Steel Manufacturing

(NAICS 3311, 3312)

SIGNIFICANT POINTS

- Employment is expected to continue to decline due to consolidation and further automation of the steelmaking process.
- Employers staffing production jobs increasingly prefer individuals with 2-year degrees in mechanical or electrical technology.
- Opportunities will be best for engineers, computer scientists, business majors, and skilled production workers.

Nature of the Industry

Faced with international competition and a worldwide glut of steel, the U.S. steel industry continues to respond by modernizing its manufacturing processes and consolidating businesses to increase productivity. Despite successful efforts to reduce costs and an improving competitive position, steel manufacturing firms still face stiff competition—and employment is expected to continue to decline. However, investment in modern equipment and worker training has transformed the U.S. steel industry from one of the Nation's most moribund to one of the world's leaders in worker productivity and the lowest cost producer for some types of steel.

Establishments in this industry produce steel by melting iron ore, scrap metal, and other additives in furnaces. The molten metal output is then solidified into semifinished shapes before it is rolled, drawn, cast, and extruded to make sheet, rod, bar, tubing, and wire. Other establishments in the industry make finished steel products directly from purchased steel.

The least costly method of making steel uses scrap metal as its base. Steel scrap from many sources—such as old bridges, refrigerators, and automobiles—and other additives are placed in an electric arc furnace, where the intense heat produced by carbon electrodes melts the scrap, converting it into molten steel. Establishments that use this method of producing steel are called electric arc furnace (EAF) mills, or minimills. The smaller initial capital investment required to start and operate an EAF mill has helped drive the growth of this production method. Moreover, scrap metal is found in all parts of the country, so EAFs are not tied as closely to raw material deposits as are integrated mills and can be placed closer to consumers. EAFs now account for about half of American steel production, and their share is expected to continue to grow in coming years.

The growth of EAFs comes partly at the expense of integrated mills. Integrated mills reduce iron ore to molten pig iron in blast furnaces. The iron is then sent to the oxygen furnace, where it is combined with scrap to make molten steel. The steel produced by integrated mills generally is considered to be of higher quality than steel from EAFs but, because more steps are involved in the production process, it also is more costly. The initial step in the integrated mill process is to prepare coal for use in a blast furnace by converting it to coke. Coal is heated in coke ovens to remove impurities and to reduce it to nearly pure carbon.

At the other end of the steel manufacturing process, semifinished steel from either EAFs or integrated mills is converted into finished products. Some of the goods produced in finishing mills are steel wire, pipe, bars, rods, and sheets. Products also may be coated with chemicals, paints, or other metals that give the steel desired characteristics for various industries and consumers. Also involved in steel manufacturing are firms that produce alloys by adding materials such as silicon and manganese to the steel. Varying the amounts of carbon and other elements contained in the final product can yield thousands of different types of steel, each with specific properties suited for a particular use.

Steel companies, like most businesses, have entered the era of sophisticated technology. Taking several forms, this technology has improved both product quality and worker productivity. Computers are essential to most technological advances in steel production, from production scheduling and machine control to metallurgical analysis. Computerized systems change the nature of many jobs, while they eliminate or reduce the demand for others.

For workers, modernization of integrated and EAF steel mills often has meant learning new skills to operate sophisticated equipment. Competition also has resulted in increasing specialization of steel production, as various producers attempt to capture different niches in the market. With these changes has come a growing emphasis on flexibility and adaptability for both workers and production technology. As international and domestic competition continue for U.S. steel producers, the nature of the industry and the jobs of its workers are expected to continue to change.

Working Conditions

Steel mills evoke images of strenuous, hot, and potentially dangerous work. While many dangerous and difficult jobs remain in the steel industry, modern equipment and facilities have helped to change this. The most strenuous tasks were among the first to be automated. For example, computer-controlled machinery helps to monitor and move iron and steel through the production processes, reducing the need for heavy labor. In some cases, workers now monitor and control the equipment from air-conditioned rooms.

Nevertheless, large machinery and molten metal can be hazardous unless safety procedures are observed. Hardhats, safety

shoes, protective glasses, earplugs, and protective clothing are required in most production areas.

