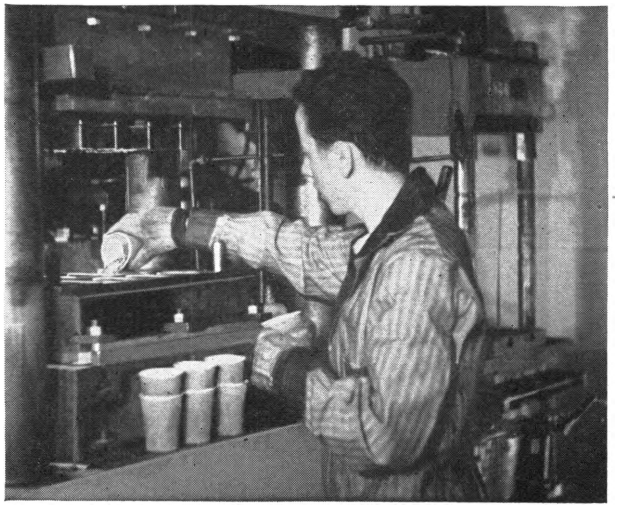
Jobs in the Molding Department

In the plastics molding plant, molding is the heart of the production process. Over one-fourth of total employment in the industry is in the molding departments. Most of the workers in the molding department are machine operators, running the various kinds of molding presses.

Duties

What a *compression molding machine operator* does and what he has to know depends on the kind of machine—hand, semiautomatic, or fully automatic. Semiautomatic machines are the most common in compression molding. If he operates one of these, he loads the proper amount of powder or preformed materials into the mold cavity. He starts the machine by pressing the starter button. By means of electric timing controls the machine automatically closes, cures, opens, and breaks the article free from the mold. These controls are usually set in advance, by a set-up man, for each run of identical pieces. Finally, the operator removes the molded article from the machine and cleans the mold with an air hose. It is clear that the machine does most of the work and that its operator needs little skill.

Fully automatic machines have these features, but go even further. With their automatic loading and ejection devices, the operator need only keep the hopper full of molding materials and call his supervisor if anything goes wrong with the machine. In some plants, automatic and semiautomatic compression molding machines are arranged and timed so that one operator may run several machines.



Operator loading plastic material into the mold cavities of a compression molding machine, which is the most widely used type of molding press.

Hand molding is used only for experimental and laboratory work and for the making of articles required in very small quantities. There are therefore, relatively few hand molders. The hand molder removes the mold from the machine and fills it with plastic materials. He then assembles the mold and places it into position in the press. When the curing time is up, the press is opened

and he removes the mold from the press, takes it apart, and removes the molded piece. Clearly, the hand molder must have considerably greater skill and must use more judgment than other molding machine operators.

In *transfer molding*, the operator's duties are similar to those of the compression molding machine operator.

The *injection molding machine operator* fills the machine hopper with plastic materials and starts the machine, which automatically does the molding. When the molding is completed, the mold opens automatically and the operator removes the molded pieces. While the machine is running the operator may perform other tasks, such as cutting excess material from the pieces and packing the molded pieces into a box.

An *extrusion machine operator* feeds his machine with plastic materials and watches the extruded strips, as they are carried away from the machine on a conveyor, to see if the pieces are of the right size and without flaws. He may cut the plastic strips as they come from the press.

The job of the *set-up man* (also known as a "mold setter" or "die setter") is to make ready the molding machines used by semiskilled or unskilled operators. He bolts and clamps the mold into place in the machine and checks mold alignment. The set-up man regulates the time, heat, and pressure controls and makes other adjustments of the machines as required from time to time. His job is more difficult and responsible than that of most machine operators.

Training and Qualifications

Usually no previous experience or training is required to obtain the job of molding machine operator. The general practice is to hire inexperienced persons and to train them on the job.

The operator has to be an alert and dependable person. Although the skill needed is small, the job involves careful watching of the process and the use of expensive and complicated machines. His strength should be average, and he should be able to move about freely. Some women are employed as operators, usually of injection machines. The training period varies from the 2 or 3 weeks necessary to learn operation of the more automatic machines to the 12 to 18 months needed to become a skilled hand molder. With little additional training, workers can transfer from one type of molding machine to another; e.g., from compression to injection machines.

Set-up men are selected from among experienced molding machine operators or from among the tool room workers. Jobs as molding room foremen are filled by promoting machine operators or set-up men.

Earnings

What may a young person who gets a job as a molding machine operator expect in the way of earnings?

In the early part of 1948, most of the experienced men operating compression molding machines earned from $1.10 to $1.75 an hour. Experienced men operating injection molding machines typically earned from $1.00 to $1.40 an hour. These earnings include any incentive pay received, but exclude extra pay for overtime and night work. Earnings of women, as is true in most jobs in the industry, are often 5 to 20 cents an hour less than those of men. Beginning pay for inexperienced workers ranged from 75 cents to $1.00 an hour. Set-up men earned from $1.10 to $1.75 an hour. The hourly rate for molding foremen varied from $1.20 to $2.00.

