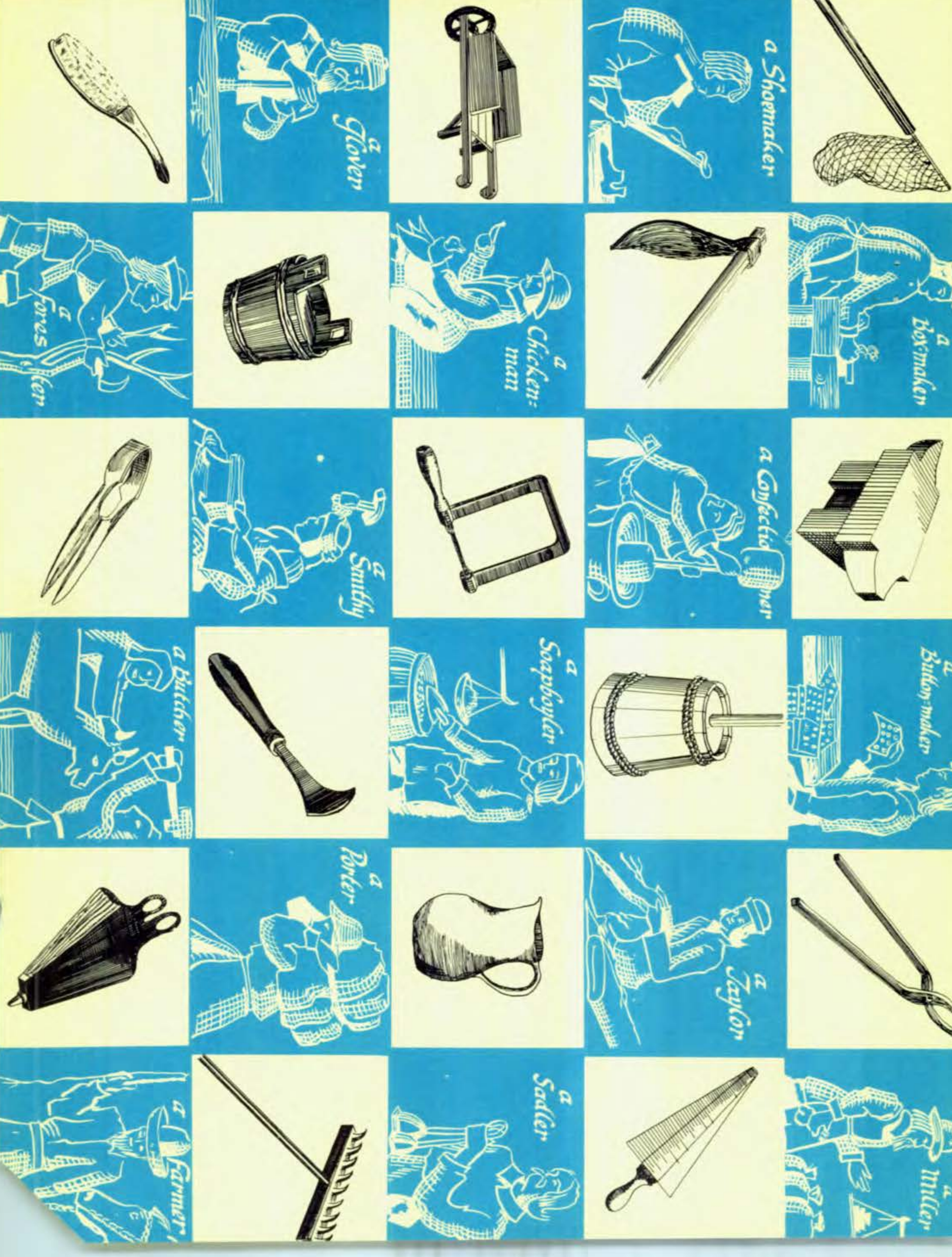
MAN, MEDICINE, and WORK

HISTORIC EVENTS IN OCCUPATIONAL MEDICINE

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service


a Glover
a Shoemaker
a Chicken-man
a Box-maker
a Smithy
a Butcher
a Soapboyler
a Button-maker
a Porter
a Taylor
a Sadler
a Farmer
a Miller

In 1964, the Division of Occupational Health will commemorate its 50th year in the service of the American worker's health. We believe it especially fitting at this time to present this impressive history of occupational medicine by Professor Jean Spencer Felton and his associates. As the next half of the century unfolds, we are confident that its dramatic technologic prowess will be paralleled by imaginative advances in the protection and preservation of the worker's health.

Harry Heimann

Chief,
Division of Occupational Health

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HISTORIC EVENTS IN OCCUPATIONAL MEDICINE

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The Gods had condemned Sisyphus to ceaselessly rolling a rock to the top of a mountain, whence the stone would fall back of its own weight. They had thought with some reason that there is no more dreadful punishment than futile and hopeless labor.

Albert Camus

PROLOGUE

Human history is the story of man's attempts to control his natural environment through his own productive labor. In the course of a million years or so, at incalculable cost in injury, disease, and death, he has moved from pebble tool to miniaturized part, from neolithic hoe to corporate farm, from flint diggings to mechanized mines, from copper reduction to modern metallurgy, from alchemy to chemistry and nuclear physics.

Out of magic, mysticism, and trial-and-error, he had evolved the scientific method. Its aim is prediction, which is the essence of control.

The story of occupational medicine, then, is not a cataloguing of diseases. Rather, it is a picture of increasing success in achieving the mastery of his life situation which enables the worker to fulfill his material and spiritual needs and gain personal satisfaction through work, without the penalties of trauma and disease. Occupational medicine is not less than this—it does not need to be more.

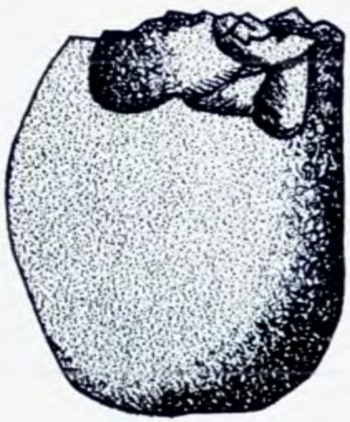
PREHISTORY

Properly speaking, definable occupations—and, consequently, occupational diseases—come into being only as divisions of labor and requirements of skill create specialized crafts. A definable occupation needs also to be differentiated from other areas of a man's life. When Australopithecus, a million years ago, first picked up a stone to use as tool or weapon and thereby control in some degree the natural world around him, he began *human* life, as distinct from primate life—although he himself was still a somewhat less than finished human. But the cuts and eye injuries suffered by the early flint knapper, or the anthrax contracted by the hunter skinning his bison, could scarcely be distinguished from non-occupational injuries. All of life was a struggle for subsistence and survival, and life itself was an occupational disease.

The agricultural revolution of Neolithic man in the Fertile Crescent began a food-producing economy that enabled man to live in larger aggregates, and led directly to the urban revolution in Mesopotamia. Labor became more specialized, and it also became distinct from other life activities. The history of occupations had begun.

Pottery, for example, had long been made by everyone, and its manufacture had released no one from the continuous necessity of hunting and foraging. Metallurgy, however, required skills which not everyone could master and involved tools and equipment calling for concentrated effort. So with the advent of copper and bronze, metal workers were released from primary food production and supported from the surplus produced by their fellows. Metallurgy, thus became the first specialized craft.

Man's first tool was probably a pointed stick. His first known implements were pebble tools—crude cutting tools made by breaking or splitting a water-rounded pebble. These two, found in the Transvaal, South Africa, date to the beginning of the Pleistocene Age.



The bison shown here symbolizes the hunt and is representative of a group of magnificent cave drawings from Altamira, Spain. The Altamira paintings are considered to be among the greatest examples of paleolithic art.

Food-gathering was man's first and most basic activity. Using a stick, he dug up roots. Later the stick was sharpened and used as a spear. Man became a hunter.

Ancient cities of Mesopotamia were located mainly along the Tigris and Euphrates rivers. The discovery and use of metals, the assurance of a food supply, and the abundance of slave labor made possible the rise of ancient cities.

A second interglacial handax found on the banks of the Thames River. A considerable advance over the pebble tool, this beautiful artifact remains a testimony to the technical skills of prehistoric man.

Neolithic tools. (1) blade core, (2) sickle blade, (3) stone chisel, (4) flint knife from Scandanavia, (5) bone fork, (6) polished-stone axhead.

Techniques or occupations evolved concurrently with man's evolution. As man created occupations, he created himself.

As metallurgy became a craft, man found himself with new tools. As the stone had supplanted the stick, metals supplanted stone. Man's body and man's tools evolved concurrently. With tools began the first occupational pressures.