Cases of occupational injury and illness in the industry were 8.6 per 100 full-time workers in 2002, higher than the 5.3 cases per 100 workers for the entire private sector and slightly higher than the 7.2 cases per 100 for all of manufacturing.

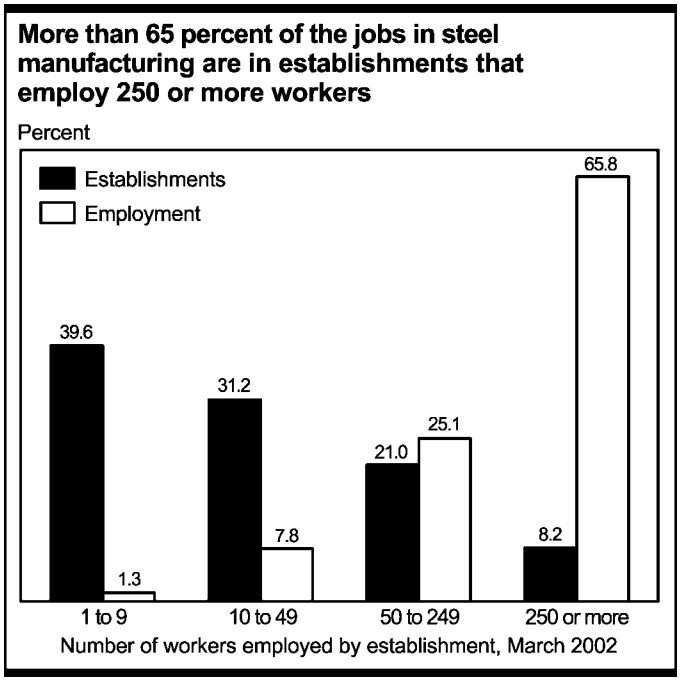
The expense of plant and machinery and significant production startup costs force most mills to operate around the clock, 7 days a week. Workers averaged 43 hours per week in 2002, and only about 2 percent of workers are employed part time. Workers typically work varying shifts, switching between working days one week and nights the next. Some mills operate two 12-hour shifts, while others operate three 8-hour shifts. Overtime work during peak production periods is common.

Employment

Employment in the steel industry declined to about 170,000 wage and salary jobs in 2002, 80,000 fewer than in 1992. The steel industry traditionally has been located in the eastern and midwestern regions of the country, where iron ore, coal, or one of the other natural resources required for steel are found. Even today, about 46 percent of all steelworkers are employed in Pennsylvania, Ohio, and Indiana. The growth of EAFs has allowed steelmaking to spread to virtually all parts of the country, although many firms find lower cost rural areas the most attractive. Large firms employ most workers in the steel industry. More than 65 percent of the jobs in 2002 were in establishments employing at least 250 workers (chart 1).

Occupations in the Industry

Opportunities exist in steel manufacturing in a variety of occupations, but the largest group of workers—47 percent—is employed in production occupations (table 1). Other large groups of workers are installation, maintenance, and repair workers and transportation and material-moving workers.



Although the steel making procedure varies with the type of furnace used, the jobs associated with the various processes are similar. Most jobs in steel mills can be classified into 1 of 3 types: Operators, maintenance and repair workers, and supervisors and managers. In addition, significant numbers of electricians, engineers, inspectors and testers, and material-moving workers are needed to assist in the production process and repair of equipment. Workers generally are assigned to work in a particular sector of the production line, such as the blast furnace or rolling mill areas, and their titles reflect the types of machines they work on.

At integrated mills, production begins when *material-moving* workers load iron ore, coke, and limestone into the top of a blast furnace. As the materials are heated, a chemical reaction frees the iron from other elements in the ore. *Metal-refining furnace operators and tenders*, also known as *blowers* and *melters*, direct the overall operation of the furnace to melt and refine metal before casting or to produce specific types of steel. They gather information on the characteristics of the raw materials they will use and the type and quality of steel they are expected to produce. They direct the loading of the furnace with raw materials and supervise the taking of samples, to ensure that the steel has the desired qualities. They may also coordinate the loading and melting of raw materials with the steel molding or casting operation to avoid delays in production.