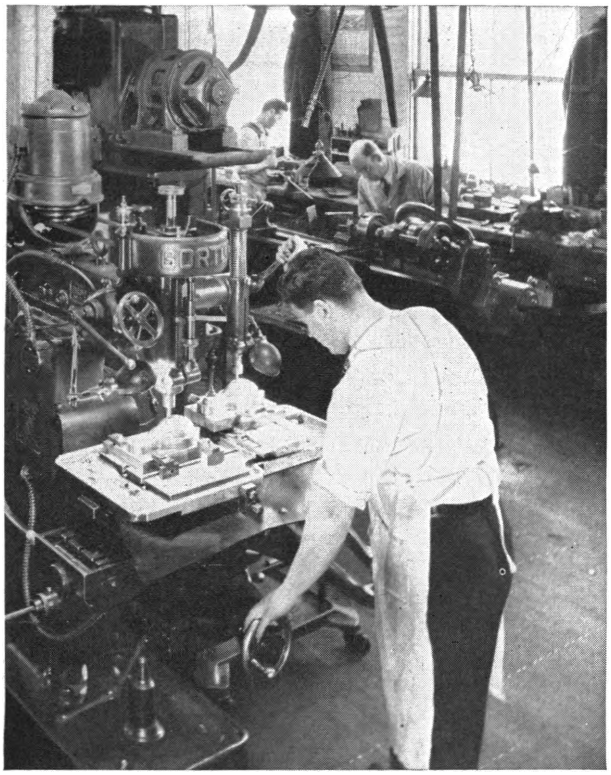
Jobs in the Tool Room

Many molding plants, especially the larger ones, make their own molds instead of buying them from outside machine shops. These molding plants have tool rooms in which skilled tool and die makers and machinists are employed. Although this is only a small part of employment in the plastics products industry, with less than 3,000 workers at the end of 1946, it is the place in the industry where most of the skilled jobs are found. (However, this industry is just one of the many places where tool and die makers and machinists work, since the bulk of them are employed in the various metalworking industries.)

Duties

Tool and die makers use machine tools and hand tools to shape molds from steel. They must be able to read blueprints, to use precision measuring instruments, and to set up and operate various machine tools, such as lathes and boring mills. *Machinists* assist the tool and die makers, recondition and repair worn or damaged molds, and make replacement parts for the various machines

in the plant. Machinists must be able to set up and operate machine tools.



Machining a plastics mold in the tool room. Tool and die makers are the most skilled production workers in the plastics products industry.

Training and Qualifications

The work of the tool and die maker is usually learned through formal apprenticeship or the equivalent in other types of on-the-job training. A tool and die apprenticeship ordinarily covers 4 or 5 years of shop training in various parts of the job. In addition, during the apprenticeship, courses such as shop arithmetic and blueprint reading are given in vocational schools. One may become a machinist through a 4-year apprenticeship similar to that of the tool and die maker. Men also become machinists by picking up the trade while working in the tool room as machinist's helpers or machine tool operators.

Earnings

Earnings of first-class tool and die makers in the plastics products industry ranged from $1.50 to $2.00 an hour, straight-time, in early 1948. This is the highest-paid factory job in the industry. Machinists generally earned between $1.30 and $1.75 an hour. Apprentices usually start at about half of the journeyman rate. The hourly rate for toolroom foremen varied from $1.75 to $2.50.

Jobs in Finishing Operations

One of the largest groups of jobs in the plastics products industry is the finishing department group. Most molded plastics undergo a series of finishing operations before they are ready for use. In general, not much skill is needed of finishing department workers, most of whom are women.

There are a number of different jobs in finishing rooms. *Tumbler operators* place molded pieces in wire tumbling barrels containing polishing materials and start the tumbling machine. The rotating motion of the barrel rubs the pieces against one another and against the polishing material, which gradually removes the excess material. *Bench grinders* hold the molded articles against rotating abrasive wheels to remove excess material. *Hand filers* or *burrers* use hand files or carving spindles to smooth edges and remove material. *Buffers* and *polishers* polish articles to a high luster by holding them against rapidly rotating wheels. *Drill-press operators* drill holes in plastic pieces and clean the excess material from holes. In some plants, a number of *assemblers* are employed to put together molded pieces, making the finished product.

Because these jobs are easy to learn, unskilled and inexperienced workers are hired. Training to operate the various machines and tools is given on the job.

Workers in the various finishing operations in the first part of 1948 usually earned from 85 cents to $1.20 an hour, depending on the job and the skill involved. Beginning rates for inexperienced workers were as low as 60 cents an hour. Finishing department foremen earned from 85 cents to $1.50 an hour.

Jobs in the Inspection Department

Plastics products usually must be inspected before they leave the plant. The amount of inspection needed differs widely. For some molded products, the workers only look over the articles for blisters or improper finish. Other products must be examined more closely to see if they are

the exact shape and size required and meet other specifications. As in finishing, a large proportion of the workers are women.