When the last bronze age ended in the Near East, the first distinctive urban and rural populations had appeared throughout the civilized world; men mined flint and ores and made metal tools and weapons. They had learned to glaze pottery which was now made on the potter's wheel, to fire glass, and to transport goods. A social stratification now divided primary producers from those engaged in commerce and from the ruling groups; but the artisan's skills still won him respect and freedom that he would not always enjoy.

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FROM EGYPT TO ROME

Throughout the classical era and the medieval period which followed, the dominant orientation of medicine swung from magic to rationalism and back to magic, and advances in real science and the understanding of disease were made and lost and retrieved, at least in part. But none of this medicine was remotely concerned with the health of people who worked.

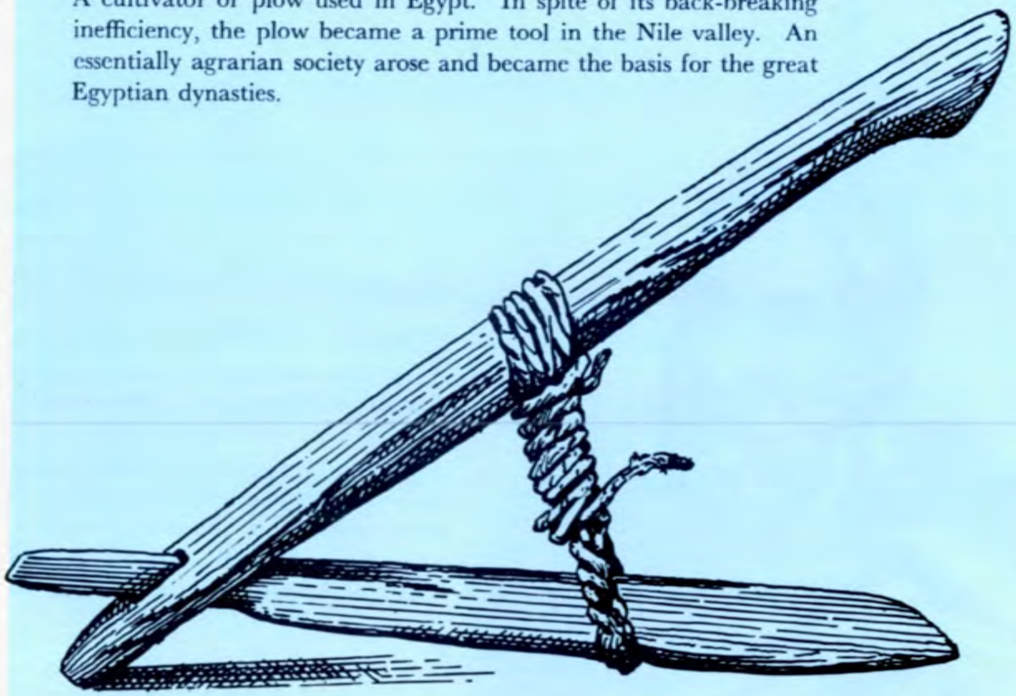
For classical industry was based on slavery, and wars brought a seemingly inexhaustible supply of slaves. Even small farmers in fifth century Athens owned a slave or two. The majority of craftsmen producing pottery, arms, and other goods in Greek workshops and factories were slaves as were the Egyptian miners of gold in Nubia and sandstone in Sinai, and the Roman workers in the Almaden cinnabar mines in Spain. The ancient physicians reflected accurately the prevailing debasement of manual labor. In theory and in practice, they ignored both the craftsman-laborer and the role of occupations in the etiology of disease.

A wall painting preserved by the Egyptian sands provides a beautifully documented record of a high civilization in which specialized occupations had emerged. Occupational medicine did not exist. Occupations leading to disease did. Mining, metal work, and agriculture all thrived in Egypt. Mining and heavy labor were done by slaves and therefore were not considered medical problems.

There is evidence, however, that the effects of the appalling conditions of the worker's labor were known throughout ancient times. This knowledge accounts, perhaps, for the contempt for craftsmanship which was so great in many cities it was illegal for a citizen to ply a trade. In cultures that placed as high a value on physical and moral perfection as did those of the ancient world, activities which maimed and destroyed must have been viewed with fear. Unable to control the hazards of work, the ruling classes of Egypt, Rome, and Greece chose to banish them from civilized society.

It proved a costly method of adjustment. The cheap, efficient tools of the early iron age, the spread of literacy through the invention of the Phoenician alphabet, and the diffusion of wealth made possible by money coinage had widened the manageable boundaries of man's world. By increasing the production of real wealth, they had paved the way for the rise of classical civilization. But as the number of slaves and free workers alike grew larger, they sank deeper into poverty and disease, and their flourishing cities were overwhelmed finally by their own impoverished populations.

A cultivator or plow used in Egypt. In spite of its back-breaking inefficiency, the plow became a prime tool in the Nile valley. An essentially agrarian society arose and became the basis for the great Egyptian dynasties.



HIPPOCRATES

The body of writing attributed to Hippocrates contains a few passing and sometimes disputed references to diseases which might have arisen in the course of work. But he dealt almost exclusively with the health of citizens, not workers.

PLINY

Plinius Secundus, 23–70 A.D., known as Pliny, the Elder. A Roman scholar and author of *Historia Naturalis,* a classical encyclopedia of the natural sciences, Pliny is credited with the earliest mention of a protective mask. The mask consisted of a bladder which was placed over the face to prevent inhalation of dust. His mask was also recommended for cinnabar grinders and workers subjected to lead fumes. Agricola mentions Pliny's contribution to the protection of vermilion workers.

GALEN

Galen, a second century Greek physician, lived and practiced in Rome, where he enjoyed a high position as the best practitioner of his day. A voluminous writer, he left an excellent description of the anatomic and pathologic theory of his time. Unfortunately, there was an absoluteness and dogma about his theories which held European medicine at a stagnant level until the time of Vesalius, almost 1,400 years later.

Galen's contribution to occupational medicine consists of reference to various occupations. He reputedly visited a copper mine where he observed great danger to the miners from acid mists. His discourses on public health, however, did not include the alleviation of occupational diseases.

Prejudice in Greece against tradesmen and manual labor limited the practice of occupational medicine much as it had in earlier civilizations. The state existed for citizens, and so in turn did the practice of medicine. This prejudice, however, did not prevent the arts from flourishing and artisans of great talent were not precluded from citizenry.

Greek women preparing bread for baking.

Bruegel's painting, "The Harvest", depicts a scene typical of a feudal estate.

THE MIDDLE AGES

With the decline of the ancient city-states, the self-sufficient baronial manor of the great landlord became the principal economic unit. Feudalism was the characteristic social order of the Middle Ages throughout Europe. Serfdom was its hallmark—the peasant was tied to the land and the artisan to the household. Each estate maintained its own small-scale smithies, potteries, and brick-kilns, and employed weavers, carpenters, tile-workers, and other craftsmen. Although an advance over the slavery of earlier times, feudalism did little to further human control of the natural environment.

As newly deforested areas came under cultivation, however, many peasants fled the manors to become free small farmers, with windmills, water mills, and improved agricultural implements to increase the productive yield of their acres over that of any period in history. As the Renaissance approached, the walled and crowded medieval towns—independent and autonomous—attracted still more peasants and workers from the slowly depopulating manors. New classes of merchants, free artisans, and laborers developed. The rigidly organized guilds regulated nearly every aspect of their lives, but they also provided assistance to ill members, afforded economic protection to their crafts, and maintained the high standards of workmanship which resulted both in prestige and in genuine personal satisfaction to the worker.

Medicine during most of the Middle Ages was principally a matter of copying, codifying, and commentary rather than of scientific advance, and had it not been for the Moslems the whole of Greek classical science might have been permanently lost. In Europe, the monastic "hospitals" and the monks provided the only care available to the sick, and maintained the only libraries, until the founding of the first non-church medical school at Salerno in the 10th century, and the rise of the great universities at Bologna, Montpellier, Padua, and Venice in the 12th and 13th centuries. These institutions inaugurated a period of renewed interest in observation and experimentation, but they made no contributions to the study of occupational diseases. Nor did anyone else throughout the Middle Ages.

A thimble-maker, illustrative of the "cottage craftsman." Precursors of the factory system, an individual or a small group of people plied their trades in the home.

Nowhere in the literature are the people of the Middle Ages more colorfully described than in the *Canterbury Tales* written by Chaucer (1340–1400). Numerous trades and professions are identified. The Canterbury pilgrims shown here include a knight, a squire, the Wife of Bath, a monk, a prioress, a clerk, the summoner, a pardoner, a friar, a nun, and a franklin.

Monastic hospital of the 12th century.