Generally, either a basic oxygen or an electric arc furnace is used to make steel. Operators and tenders use controls to tilt the furnace to receive the raw materials. Once they have righted the furnace, they use levers and buttons to control the flow of oxygen and other materials into the furnace. During the production process, *testers* routinely take samples to be analyzed. Based on this analysis, operators determine how much longer they must process the steel or what materials they must add to meet specifications. Operators also pay close attention to conditions within the furnace and correct any problems that arise during the production process.

Metal pourers and casters tend machines that release the molten steel from the ladle at a controlled rate into water-cooled molds, where it solidifies into semifinished shapes. This process is called "continuous casting." These shapes are then cut to desired lengths as they emerge from the caster. During this process, operators monitor the flow of raw steel and the supply of water to the mold.

The "rolling" method is used to shape most steel processed in steel mills. In this method, hot steel is squeezed between two cylinders, or "rollers," which flatten or shape the steel. *Rolling machine operators* operate the rolling mills that produce the finished product; the quality of the product and the speed at which the work is completed depend on the operator's skills. Placing the steel and positioning the rollers are very important, for they control the product's final shape. Improperly adjusted equipment may damage the rolling mill or gears.

Extruding and drawing machine operators control equipment that extrudes, or draws, metal materials into tubes, rods, hoses, wire, bars, or structural shapes. *Cutting, punching, and press machine operators* operate machines that saw, cut, shear, slit, punch, crimp, notch, bend, or straighten metal. *Welding, soldering, and brazing workers* join metal components or fill

holes, indentations, or seams of fabricated metal products. *Multiple machine tool operators* are skilled in the operation of more than one type of cutting or forming machine tool or robot.

Team assemblers and leaders work as part of a team responsible for assembling an entire product or component of a product. Team assemblers can perform all tasks conducted by the team in the assembly process and rotate through all or most of them rather than being assigned to a specific task on a permanent basis. They may participate in making management decisions affecting the work. *Machinists* operate a variety of machine tools to produce precision parts and instruments. They may fabricate and modify parts to make or repair machine tools or maintain industrial machines. *Inspectors, testers, sorters, samplers, and weighers* check parts or products for defects, wear, and deviations from specifications.

Millwrights are employed to install and maintain much of the sophisticated machinery in steel mills. As the technology becomes more advanced, they work more closely with *electricians*, who help repair and install electrical equipment such as computer controls for machine tools.

Engineers, chemists, and computer specialists are playing an increasing role at steel mills, helping to address a variety of issues. *Industrial engineers* make plants more productive and energy efficient by designing and installing the latest technology. *Mechanical engineers* often are found in supervisory or management jobs, helping to solve mechanical problems on the production line. *Environmental engineers* design environmental control systems to maintain water and air quality standards or to clean up old sites. *Metallurgical engineers* work with the metals and ores that go into steel in order to change or improve its properties or to find new applications for steel.

Additionally, as with most companies, there are accountants, sales agents, various managers, and administrative and clerical workers who run the company and process paperwork.

Training and Advancement

Many jobs in steel manufacturing require only a high school diploma. However, machinery continues to become more complex, and growing numbers of operating and maintenance positions are highly skilled, so employers increasingly prefer to hire graduates from formal postsecondary technical and trade schools. Two-year degrees in mechanical or electrical technology or 2- to 4-year apprenticeships are recommended for persons seeking to advance into the best production jobs.

After production workers are hired, they receive specific training on the job. New workers entering the production process as lower skilled operators and maintenance personnel generally assist more experienced workers, beginning with relatively simple tasks. As workers acquire experience, they specialize in a particular process and acquire greater skill in that area. The time required to become a skilled worker depends upon individual abilities, acquired skills, and available job openings. It generally takes at least 2 to 5 years, and sometimes longer, to advance to a skilled position. At times, workers

Table 1. Employment of wage and salary workers in steel manufacturing by occupation, 2002 and projected change, 2002-12
(Employment in thousands)