Previous experience is usually not required. Good eyesight is essential, but little physical strength is called for. Very brief training is needed to perform most of the inspection operations. On the other hand, instruction in blueprint reading and use of measuring instruments such as micrometers, dividers, and the various types of gages is essential for some inspectors and supervisory inspectors.

In early 1948, the hourly earnings of experienced inspectors in molding plants generally ranged from 85 cents to $1.20 an hour. Supervisory inspectors earned from $1.05 to $1.75.

Jobs in Laminating

About 6,500 workers were engaged in laminating operations at the end of 1946. Most of the jobs are in plants which specialize in laminating, although some plants which do molding also have laminating departments.

Most of the workers in the laminating shops are semiskilled machine operators, helpers, and laborers. Three typical jobs are those of coater, press operator, and mandrel man.

The *coater* operates the machine that impregnates paper or fabrics with synthetic resins. He places large rolls of paper or fabric into the machine and directs the course of the material through a resin bath and through drying ovens. After that, the dried material is wound in rolls by the same machine.

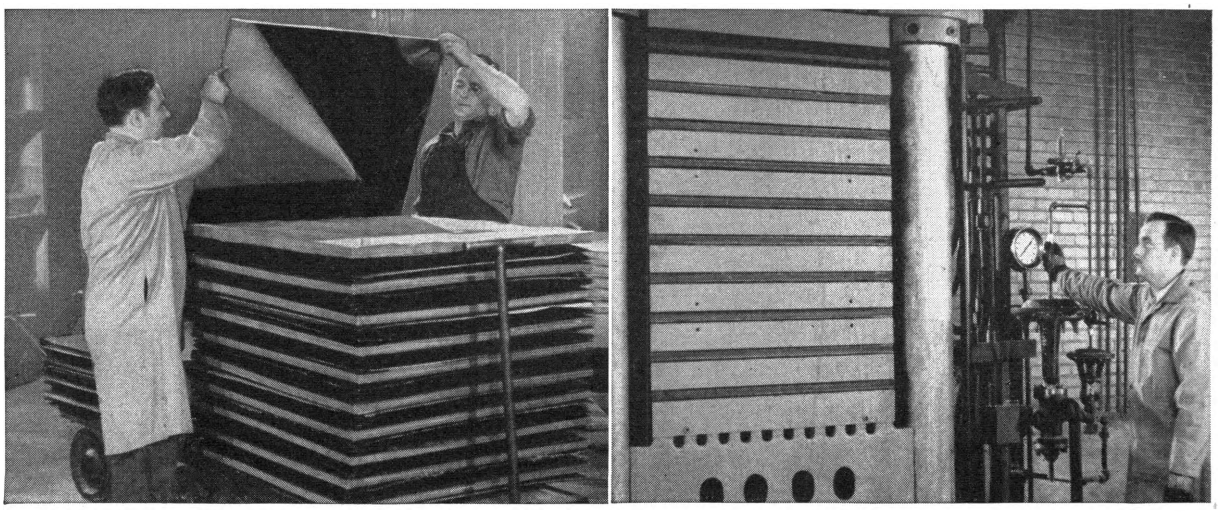
A *laminating press operator* runs a hydraulic press which produces sheets of plastic material by pressing layers of resin-impregnated paper, textiles, or other material between steel plates. The laminating press operator has to regulate the heat and pressure controls.

The *mandrel man* tends a semiautomatic machine which winds resin-impregnated paper or fabric onto heated cores (mandrels) used in making laminated plastic tubing. He regulates the thickness of the tube by using simple gaging tools. After the desired thickness is reached he stops the machine and cuts the material. The tube is then taken to an oven where the cure is completed.

In laminating plants, sheets and tubes are often fabricated into finished products such as gears and bearings, before they are shipped. This work is done by *lathe operators*, *power-saw operators*, and other machine operators, most of them semiskilled.

Production workers in laminating departments usually learn their work through informal on-the-job training. The amount of training required ranges from 2 to 12 months, depending on the complexity of the job and the kind of machinery used. Inexperienced workers are usually hired as laborers or learners and are upgraded to fill vacancies as they occur.

Laminating plastics products. Workers stack sheets of resin-soaked paper between metal plates; after the stack is placed in a hydraulic press, heat and pressure are applied.



At the beginning of 1947, semiskilled production workers in laminating shops, such as coaters and press operators, were earning from 80 cents to $1.25 an hour.

Professional, Technical, and Sales Jobs

Although most of the jobs in the plastics products industry require little skill or knowledge, such technically trained people as chemists, engineers, designers, and draftsmen are needed to carry on this complex, rapidly changing industry. Plastics products companies must also have salesmen, men who know plastics products and who can go out and sell them to skeptical purchasing agents and production men in competition with other materials. Most of the technicians work at developing new products and improving old ones. Qualified production superintendents are also needed to plan and oversee plant operations, keeping the plant running efficiently and turning out high quality products.