Medieval manuscript books were illustrated by skilled illuminators. The beautiful volumes were decorated with "miniatures"—drawings using gold metallic paints and vermilion. The word "minimum" itself means "vermilion."

Although it is not documented, there is a widespread theory that medieval scribes possibly suffered from lead and mercury poisoning as a result of tipping their quills with their tongues and dipping them in the metallic solutions used.

If medieval learning was a responsibility of the church, so was medicine. The development of Christian compassion toward the weak and suffering emerged, if slowly, and culminated in secular nursing and hospital institutions.

The great hospital movement of the Middle Ages was of tremendous importance in furthering the medical schools of the late Middle Ages and the early Renaissance.

A woodcut of a medieval grinder. "Grinders' Disease" or silicosis, an old and still present disease, was a hazard in this occupation.

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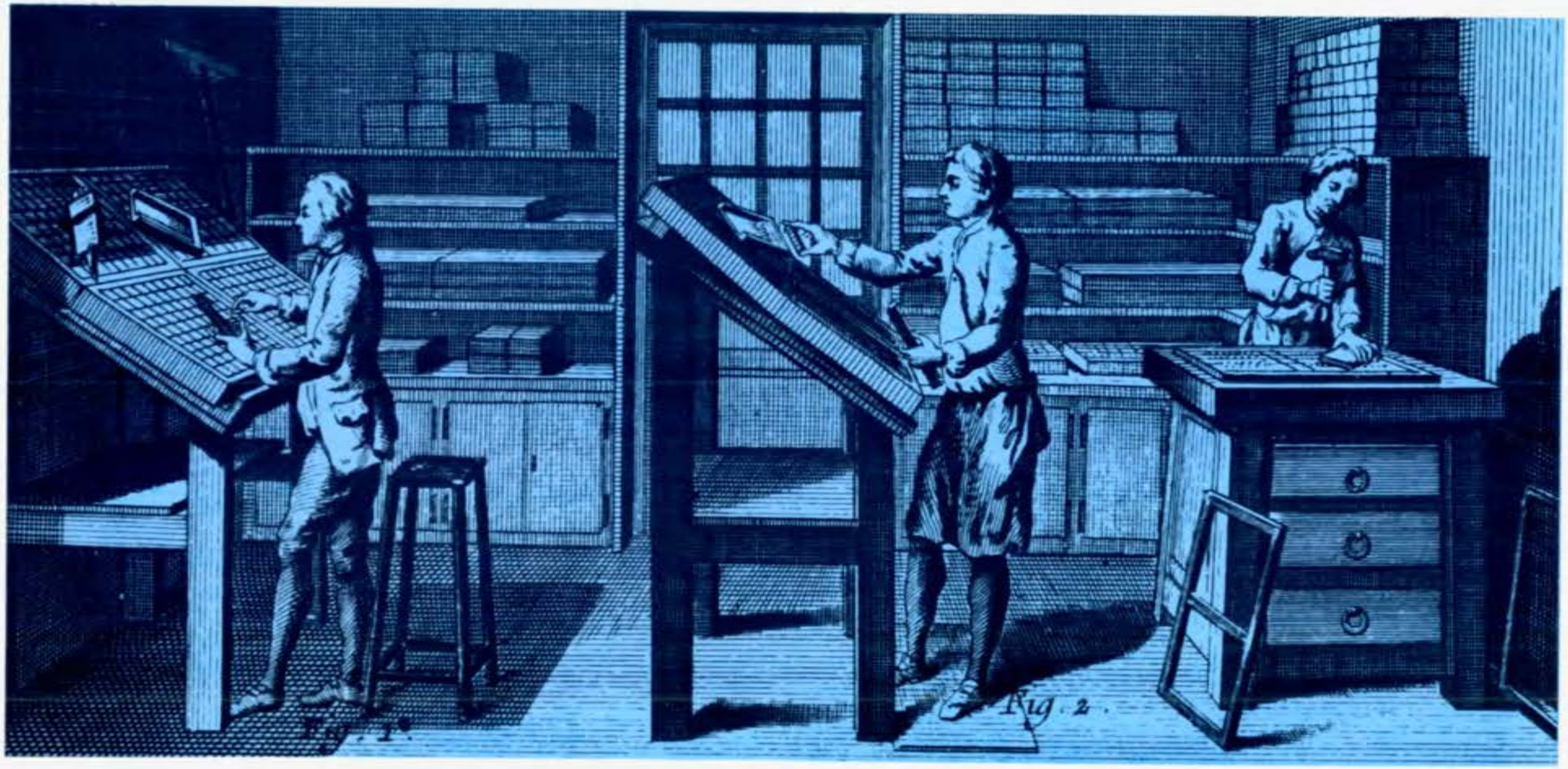
The Middle Ages was characterized by epidemic diseases attributed to various supernatural influences, but actually caused by the crowded and unsanitary living conditions and the total lack of public hygiene. The Black Death (bubonic plague) caused the death of one-fourth of the population of the world. It broke out in Europe in 1348 and continued to break out at intervals until the 17th century.

The one good effect of the Black Death was to force early attempts at quarantine.

As feudalism began to break, more and more workers moved to the burgeoning medieval towns. Mining and the increasing abundance of materials made possible the rise of new skills and craftsmen. Guilds were developing and brought with them specialization. From protective associations, the trade guilds evolved into powerful governing bodies.

Alchemy of the Middle Ages was still in its semi-mystical stage of development—not far removed from magic and wizardry. Alchemy was to play an important part in the development of medicine and chemistry, but would retain its tie with magic for centuries.

In 965 silver was discovered in the Harz Mountains. Between 1100–1300 precious metals were discovered in various parts of Europe. Mining emerged from the Middle Ages as an important industry.



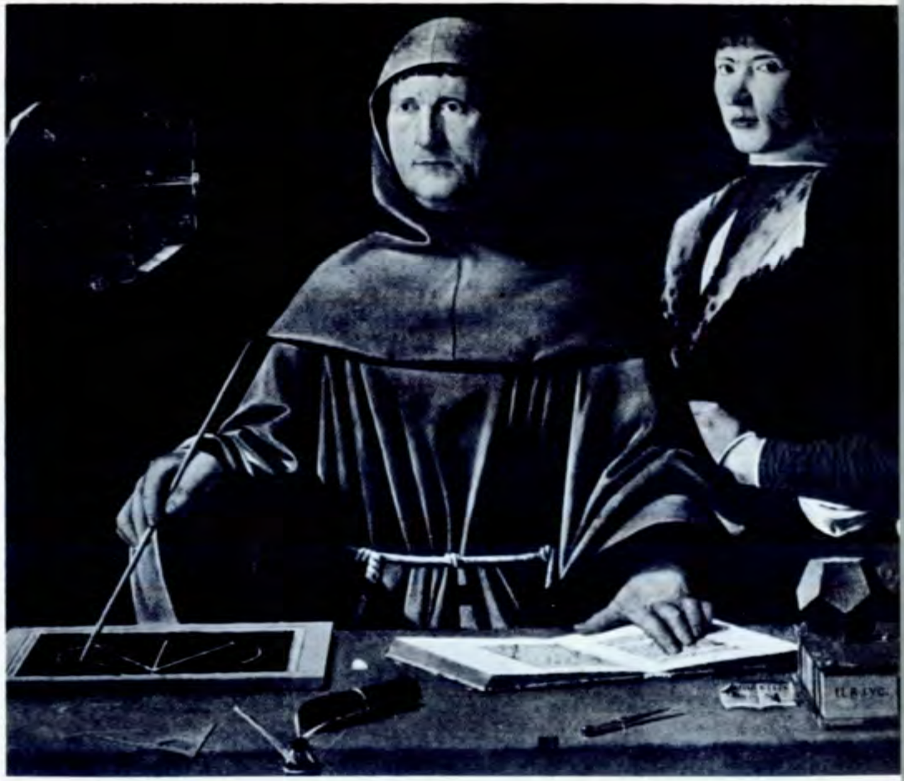
FROM THE RENAISSANCE TO THE MODERN STATE

The revival of learning which began in Italy in the 14th century was accelerated by a technologic event of major importance. The invention of printing in the western world allowed widespread dissemination of the written word, and ended forever the monopoly of handwritten libraries by the monks. The "holding operation" of the Middle Ages gradually came to an end and men began to observe the world around them with new interest and with more realistic vision. The discovery of the New World and the vast sea-going explorations were teamed with the individualistic, experimental spirit of Renaissance man to enlarge the vision and change the living and working habits of Europe as well as of the new countries.

As in all economic transitions, it was neither peaceful nor easy. From the close of the Middle Ages, the craft and trade guilds altered in character and became increasingly differentiated, competitive, and monopolistic. The security which the journeyman had enjoyed under the earlier system was dissipated, as a new merchant and manufacturing aristocracy was created. The resulting spirit of revolt was expressed among the craftsmen and laborers in the towns who began to form their own organizations and to strike and among the increasingly landless peasants who were the backbone of the times.