Occupation	Employment, 2002 Number	Employment, 2002 Percent	Percent change, 2002-12
All occupations	170	100.0	-20.0
Management, business, and financial occupations	10	5.7	-13.4
Industrial production managers	2	1.0	-14.0
Professional and related occupations	8.1	4.8	-17.2
Industrial engineers, including health and safety	1.0	0.5	-16.3
Materials engineers	1.0	0.5	-19.7
Mechanical engineers	1.0	0.5	-14.8
Engineering technicians, except drafters	1.0	0.7	-17.7
Sales and related occupations	2.4	1.4	-11.9
Office and administrative support occupations	14.0	8.2	-24.9
Production, planning, and expediting clerks	3.3	2.0	-20.6
Shipping, receiving, and traffic clerks	1.8	1.1	-22.0
Construction and extraction occupations	7.9	4.7	-16.9
Electricians	3.6	2.1	-13.3
Installation, maintenance, and repair occupations	20.6	12.1	-21.7
Industrial machinery mechanics	2.3	1.4	-20.0
Maintenance and repair workers, general	6.6	3.9	-16.6
Millwrights	4.3	2.5	-29.4
Production occupations	79.6	46.8	-19.1
First-line supervisors/managers of production and operating workers	7.7	4.5	-16.0
Extruding and drawing machine setters, operators, and tenders, metal and plastic	5.3	3.1	-12.8
Rolling machine setters, operators, and tenders, metal and plastic	5.9	3.5	-24.2
Cutting, punching, and press machine setters, operators, and tenders, metal and plastic	7.9	4.6	-18.0
Grinding, lapping, polishing, and buffing machine tool setters, operators, and tenders, metal and plastic	2.0	1.0	-19.6
Machinists	3.1	1.8	-12.1
Metal-refining furnace operators and tenders	3.4	2.0	-28.1
Pourers and casters, metal	1.8	1.1	-34.4
Multiple machine tool setters, operators, and tenders, metal and plastic	1.0	0.9	-1.0
Welders, cutters, solderers, and brazers	3.6	2.1	-11.6
Heat treating equipment setters, operators, and tenders, metal and plastic	2.2	1.3	-19.0
All other metal workers and plastic workers	3.8	2.2	-30.2
Inspectors, testers, sorters, samplers, and weighers	5.3	3.1	-15.8
Helpers—Production workers	3.9	2.3	-23.1
Transportation and material moving occupations	26.2	15.4	-23.3
Crane and tower operators	6.4	3.8	-20.9
Industrial truck and tractor operators	3.7	2.2	-15.7
Laborers and freight, stock, and material movers, hand	6.6	3.9	-30.1
Machine feeders and offbearers	3.6	2.1	-28.7

NOTE: May not add to totals due to omission of occupations with small employment.

change their specialization to increase their opportunities for advancement. Workers are continuously trained to perform a variety of tasks and provide more flexibility to the firm, as company needs change. Computers have become important, as companies have modernized. Workers must learn to operate computers and other advanced equipment.

To work as an engineer or scientist, or in some other technical occupations in the steel industry, a college education is necessary. Many workers in administrative and managerial occupations have degrees in business or possess a combination of technical and business degrees. A master's degree may give an applicant an advantage in getting hired or help an employee advance. Managers need strong problem-solving, planning, and supervisory skills.

Earnings

Earnings in the steel industry vary by type of production and occupation but are higher than average earnings in private industry. Average weekly earnings of nonsupervisory production workers in 2002 were $968 in iron and steel mills, and $687 in establishments making steel products from purchased steel, compared with $619 in all manufacturing and $506 throughout private industry. Earnings in selected occupations in steel manufacturing appear in table 2.

Union membership, geographic location, and plant size affect earnings and benefits of workers. In most firms, earnings or bonuses are linked to output. Workers receive standard benefits, including health insurance, paid vacation, and pension plans.

The iron and steel industry traditionally has been highly unionized. In 2002, 37 percent of workers in steel manufacturing were members of unions or covered by union contracts, compared with 16 percent in manufacturing and 15 percent in all industries. In some instances, companies are closed shops—that is, workers must belong to the union in order to work there. EAFs, though, typically are nonunion. The overall decline of employment in traditional integrated steel mills, together with the growth of EAFs, have caused union membership to decline in recent years.