College training in chemical or mechanical engineering is a prerequisite for most technical jobs; and to qualify for the more responsible positions, such as production superintendent, considerable experience is required. These technical workers are not a large proportion of the industry's employment, and are most commonly found in the large plants, since many of the smaller molding firms do not employ designers, engineers, or draftsmen. Instead, these small companies temporarily engage the services of independent technical men and consultants for this work. Some of the development of plastics products is carried on by the plastic materials producers and they employ technical men in this activity.

Salesmen, often called sales engineers, should have some technical training. They need a knowledge of the properties of plastic materials, of costs, of plant equipment, and of marketing possibilities. It is often necessary to have experience in a plastics plant or engineering school training in order to become a salesman for a plastics products firm.

Outlook for Employment in the Plastics Products Industry

The outlook is for a relatively big increase in the number of jobs in the plastics products industry during the next year or two and for steady growth in employment thereafter. This conclusion has been reached after an analysis of trends of production and technological change in the industry.

Past Trends in Production and Employment

Since the beginning of the industry in 1869, with the invention of the first plastic material—celluloid—there has been continued expansion both in the amounts and types of materials made and in the production and uses of plastics products. In recent years, however, growth has been phenomenally rapid, as chart 2 shows.

It can be seen that in 1939 output was nearly four times that in 1931. The rise between 1937 and 1939 is significant in view of the fact that general business conditions were better in the former year than in the latter. There were many factors in this rapid growth: New plastic materials were developed; the cost of materials decreased; the methods of molding and laminating were greatly improved; widespread consumer and industrial acceptance of plastics was achieved.

During World War II there was another great expansion of the industry, with 85 percent of plastics products going directly or indirectly into military uses. These included, for example, parts for hand grenades and gas masks; housings for radio and radar equipment; aircraft ammunition boxes and bomb racks; and laminated plastics bearings and gears. In 1944, production had risen to four times the prewar rate.

Not only did wartime needs greatly expand the production of plastics products but there were also effects important in the peacetime development of the industry. For example, numerous substitutions were made of plastics in place of metal and other scarce materials; many plastic materials were improved in connection with military uses. These developments have carried over into the postwar period.

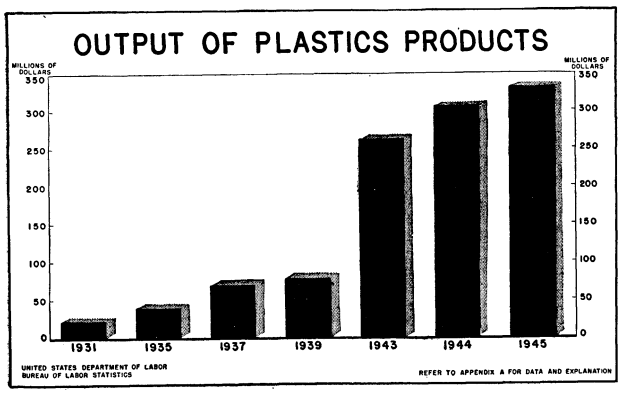


CHART 2.

In the plastics products industry the number of employees doubled between 1939 and 1943 and continued to rise during the war years. Employment did not go up nearly as much as production, however, because lengthening of working hours and use of improved production equipment and methods resulted in a great increase in output per worker. In chart 3 we have a picture of the trend of employment in the plastics products industry.

The outstanding feature of this industry's development is the fact that employment at the end of 1946 was above the wartime peak, as well as nearly three times the 1939 level. What happened was that a big increase in peacetime uses of plastics products more than took the place of their wartime uses. If it had not been for a severe shortage of plastic materials, an even greater postwar increase of the industry would have occurred.

In the spring and summer of 1947 there was a temporary slackening in the demand for products made from thermoplastics, resulting in some small lay-offs in the industry. This situation reflected an oversupply of plastics novelties and gadgets and, in some cases, buyers' resistance to high prices and improper uses of plastics. This slump in business ended in the early fall and production increased rapidly in the last few months of the year, so that by the beginning of 1948 the industry had more than recovered from its mid-1947 decline. Demand for products made from thermosetting materials remained strong, on the other hand, and the supply of these materials continued to be inadequate.

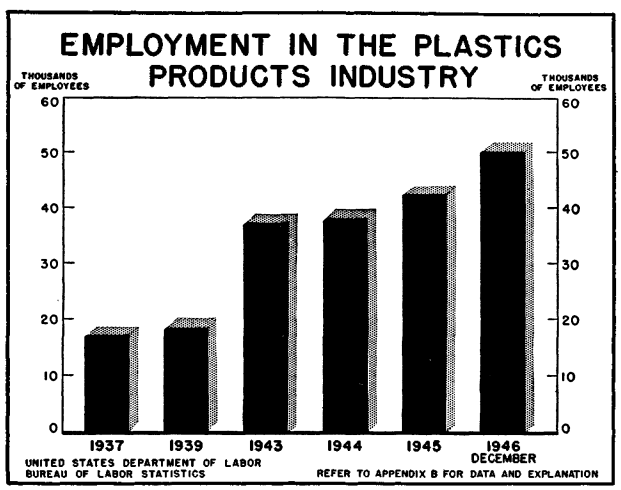


CHART 3.