Nevertheless, the 16th and 17th centuries saw an increase in the scale of manufacturing operations and a development of technique which presaged the coming change from handcraft shop to factory. A work force was created which was at once much larger than had ever been required before, and more expensive to replace. The new importance of the worker was reflected in the beginning attention which was paid to his occupational diseases. In the 16th century, Ulrich Ellenbog, Agricola, and Paracelsus described the diseases of miners.

Nearly 100 years later, Ramazzini undertook a survey of other occupations. His appalled accounts of the working conditions in the principal crafts and industries of 1700 were based on personal observation rather than classical theory. They were also the first designed "chiefly . . . to suggest such Cautions, as may serve to prevent and cure the Diseases, to which Tradesmen are usually subject."



The Renaissance burst forth in Italy where classical learning had lain preserved, but dormant. The classical ideal spread through Europe with a new force and vitality.

The mathematician, the musician, the artist, and the philosopher all were raised to a new status in society. Modern science and technology have roots in the Renaissance, but advanced more slowly than the arts. Science remained the province of the philosopher; technology was the province of the craftsman, or artisan as he became in the Renaissance.

GEORGIUS AGRICOLA

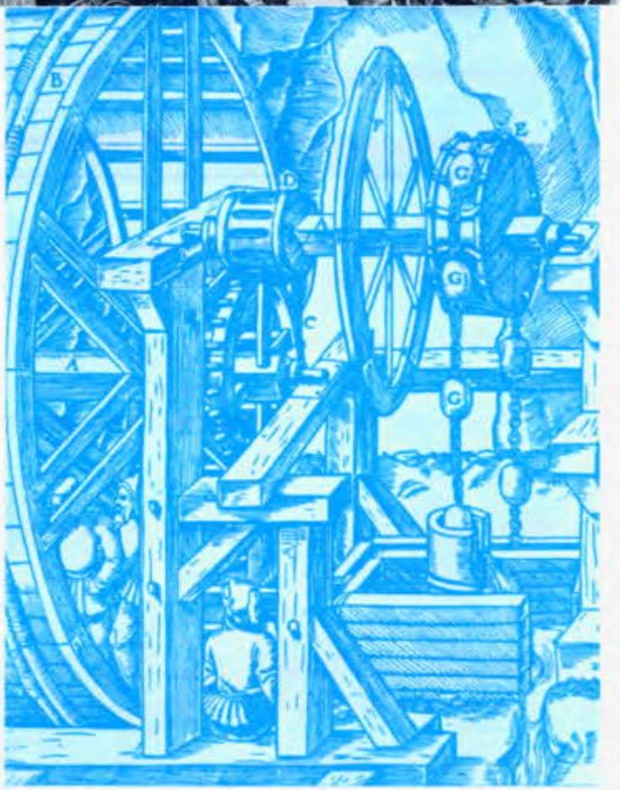
Georg Bauer, more commonly known as Georgius Agricola (1494–1553), was a German mineralogist and scholar. In 1526, after studying medicine and the natural sciences in Italy, Agricola became a physician in a mining town. Agricola's *De Re Metallica,* published in 1556, is a classic volume in metallurgy. In twelve sections, he describes every facet of mining, smelting, and refining. The twelfth section describes the diseases and accidents prevalent among miners and the means of preventing them. In 1912, Herbert and Lou Henry Hoover translated Agricola's great work.

Agricola described underground mining in great detail. The woodcut shows mine shafts in operation.

Agricola was most concerned with ventilation in mining. He considered lack of fresh air one of the greatest mining hazards and proposed several ventilating devices. One of these consists of a hand bellows, the other a fan operated by wind.

A 16th-century armorer's workshop showing grinders at work. No attempt was made to safeguard against "grinders dust."

Agricola's *De Re Metallica* is filled with delightful woodcuts, depicting quaint, dwarf-like figures. In his time, it was believed that demons, usually helpful and jolly, were found in the mines. In *De Animantibus Subterraneis,* Agricola describes these demons and speaks of prayer and fasting as ways of making them behave. These "demons of the mine" were immortalized in the story of *Snow White and the Seven Dwarfs.*



A remarkable device used to pump water from the mines—a continuous chain of buckets operated by a foot tread-wheel. Water in the mines was and is a health and safety hazard.

With its love for beauty, the Renaissance brought a greater demand for and a more specialized use of metals. New refining methods were used. The ancient occupation of mining spread through Europe and, as the demand increased, explorations to the New World began in a search for precious materials.

PARACELSUS

Alchemy came of age in the person of Aureolus Philippus Theophrastus Bombastus von Hohrenheim, better known as Paracelsus (1493–1541). The son of a Swiss doctor, Paracelsus typified the Renaissance. Steeped in Greek and Arabic learning, he became the most original medical thinker of his time, teaching and interpreting Hippocratic theory as the Hippocratic writers had set it down and not as it was handed down by medieval scholars. Paracelsus discarded Galenic medicine, publicly burning the works of Galen and Avicenna. He was forced to leave Basel for this and other heretical deeds, but went on teaching and practicing in other cities where he made important contributions to the field of alchemy. Paracelsus was able to reconcile his interest in astrology and the occult with his advanced ideas of experimentation and science. Gradually, and as a result of his own experimentation, Paracelsus began to substitute chemical therapeutics for the less scientific aspects of alchemy.

During his varied and turbulent life, Paracelsus worked for five years in a smelting plant. His observations on the hazards of metallurgy and mining were published in *Von der Bergsucht und anderen Bergkrankheiten.* Paracelsus described various respiratory diseases which he referred to as "lung sickness." He attributed these diseases to the climate and vapor of the mines, specifically the vapor from "tartarous." This substance was believed by alchemists to be a combination of mercury, sulfur, and salt. In spite of its many erroneous ideas, the book was a classic for 150 years. Its description of mercury poisoning is excellent, and its warnings about toxic metals were to point the way throughout Europe.

Paracelsus

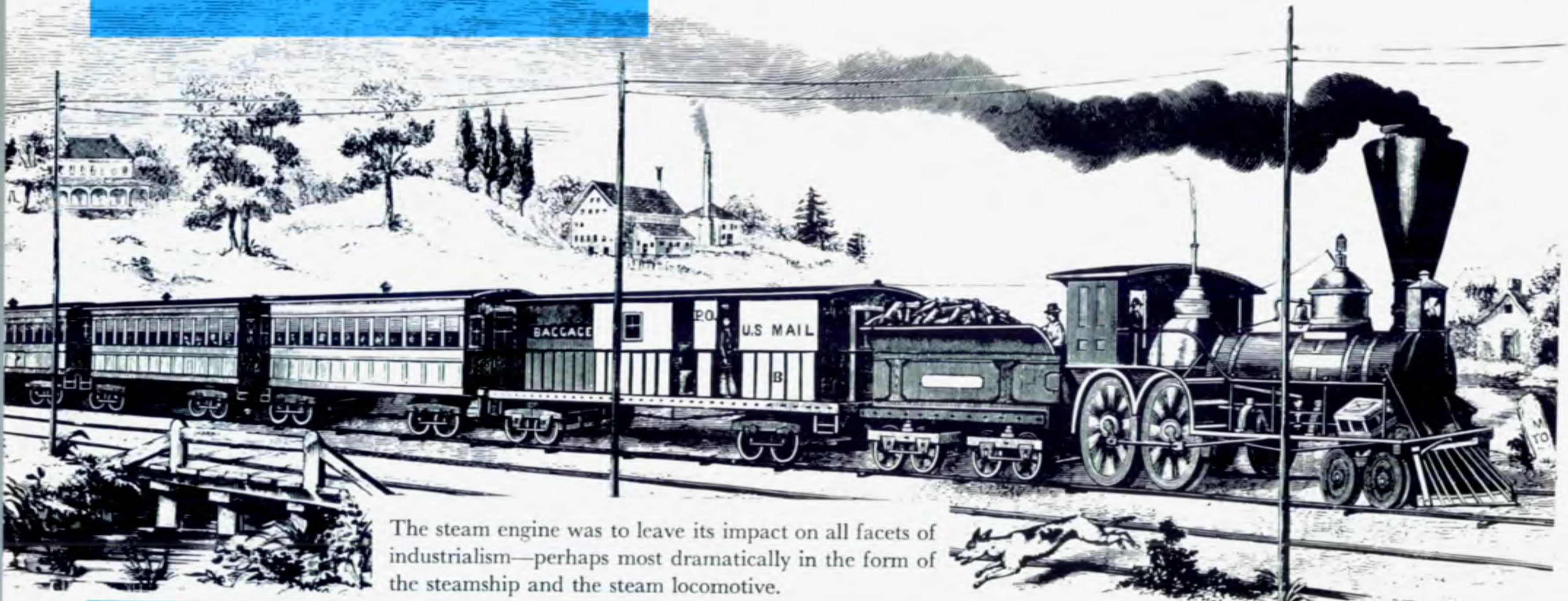
Smelting

In spite of the mastery and new uses of materials and the more specialized skills of the Renaissance, cottage industries continued to be the occupational unit. Factories in the industrial sense were unknown.