Outlook

Employment in the steel industry is expected to decline 20 percent over the 2002-12 period, primarily due to increasing consolidation in the industry as companies go out of business or are bought by other companies in the industry and their operations merge. A worldwide glut of steel and production overcapacity domestically, unless checked, will cause prices to decline to unprofitable levels and require mills to either become more productive or go out of business. As mills either consolidate or close, the result will be fewer workers, but a more productive industry that will be better able to meet foreign competition.

EAF mills, with their leaner workforce and lower cost structure, are expected to benefit from the industry's transformation and will continue to gain market share. They now produce nearly 50 percent of the country's steel, up from 25 percent two decades ago. They are also attempting to improve the quality of the steel they make by melting pig iron along with the scrap. In this way, they can more effectively compete with integrated mills in markets that demand higher quality steel. Thus, as EAFs continue to grow in relation to integrated mills, job opportunities will be better at these mills.

Automation, computerization, and changes in business practices that have led to a leaner workforce have reduced the number of man-hours needed to produce a ton of steel and raised productivity enormously in the last few decades. These productivity improvements, which were a leading cause of employment declines in the past, are not expected to be as powerful a factor in the future, as some companies have automated the process as much as they can. Technological improvements, however, will continue to be made, impacting the number and type of workers hired. Low-skilled jobs will continue to be automated and the jobs that remain will require more education and training.

Employment in the steel industry varies with overall economic conditions and the demand for goods produced with steel. For example, as the automotive industry produces more cars and light trucks, it will purchase more steel. In this way, much of the demand for steel is derived from the demand for other

Table 2. Median hourly earnings of the largest occupations in steel manufacturing, 2002

Occupation	Iron and steel ferroalloy manufacturing	Steel product manufacturing from purchased puchased steel	All industries
First-line supervisors/managers of production and operating workers	$24.96	$21.80	$20.64
Electricians	20.67		19.90
Millwrights	20.60		20.19
Production, planning, and expediting clerks	19.70		16.18
Maintenance and repair workers, general	19.33	17.39	14.12
Crane and tower operators	18.40	15.48	17.47
Machine feeders and offbearers	18.37		10.50
Metal-refining furnace operators and tenders	18.17		14.79
Cutting, punching, and press machine setters, operators, and tenders, metal and plastic	15.40	13.05	11.81
Laborers and freight, stock, and material movers, hand	14.76	11.77	9.48

products. Other industries that are significant users of steel include manufacturers of structural metal products, motor vehicle parts and equipment, and household appliances. As many of these goods require a large outlay, consumers are more likely to purchase them in good economic times.

Despite the projected decline, job openings are expected to be very good or favorable for a number of occupations. Demand for all types of engineers, including mechanical, metallurgical, industrial, electrical, and civil, is expected to be very good. Companies report great difficulty in hiring these highly skilled professionals. Also, computer scientists and business majors should be in great demand. For skilled production jobs, workers with associate degrees in technology will be highly sought after to operate computer-controlled machines and to repair equipment. Among persons without postsecondary training, those who have good math and computer skills will have better opportunities to be hired and trained for skilled production jobs. Those without a degree must be flexible and willing to go through extensive classroom and on-the-job training. Keen competition can be expected for low-skilled material handling and machine operator jobs, for which employment is expected to decline. Despite the declines in employment, many workers will need to be hired to replace those who leave the industry or retire. Especially at the integrated mills, a large number of workers is expected to retire over the next decade.

Sources of Additional Information

For additional information about careers and training in the steel industry, contact:

- American Iron and Steel Institute, 1101 17th St. NW., Suite 1300, Washington, DC 20036-4700.
  Internet: **http://www.steel.org**
- Steel Manufacturers Association, 1150 Connecticut Ave., NW., Suite 715, Washington, DC 20036.
  Internet: **http://www.steelnet.org**

Information on the following occupations may be found in the 2004-05 *Occupational Outlook Handbook*:

- Assemblers and fabricators
- Electricians
- Engineering technicians
- Engineers
- Industrial machinery installation, repair, and maintenance workers, except millwrights
- Inspectors, testers, sorters, samplers, and weighers
- Machine setters, operators, and tenders—metal and plastic
- Machinists
- Material moving occupations
- Millwrights