Since materials shortages have been a limiting factor in the industry's development, the prospective supply of materials is important in the industry outlook.

Future Supply of Plastic Materials

Scarcity of plastic materials developed because the expanding needs of the plastics products makers outran the capacity of the plastic materials manufacturers. Not only have there been shortages while new plants for making materials were being constructed, but there has also been a scarcity of many of the basic chemicals used in the manufacture of these materials. A much larger supply of plastic materials, however, is in prospect.

The plastic materials manufacturers in 1946 began a large scale program of new plant construction to be completed in 1948. Many of the necessary basic chemicals are also likely to be more plentiful. According to estimates of the Plastic Materials Manufacturers Association, the rate of production for all plastic materials after completion of the present expansion program will be double that of 1945, and the rate for molding powder (excluding vinyls) will be more than two and a half times the 1945 rate. By the end of 1947 this expansion had already greatly increased the supply of plastic materials, and the thermoplastic materials were relatively abundant.

Capacity of the Plastics Products Industry

It is expected that the plastics products industry will have adequate machine capacity to absorb the increased supply of plastic materials. The number of machines installed has grown faster than the supply of materials, so that many machines are not now being fully used. Moreover, figures

on the number of machines in use in recent years show a rising trend in capacity.

Type of machine:[1]	1941	1945	1946	1947
Injection	1,000	1,720	3,275	3,625
Compression	8,000	12,065	12,975	13,390

Some additional increase in the number of machines seems probable in the next 2 years. It appears likely, then, that there will be enough molding machines to use all the increased supply of plastic molding material. The extent to which this capacity is used in actual production, however, depends on the prospective markets for plastics products.

The Future Market for Plastics Products

Only a small percentage of plastics products are sold directly to the public as finished articles, such as toy guns, sink strainers, and combs. Most of the products go to manufacturers who use plastics parts in the making of other products, such as radios, automobiles, fountain pens, and industrial machinery. Thus, the demand for plastics products and the resulting volume of production that can be expected for the next few years will be determined primarily by the level of activity in the industries which consume plastics products and by the development of new uses for plastics by these industries. The most important industrial users of plastics products include the manufacturers of electrical machinery (both industrial electrical equipment and consumer appliances), radios, automobiles, novelties and toys, aircraft, household equipment and furniture, industrial machinery and equipment, packaging, and building supplies. A high level of activity is expected in most of these industries for the next few years.

The electrical equipment industry constituted the largest prewar market for plastics products. In view of the recent large increase in demand for electric power in this country and of foreign needs for electric-power machinery, the production of generating and distributing equipment is expected to be at an all-time high during the next few years. Because of their excellent insulating qualities, laminated and molded plastics parts are being increasingly used in this equipment in such applications as junction boxes, circuit breakers, panel boards, fuses, bases for electric motors, and meter boards.

In the next few years, there should continue to be a high volume of production of refrigerators, vacuum sweepers, and the many other electrical appliances. This should provide a good market for plastics parts. The growing use of electronic devices will expand another market for plastics.

The output of radio receiving sets in the last 2 years has been an all-time record and is expected to remain at a high level for a few more years. Apart from their other uses in radios, plastics have replaced wood largely as cabinets for table models. The probable growth of FM and television will create some additional demand for plastics products, which are used in both the transmitting and receiving equipment.

Although the automobile industry was one of the heaviest consumers of plastics before the war, the average automobile contained only about 5 pounds of plastics. The postwar cars generally showed small increases in the amounts of plastics used. Increased use of plastics parts is forecast, however, and some experts predict the use of as much as 15 to 20 pounds of plastics per car. An important application of plastics in the postwar automobile has occurred: the inside surface of some station wagons, taxis, and truck cabs consists of laminated paneling. Not only are more plastics per car likely, but also a high level of automotive output—at least 5 million cars and trucks annually—may be expected for the next few years.

The aircraft industry was one of the largest users of plastics during the war. Although current aircraft production is only a small fraction of the wartime rate, it remains considerably higher than the prewar volume. In view of the Government program for greatly increased production of military aircraft and of the new uses for plastics in airplanes, this industry should provide an expanding market for plastics products.

Another important use for plastics products has been as tops for bottles and other containers. In the past the bulk of the closures have been metal, but plastics, because they are odorless, tasteless, nonrusting, and resistant to chemicals, are expected to be used much more widely in the future.