RAMAZZINI

Bernardino Ramazzini (1633–1714) was born in a century of great men of medicine and natural science. Galileo, Newton, Boyle, Harvey, Malpighi, and Van Leeuwenhoek are but a few of the names associated with the 17th century. What these names are to science and medicine, Ramazzini was to occupational diseases. He opened up an entirely new department of modern medicine—occupational health and hygiene.

Ramazzini's *De Morbis Artifcum Diatriba* was published in 1700. It represented years of practice, observation, and study at the Universities of Modena and Padua in Italy. Ramazzini examined the conditions of work and the diseases of most of the occupations of his time. In addition to describing the diseases, Ramazzini proposed preventive measures or "cautions." Unfortunately, the suggested cautions were to be ignored for several centuries. *De Morbis,* however, set a pattern for public hygiene. Ramazzini's all-important question was to become a part of the diagnostic case-history taken by physicians from that time on. It was: "Of what trade are you?"



The steam engine was to leave its impact on all facets of industrialism—perhaps most dramatically in the form of the steamship and the steam locomotive.

TECHNOLOGY IN THE 18TH & 19TH CENTURIES

The "Age of Enlightenment" was the culmination of the somewhat mystical faith in pure reason which had begun to replace mysticism itself 200 years before. Through action based on rational thought, man would control the world about him, and all things would be possible unto him.

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DENIS DIDEROT

This expectation of undeterred human progress, to be brought about by the reasoned direction of human behavior, was not quite fulfilled. Nevertheless, the investigations of natural phenomena which occurred in the course of the attempt were fruitful ones. Diderot and his fellow encyclopedists not only described French technology more completely than anyone before them, but also helped to accelerate the transition from craft to scientific manufacture. With Lavoisier, scientific chemistry at last emerged from the alchemy which had begun in Egypt and ancient Greece. Steel for construction became abundant and cheap, as new methods were invented for producing it. Gas enabled factories to be illuminated artificially, and the voltaic pile made it possible to produce electricity from batteries in far larger quantities than had been possible through friction. This led, in turn, to the understanding of electromagnetic induction, and the basic principle of electric motors. The associated names of Oersted, Faraday, and Ampère became part of the language.

America contributed the reaping machine and the cotton gin to large-scale agriculture, and the method for precision manufacture of interchangeable parts to the production of machine tools. In this country, the development of mass-production economy depended as well on the vast network of railroads which finally tied the continent together.

As previously with windmill and water mill, however, a new source of power was the primary factor in the changing economy. It was the steam engine which ultimately made possible the transition from cottage industry to the factory system, and the beginnings of the modern age. Some of the effects of this complex social change on living conditions and occupations will be explored in the following pages.

"Let us at last give the artisans their due. The liberal arts have adequately sung their own praises; they must now use their remaining voice to celebrate the mechanical arts. It is for the liberal arts to raise the mechanical arts from the contempt in which prejudice has for so long held them, and it is for the patronage of kings to draw them from the poverty in which they still languish. Artisans have believed themselves contemptible because people have looked down on them; let us teach them to have a better opinion of themselves; that is the only way to obtain more nearly perfect results from them. We need a man to rise up in the academies and go down to the workshops and gather material about the arts to be set out in a book which will persuade artisans to read, philosophers to think on useful lines, and the great to make at least some worthwhile use of their authority and wealth."

Diderot in ART

In Diderot's world, writing was not only a creative occupation, but a means of recording business as well. Until the typewriter was invented, "writer's cramp" was a serious syndrome. Hundreds of articles appeared in the medical journals of the early and mid-19th century discussing this occupational disease.

Gilding was an important industry in the 18th century with the great demand for ornamentation. Gilders were exposed to all sorts of toxic substances—acids, varnishes, powdered metals, and mercury.

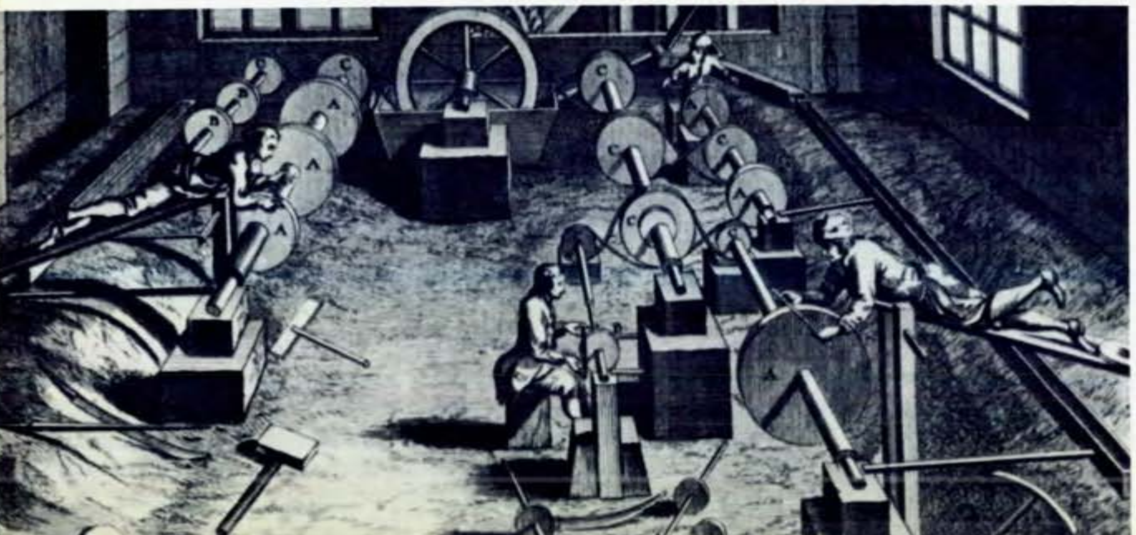
Denis Diderot (1713–1784) was, in many ways, a representative of the 18th century as Paracelsus was of the 16th. As a philosopher and essayist, Diderot attempted to apply 18th-century rationalism to religious doctrine. For twenty years Diderot dedicated himself to the undertaking of his life—the monumental *Encyclopédie*. From its inception the work was to attract trouble and criticism from the orthodox institutions of France. Finally the work was suppressed.

Diderot took for granted religious tolerance and freedom of the individual. He exalted scientific knowledge and harmonious industry. It is this last concept that is of interest to occupational medicine. In the excellent plates of the *Encyclopédie*, Diderot systemized and lifted the artisans from the prejudice they had suffered for centuries.

The Marble Cutters of Paris.

Extracting sulfur from pyrites—a step in the manufacture of sulfuric acid. Note heavy fumes.

These grinders did not wear protective masks—nor were there any other protections from dust—a major cause of silicosis.

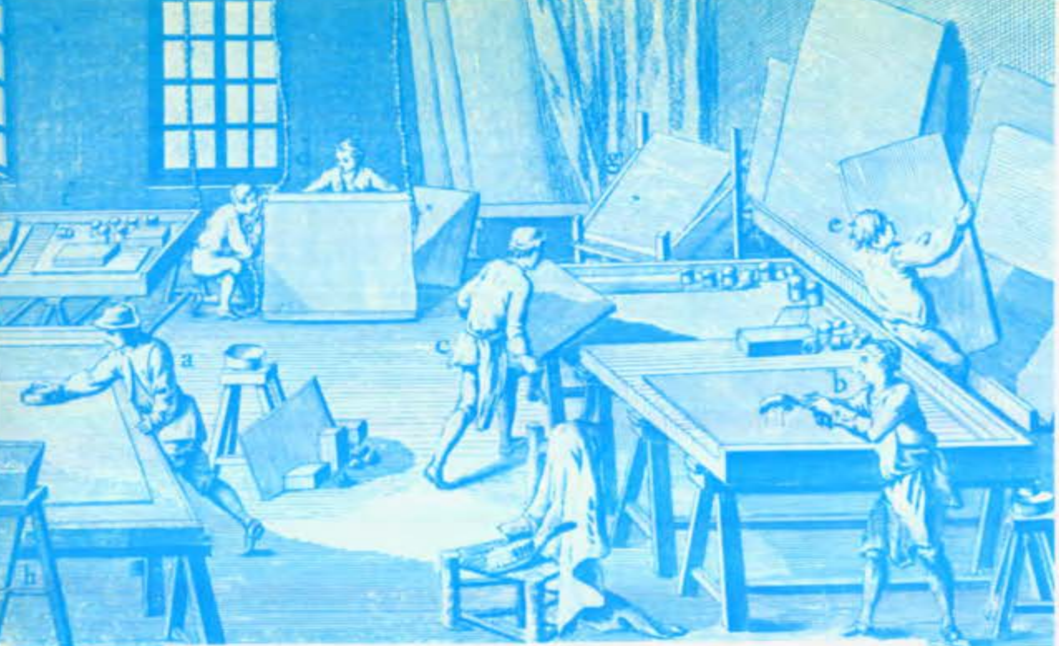


Dyeing—another example of exposure to toxic inhalants.