In other important plastics-products-consuming

[1] Data are from Modern Plastics (New York, N. Y.), January 1948. These estimates include machines used in plastics departments of plants in other industries, as well as in the plastics products industry. They do not include laboratory presses nor make allowances for scrapping of older machines.

industries—the building, household equipment and furniture, and novelty and toy industries—production is expected to be at a high level for several years, with some new uses of plastics also being introduced. Already plastics have appeared in many new uses in buildings and furniture, and the trend to plastics is growing. An example is the recent development of plastic bathroom tile. A visit to any 5-and-10-cent store will show that numerous familiar items, such as tool handles and towel racks, formerly made of other materials, are now often plastic.

All in all, market prospects for plastics products appear highly favorable, provided general business conditions continue to be good. It seems entirely possible that in 1950 the industry, together with the plastics departments of plants in other industries, will be using all or nearly all of the increased supply of materials expected to be available at that time. This would mean a rate of output of plastics products as much as 75 percent higher than in the latter part of 1946, itself a record period. This increase will not be achieved, however, unless the use of plastics products is intensively promoted. The rise in the output of the industry might vary somewhat from the estimate of 75 percent, depending on how much of the expanded production occurs in the plastics departments of plants in other industries. There are some indications that such departments may grow more rapidly than the independent industry.

The demand for plastics products over a longer period—for example the 5-to-10-year period beginning about 1950—will depend not only on the rate of production of the present users of plastics, but also to an increasingly important extent on new applications by these and other industries.

After a few years, the demand for plastics products for use in the electrical appliance and radio industries will probably decline somewhat. Nevertheless, these industries, as well as other major consumers of plastics products, such as the automobile industry, are expected to continue at relatively high levels of production.

Further growth of the plastics products industry, however, will depend mainly on the new uses that will be developed. As has previously been indicated, many of the present industrial consumers expect to develop new uses for plastics parts in their products. This is especially true in the construction, automobile, railroad equipment, and household equipment industries. Some of the new applications of plastics, which have been deferred because of the shortage of materials, will come on the market within the next few years. Moreover, extensive research is continually in progress in an effort to find additional uses for plastics products and to develop new plastic materials with properties which will create new fields for plastics.

Prices of plastics products are especially important in the long-range outlook. For some time there has been a downward trend in the prices of plastic materials, especially in the newer materials, such as polystyrene. Plastics prices, as a whole, are still high compared with other materials, and as a result many important markets are closed to plastics products. As the production of the different plastic materials increases, however, some further price reductions are probable. Costs of making plastics products may also decline because of the increased efficiency of the newer machinery and methods. Wider use of new methods, such as low-pressure laminating, may open up some new markets for plastics, because these processes can produce larger and more intricate shapes.

To sum up, it seems likely that with development of new markets for plastics products, and with continued growth of population and national income, a long-range upward trend in the volume of output is in prospect. This growth, however, will probably be much less rapid than the rate of increase expected to occur in the next few years.

Technological Changes Affecting Employment

In order to estimate from the anticipated volume of output how many workers will be employed in the industry, it is necessary to consider prospective technological changes which affect the quantity each worker can produce.

The use of new equipment will considerably increase output per worker. The many new machines delivered to the industry in the last 2 years have been generally more efficient, faster, and capable of molding larger pieces. A high proportion of the new equipment consisted of injection-molding machines, which are faster than the more widely used compression machines. The industry has begun to make greater use of fully automatic machines; one semiskilled worker can operate several of these machines simultaneously. Moreover, many molding firms are modernizing

their old molding machines to obtain more efficient operation.

It is also possible that the average order received by molding plants will be larger in the future, so that the plant will be able to make longer production runs with less time out for changing molds and materials. The end of the shortages of materials will also permit more efficient operations. Moreover, as the industry develops and as competition among plants becomes keener, the tendency will be for the least efficient plants to close down. Higher output per man in the industry as a whole will result.

Other technological changes that will affect employment include increased use of the faster transfer-molding method and further application of electronic preheating of molding preforms, which has speeded up compression molding.

Partly offsetting technical advances will be the probable reduction of the workweek. In the first part of 1948, many plastics products workers were on a 44- or 48-hour week. The tendency will be to cut their hours to around 40.

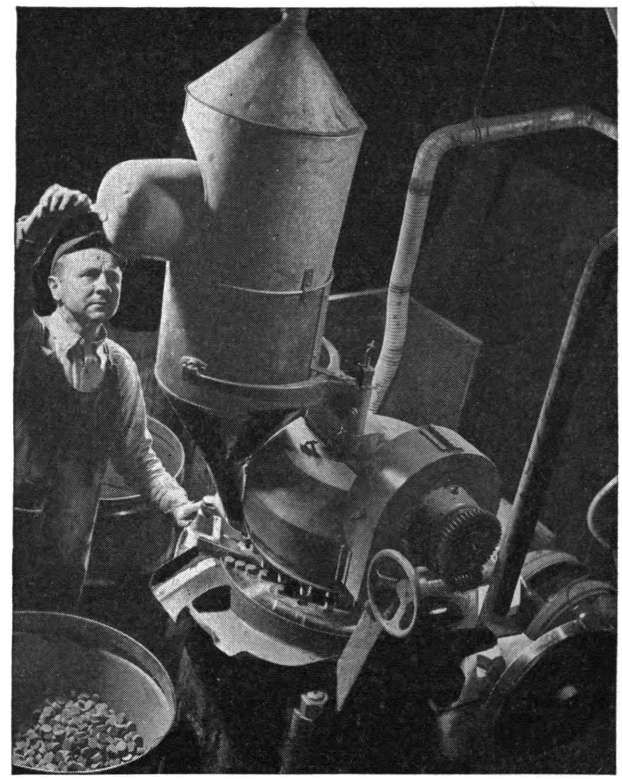
All in all, since machinery and processes are continually improving, output per worker in the plastics products industry will rise considerably; employment, therefore, is not expected to increase as rapidly as production.

Employment Outlook

Taking into account the prospects in production, and allowing for the probable effects of technological change, it would appear that a sharp increase in the number of workers in the plastics products industry is in store for the next 2 years. In 1950, if the demand for plastic products is then as great as expected, the number employed in the industry may reach 75,000—an increase of 25,000 over employment at the end of 1946. Added to these new jobs will be the openings created in the replacement of those workers who die or retire, or who leave the industry for one reason or another. Also, plastics molding and laminating departments of plants in other industries will hire additional workers, and this will have the same general effect on employment opportunities for plastics workers as the expansion of the industry.

Looking further into the future, the prospects are for a continued, but gradual, rise in employment. This is important, because it means that those entering the industry during the next few years will have good chances of continued employment over a long period.

It must be remembered, however, that the plastics products industry will be relatively small, even after the anticipated expansion. Normal replacement needs of each of such large industries as automobiles, cotton textiles, or iron and steel will create more job opportunities each year than the combination of new jobs and replacements in the plastics products industry.



Preforming of plastic material into pellets preparatory to molding. Preform machine operator puts plastics material into the hopper at one end of the machine; the pellets come out at the other end.

Future opportunities in the plastics products industry cannot be measured solely by the number of jobs; the types of work are of equal importance. The fact is that most of the openings will be for inexperienced persons, who will be trained on the job for semiskilled or unskilled production jobs in the molding and laminating plants. Earnings, however, are about equal to those in manufacturing industries as a whole, and the working conditions are generally satisfactory. The long-run growth of the industry will improve the

workers' chances for promotion to better jobs.

In addition, there will be some openings for apprentices to be trained for skilled jobs in the tool rooms. There also will be vacancies for office and maintenance help. A small number of persons with engineering training will be hired for such positions as production engineer and mold and product designer. Some men will be hired as salesmen—one of the better paying and more interesting positions. Selling jobs, however, will still be only a small part of the industry's employment.

In recent years, many men have opened up small molding plants. There will continue to be some opportunities of this kind, but only for those who have adequate capital and a thorough knowledge of plastics production and marketing.

Training Opportunities for New Workers

On-the-Job Training

As we have seen, most of the new workers who will enter this industry will fill semiskilled or unskilled production jobs. These employees will in most cases learn their jobs through relatively short, informal, on-the-job training. Those interested in obtaining such trainee jobs can consult the nearest local office of their State employment service or can apply directly to the plastics products companies. The addresses of plastics products plants in one's community can be found in the classified section of the local telephone book. A list of molding and laminating firms and their addresses may be obtained by writing to the Society of the Plastics Industry, Inc., 295 Madison Avenue, New York 17, N. Y. Veterans may get information about Government financial aid while training, at the nearest office of the Veterans Administration or at a Veterans Information Center.

Young men interested in training for the jobs in the toolroom should investigate the possibilities of apprenticeship. This is the main route to skilled jobs, such as tool and die maker or machinist. Persons interested in apprenticeship can consult the local office of their State employment service or apply directly to the employers. Since most tool and die makers and machinists are employed outside of the plastics products industry, mainly in the metalworking industries, young men can also apply to companies in those industries. They may also write to, or visit, the local headquarters of unions which include machinists or tool and die makers among their members.[2]

[2] Some of the more important of these unions are the International Association of Machinists (independent), the United Electrical, Radio & Machine Workers of America (CIO), the United Automobile, Aircraft, & Agricultural Implement Workers of America (CIO), and the Mechanics Educational Society of America (independent).

Trade Schools

There are a number of trade schools in the plastics field—usually located in the larger cities. These schools give training in the various branches of the plastics industry and include in their courses such subjects as properties and applications of plastic materials, molding and laminating practices, and techniques of fabrication. The large majority of employees in the plastics products industry have not had these courses, nor are such courses generally necessary to obtain jobs in the industry, since the bulk of the jobs are learned while working in the plants. However, training in a good plastics trade school may be helpful for those interested in becoming salesmen for plastics molding firms. In some cases, for those already working in the industry, training in a plastics trade school may be helpful in obtaining promotions to supervisory jobs. These courses may also be very helpful for those who intend to open up small fabricating businesses of their own.