An 18th-century mine. Compare with Agricola's woodcuts of the 16th-century mines.

Mercury, the easiest metal to extract from ore, always figured prominently in the history of chemistry, alchemy, and medicine.

The vapor from mercury distillation was so toxic that workers in France were employed only one month a year. Mercury's poisonous qualities were known to the Romans, and it was to continue as an occupational hazard until well into this century. From Ramazzini through Dr. Alice Hamilton, occupational physicians were to explore the problem of mercury in industry.



Silvering mirrors, another source of mercury poisoning.

Glass blowers and the glass furnaces. The fabrication of glass poses occupational hazards from the intense heat, dust irritation, metallic poisoning, and emphysema.

Diderot devoted considerable space to agriculture. This plate shows how far the plow had come by the 18th century.

Some notable physicians of the 18th century and their contributions to occupational medicine. . . .

JOHN HUXHAM

John Huxham (1692–1768), a Devonshire physician and student of Boerhaave, contributed work in the fields of fever and infectious diseases. He is important to occupational medicine as the first man to describe "Devonshire colic" in *De Morbo Colico Damnoniensi*, 1739. Although he described the symptoms accurately and well, he ascribed the colic incorrectly to apple tartar.

SIR GEORGE BAKER

Sir George Baker (1722–1809), another Devonshire physician was to go beyond Huxham's work and discover the cause of Devonshire colic. In 1767, in his *Essay Concerning the Cause of Endemial Colic of Devonshire,* Baker pointed out that Devonshire cider contained lead while cider from other parts of England did not. He traced it to the Devonshire practice of lining cider presses and vats with lead which was the cause of the colic. Baker was responsible for the abandonment of lead in the cider industry which ended the colic.

PERCIVALL POTT

Percivall Pott (1714–1788) had a long and distinguished career as surgeon at St. Bartholomew's Hospital in London. His contributions include treatises on hernia, head injuries, hydrocele fractures, and his classic pamphlet on palsy from spinal deformity.

Pott's great contribution to occupational medicine was his first description of an occupational cancer. In 1775 he drew attention to soot as a cause of scrotal cancer—chimney sweep's cancer. The Chimney-Sweepers Act of 1788 was a result of Pott's account of the cancer.

An interesting and significant event took place in the Massachusetts Bay Colony in 1726. Prior to the work of Huxham or Baker, an act was passed in Boston to prevent the use of lead in the distilling of rum and other liquors. A. H. Whittaker wrote: "The many years which followed the determination of the cause of lead poisoning, in distilling and beverage preparation in this country, before the knowledge became widespread in England, also suggests that while medical knowledge was constantly coming from Europe and England to the Colonies, very little medical knowledge was traveling in the other direction."

—Industrial Medicine 10:535, 1941

THOMAS CADWALADER

Thomas Cadwalader (1708–1779) left a classical description of lead (Devonshire) colic and lead palsy, entitled *An Essay on the West-India Dry-gripes with the Method of Preventing and Curing that Cruel Distemper.* Benjamin Franklin, who published the book in 1745, later referred to it in attributing lead poisoning to rum distilled through lead pipes. Cadwalader's book is believed to be the first medical monograph published in the United States.

CHARLES THACKRAH

Charles Turner Thackrah (1795–1833), a physician from Leeds, devoted his life to the study and prevention of occupational hazards which accompanied industrialism. In Thackrah's time, Leeds fostered 128 different trades. After studying with Sir Astley Cooper of Guy's Hospital, London, Thackrah returned to Leeds. In 1828, he opened the Leeds School of Anatomy, which grew into the Leeds University School of Medicine.

Thackrah's 220-page treatise on occupational medicine was the first book of its kind to be published in England. It attracted men interested in social reform, as well as medical men. Thackrah's systematic observations on industrial disease and its prevention played an important part in stimulating factory and health legislation. Thackrah's influence spread through the medical and political spheres of Victorian England.

THOMAS BEDDOES

Thomas Beddoes (1760–1808), an English physician and scientific writer, is best remembered for his founding of the Pneumatic Institution at Clifton, where inhalation therapy was first used in the treatment of respiratory diseases. Beddoes and his assistant, Humphry Davy, experimented with "factitious airs" or gases as therapy.

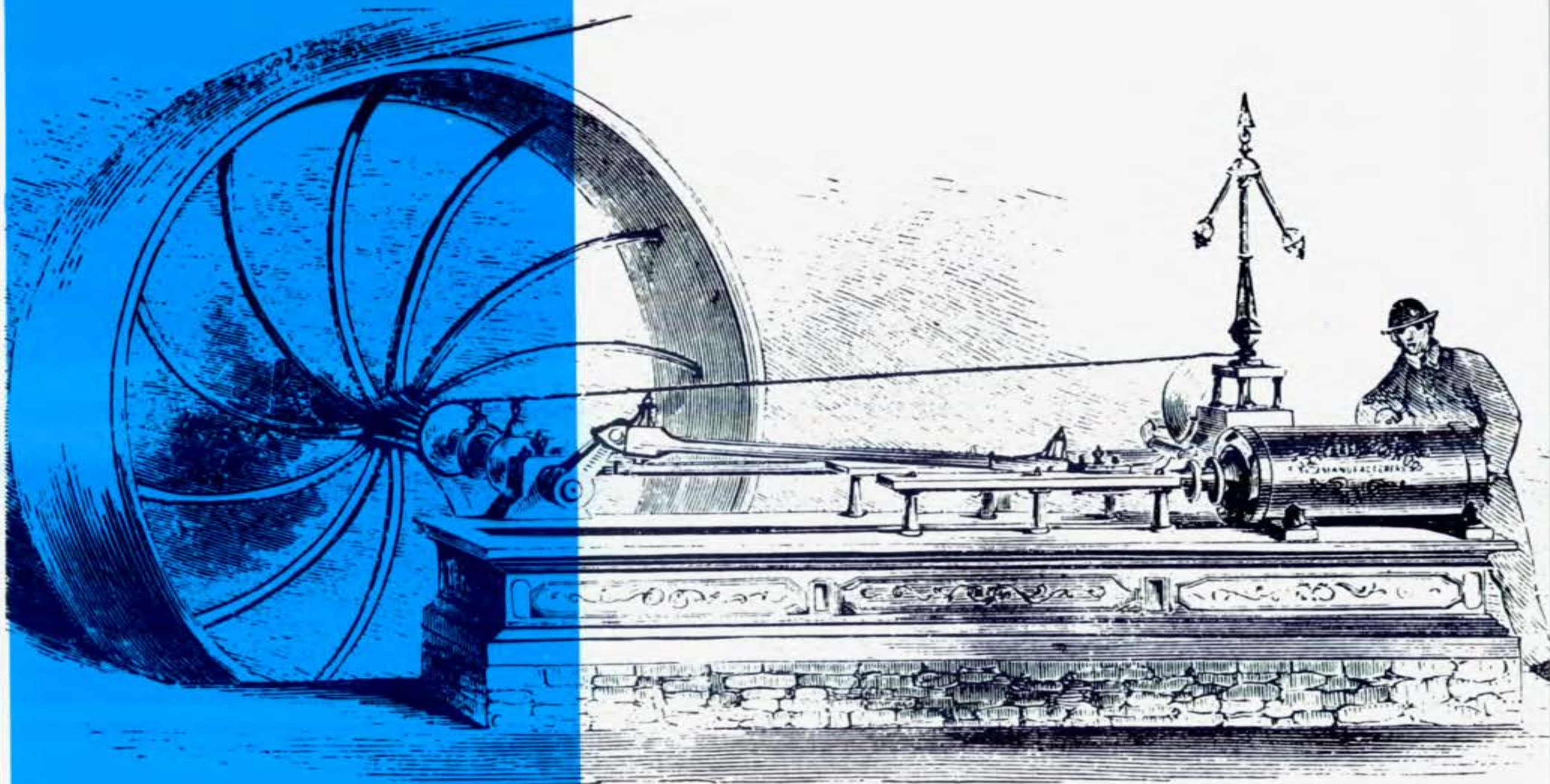
Beddoes was interested in the prevention of lung diseases as well as treatment. In his book, he discusses occupations "more liable to phthisis" (tuberculosis). He places stone and metal grinders in this category.