A list of private plastics trade schools and information regarding the standing of these schools can be obtained from the National Council of Technical Schools, 839 17th Street NW., Washington 6, D. C. Names and addresses of schools may also be obtained from the Society of the Plastics Industry, Inc., 295 Madison Avenue, New York 17, N. Y.

Colleges and Universities

Specific courses in plastics are offered by a growing number of colleges and universities. Some schools have separate courses in plastics; others provide instruction in plastics as part of broader training in engineering or chemistry. However, these courses are not usually needed for the profes-

sional jobs in the industry, since it has been the custom to require only basic mechanical or chemical engineering training, the necessary specialized knowledge of plastics being learned in the plant or by home study.

Names and addresses of these schools and the kinds of plastics courses given may be obtained from the 1947 Modern Plastics Encyclopedia, published by the Plastics Catalogue Corp., and available in most main libraries. A list of colleges giving plastics courses is also obtainable from the Society of the Plastics Industry. One may get a list of accredited engineering schools from the Engineers' Council for Professional Development, Engineering Societies Building, 29 West 39th Street, New York, N. Y.

Appendix A

Output of Plastics Products, 1931–45 [1]

Year	*Value*
1931	$20,900,000
1935	38,300,000
1937	67,700,000
1939	76,100,000
1943	261,000,000
1944	306,000,000
1945	330,000,000

[1] Data for 1931–39 are from the Census of Manufactures; for 1943–45 from the Civilian Production Administration. The value of output includes plastics products made in plastics departments in plants of other industries, as well as in the plastics products industry.

Appendix B

Estimated Employment in the Plastics Products Industry [1]

Year	*Number of employees*
1937	16,900
1939	18,000
1943	36,800
1944	37,700
1945	42,000
1946 (December)	50,000

[1] 1937–46 estimates are derived from the 1939 Census of Manufactures and from unpublished data of the Bureau of Employment Security of the Social Security Administration. Estimates for 1943–46 may be slightly understated because in some States employment data for very small establishments are not available to the Bureau of Employment Security.

The photographs reproduced in this bulletin are by courtesy of Boonton Molding Co., U. S. Office of Education, Shaw Insulator Co., and *Modern Plastics*.

Occupational Outlook Publications of the Bureau of Labor Statistics

Studies of employment trends and opportunities in the various occupations and professions are made by the Occupational Outlook Service of the Bureau of Labor Statistics.

Reports are prepared for use in the vocational guidance of veterans, young people in schools, and others considering the choice of an occupation. Schools concerned with vocational training and employers and trade-unions interested in on-the-job training have also found the reports helpful in planning programs in line with prospective employment opportunities.

Two types of reports are issued:

Occupational outlook bulletins describe the long-run outlook for employment in each occupation and give information on earnings, working conditions, and the training required.

Special reports are issued from time to time on such subjects as the general employment outlook, trends in the various States, and occupational mobility.

The reports are issued as bulletins of the Bureau of Labor Statistics, and may be purchased from the Superintendent of Documents, Washington 25, D. C.

Occupational Outlook Bulletins

Employment Opportunities for Diesel-Engine Mechanics
Bulletin No. 813 (1945), price 5 cents.

Employment Opportunities in Aviation Occupations, Part I—Postwar Employment Outlook
Bulletin No. 837–1 (1945), price 10 cents.

Employment Opportunities in Aviation Occupations, Part II—Duties, Qualifications, Earnings, and Working Conditions
Bulletin No. 837–2 (1946), price 20 cents. Illustrated.

Employment Outlook for Automobile Mechanics
Bulletin No. 842 (1945), price 10 cents.

Employment Opportunities for Welders
Bulletin No. 844 (1945), price 10 cents.

Postwar Outlook for Physicians
Bulletin No. 863 (1946), price 10 cents.

Employment Outlook in Foundry Occupations
Bulletin No. 880 (1946), price 15 cents. Illustrated.

Employment Outlook for Business-Machine Servicemen
Bulletin No. 892 (1947), price 15 cents. Illustrated.

Employment Outlook in Machine-Shop Occupations
Bulletin No. 895 (1947), price 20 cents. Illustrated.

Employment Outlook in Printing Occupations
Bulletin No. 902 (1947), price 20 cents. Illustrated.

Employment Outlook in Hotel Occupations
Bulletin No. 905 (1947), price 10 cents. Illustrated.

Special Bulletins

Occupational Data for Counselors, a Handbook of Census Information Selected for Use in Guidance

Bulletin No. 817 (1945), price 10 cents. (Prepared jointly with the Occupational Information and Guidance Service, U. S. Office of Education.)

Factors Affecting Earnings in Chemistry and Chemical Engineering

Bulletin No. 881 (1946), price 10 cents.

State and Regional Variations in Prospective Labor Supply

Bulletin No. 893 (1947), price 15 cents.

Labor in the South

Bulletin No. 898 (1947), price 35 cents.

Recent Occupational Trends

Serial No. R 1902 (1947). Limited supply available for free distribution. Order directly from Bureau of Labor Statistics.

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