SIR HUMPHRY DAVY

Sir Humphry Davy's (1778–1829) great contribution evolved out of his experience with gases while at Beddoes Pneumatic Institution.

In 1815, the Sunderland Society, which had been formed by the Reverend John Hodgson to prevent accidents in mines, asked Sir Humphry Davy to investigate the problem of mine explosions. The same year, Davy and George Stephenson developed the miner's safety lamp.

Factories were a natural outgrowth of industrialism and grew around the industrial resources. The early 19th-century factories here retain their pastoral surroundings. Too soon the industrial slums would appear.



THE IMPACT OF INDUSTRIALISM

Despite the increased knowledge of occupational diseases which had been gained by the beginning of the 18th century, little more had been done to safeguard workers than during the days when Pliny described the ancient slave-miners of mercury devising their own bladder-skin masks in a pathetic and fruitless attempt to avoid inhaling toxic dusts.

Early in the century, however, the slow, uneven process of Western transition from an agrarian-mercantile economy to industrial society began in England. It was a time of optimism, faith in "progress," increased prosperity for some—and incredible hardship for others. The skilled handcraftsman was displaced by the cheaply bought labor of women. Housework became an extension of the factory piece-work system with its pressures and absence of personal freedom, in contrast to the more leisurely home craftsmanship practiced earlier by the small farmer. The growing urbanization of workers and conversion of agriculture to cash-crop farming rendered most of the population totally vulnerable to the recurring cycles of inflation, depression, and unemployment. Along with an increase in the production of real wealth, work presented new opportunities, new goals, and new occupational hazards.

Side by side with the first modern trade-unions, a new kind of public sentiment appeared. It consisted of a blend of economic self-interest on the part of certain industrialists, a genuine humanitarianism, and utopian socialism. Aided by a courageous and vocal segment of the medical profession, the result was a reform movement that lasted well into the 20th century.

Ramazzini, for example, in the 18th century, had suggested palliatives for the diseases he described.

Industrialism had developed slowly—a combination of technology, improved sources of power and new materials, and the growth of a wage-earning class. The social changes wrought by industrialism were far less beneficial than were the technical advances. England was the center for the changes to be wrought by industrialism.

During the mid-19th century, coal replaced charcoal as the principal fuel for blast furnaces, but the workers still spent the day in violent heat. The demand for coal was at its greatest during the final years of the century.

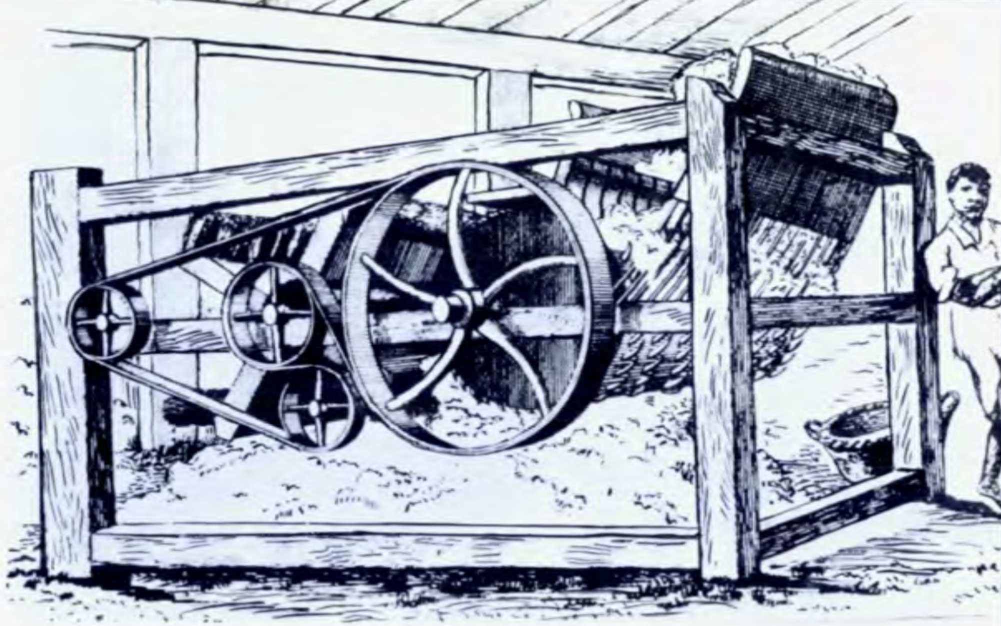
Murdock's gas-making plant, London, 1806.

George Thackrah, in 19th-century England, observed the occupations around him with equal care and greater clinical knowledge, and laid the responsibility for their toll firmly where he felt it rested: "Each master . . . has in great measure the health and happiness of his workpeople in his power . . . let benevolence be directed to the *prevention,* rather than to the relief of the evils, which our civic state so widely and deeply produces."

Alice Hamilton, in early 20th-century America, also observed conditions at first hand and accepted social action as medicine's responsibility. She did not rely on the benevolence of owners, but accosted startled mine owners, factory managers, and State officials with evidence of illness correlated with toxic exposures, and presented concrete proposals for their elimination. Armed with that implacable determination and bland, almost naive, assumption of success that characterized the socially conscious woman of the early 1900's, she exercised tremendous influence. In a sense, she epitomizes all of the physicians, toxicologists, social workers, and teachers who helped pave the way in the country for what had evolved in England a century before: the concept of society's responsibility for the health and welfare of its citizens—including people at work.

Clearly, only battles, not wars, were won in the 19th and early 20th centuries, but the sense of community responsibility which was born in that era constituted as great a breakthrough in man's control of his environment as did the technology of these decades.

Many new industries were to emerge . . . especially iron, cotton, and pottery. The American cotton gin, invented in 1792, was to have its industrial impact in England where the great textile mills were to develop, demanding a greater labor force and making use of child labor.



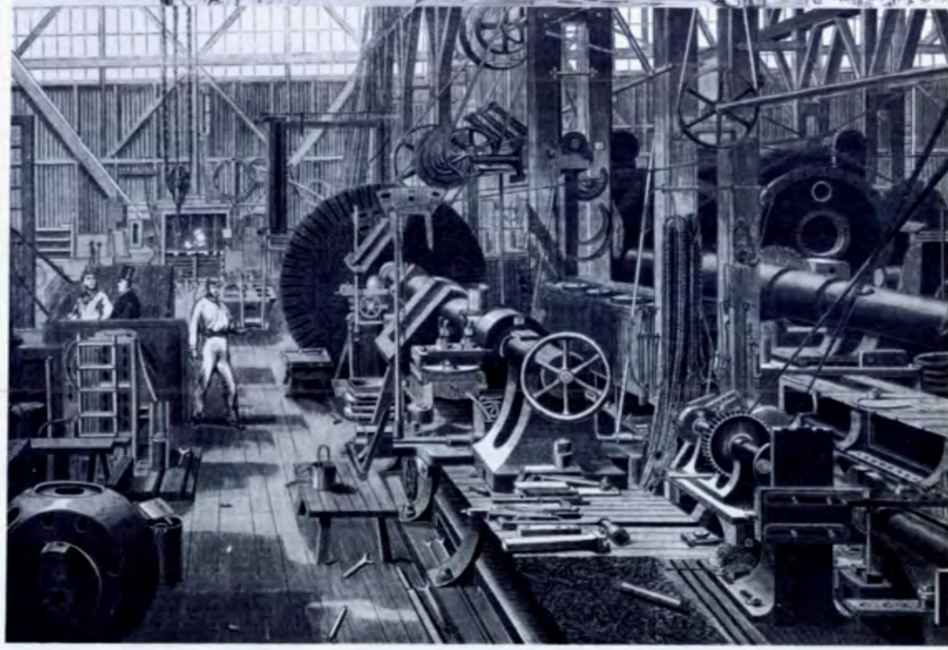
The demand for both fuel and ore necessitated an even greater expansion of mining. Accompanying this expansion were the ever present occupational hazards and the exploitation of cheap labor, including women and children.

A woman mine worker, 1840. Drawn by Dr. Southwood Smith.

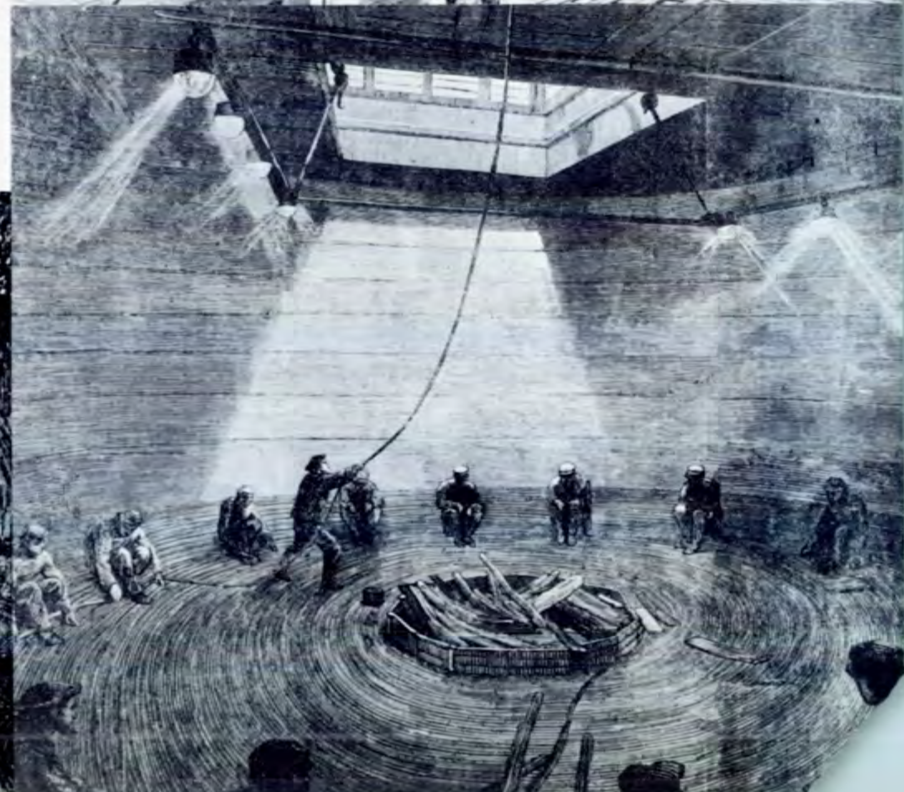
Mining explosions were not uncommon. Quite naturally, they attracted considerable publicity and the public sympathy. The two drawings shown here are from the *London Illustrated News,* the most popular periodical of its day. The explosion shown here took place at Tredegor, Monmouthshire. The account pointed out the utter negligence on the part of the mine operators in not testing for gas on the day of the explosion. The *News* further stated that safety lamps had not been provided.

Industrialism enjoyed enormous patronage in 19th-century England. The old European fairs now became trade exhibitions. Great exhibition centers were built, such as the Crystal Palace. These industrial displays reached their culmination under Queen Victoria. Later, similar exhibitions would be seen in the United States at the World's Fairs in St. Louis, Chicago, and San Francisco.

A 19th-century factory—Note the labyrinth of hazards . . . belts, open lathes, hanging chains, and hanging cables.



The laying of the Atlantic telegraph cable was considered one of the engineering feats of the 19th century. The famous ship, *Great Eastern,* was used for cable laying. The ship itself was an industrial feat; built in 1854, she was the largest iron steamship of her time.



The late 19th century was a period of unrest among labor in this country. Poor working conditions, the great influx of immigrants, and the rapid growth of trade unionism led to violence. Strikes were prevalent, but were quickly put down by police. Public opinion was divided between a sympathy for the worker and a fear of mob rule.

On May 1, 1886, the famous Haymarket Riot broke out in Chicago.

Industry expanded enormously in the United States between the 1870's and 1918. It was the period of the robber barons, the railroads, and America's "manifest destiny."

As in Europe, new sources of power were put to use. Mass production was on the way.

Sweatshops grew up in New York and other large cities. At first they were similar to the cottage industries of 18th-century Europe. This was a result, in part, of the influx of immigrants, forced by language and economic barriers to form "ghettos." Work was done by families and groups of friends.

The first automobile assembly line at Henry Ford's Detroit plant. Mass production had come of age.

In a short time, sweatshops moved from tenement houses to loft-type factories. The working conditions were appalling—long hours, poor ventilation, and child labor. The Triangle Shirtwaist Fire, a disaster in which workers burned because of a lack of fire escapes, brought sweatshop conditions to the attention of the public.

Robert Owen

The years from 1910–1912 were something of a Golden Age in occupational medicine. Physicians were writing on occupational diseases. The public was becoming aware of occupational hazards, and long-needed legislation was being written.

In addition to the publication of medical monographs and articles, occupational medicine was becoming a part of medical education. These clinical pictures appeared during this period.

Top left, a 31-year-old patient before working in a factory as a boxer of phosphorus matches. Lower left, the same patient after four years' work. Maxilla removed in Lakeside Hospital, Cleveland, Ohio, in 1911. Patient cannot articulate and can eat only fluid food.

Top center, chronic lead poisoning with double wristdrop and extreme emaciation. This man was slowly recovering from an almost fatal illness involving the intestines, heart, and kidneys, caused by lead poisoning. He had been a house-painter for 35 years.

Food processing was both an occupational and a public health hazard. Federal legislation finally brought an end to most dangerous practices. Workers in slaughter houses were subject to anthrax. Industrial hygiene measures were unheard of in these plants.

Phillippa Flowerday, the first industrial nurse, was appointed by the Carrow Works of the J. & J. Colman Company, Norwich, England, in 1878.

During this period of social and economic ferment, various voices stirred the public conscience. . . .

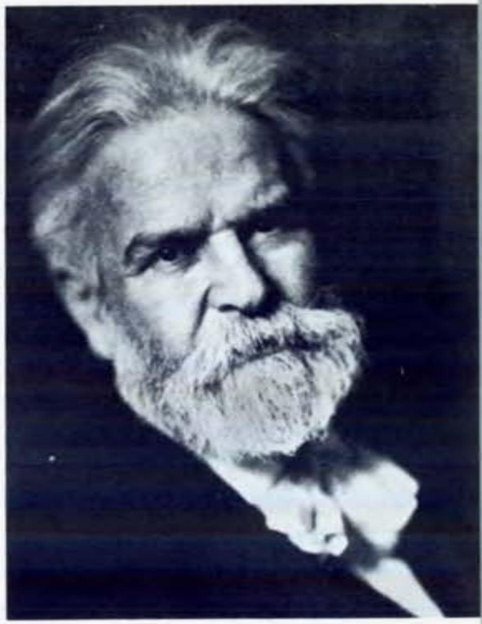
Every age has its men who are advanced far beyond their own time. Such a man was Robert Owen (1771–1858). A Welsh socialist and philanthropist, he pioneered the co-operative movement in industry. Appalled by the factory conditions in England, he bought the New Lanark Mills in Manchester in 1799. Owen stopped the employment of children, established sickness and old-age insurance, and opened educational and recreational facilities. Owen helped draft the Factory Act of 1819.

Although the employment of children was the most publicized aspect of factory life, women, too, were exploited under the factory system. Nineteenth century writers were to respond to the public clamor for reform. Charles Dickens is the most obvious example. The reform writers were extremely influential. Not only were novelists such as Frances Trollope writing of worker exploitation, but essayists and clergymen also called for legislation.

Between 1802 and 1878, a series of acts was enacted by the British Parliament which is referred to generally as the "factory acts." The Factory Act of 1833 was the first effective legislative measure in the industrial field. That act regulated the labor of children and young persons. The other truly significant act was that of 1878, which created a centralized system of factory inspection with a chief investigator in London.

Michael Armstrong, The Factory Boy.

EDWIN MARKHAM



Edwin Markham (1852–1940), poet, lecturer, and school teacher, wrote "The Man With a Hoe" in 1899. The poem received wide recognition. The obscure California school teacher became the spokesman for the underdog. He became interested in the movement to abolish child labor and devoted the rest of his life to social reform. Markham's book, *Children in Bondage,* was to cause as much furor as his poem.

Other American reform writers at the turn of the century were Frank Norris, Theodore Dreiser, and somewhat later, Upton Sinclair. All had great impact upon public opinion.

DR. ALICE HAMILTON

Alice Hamilton (1869–). Dr. Hamilton's long and fruitful career has spanned the growth of modern occupational medicine from its nebulous beginnings in the mines and factories of late 19th-century England to its high position in contemporary preventive medicine.
After receiving her M.D. in 1893 from the University of Michigan, she studied in Europe and in this country at Johns Hopkins University. She taught pathology at the Woman's Medical School, Northwestern University, in Chicago and became interested in Jane Addams' Hull House. Upon reading Thomas Oliver's *Dangerous Trades,* she made her professional choice—to apply the science of pathology to occupations.

Dr. Hamilton's impressive achievements include her classic work with lead and her appointment in 1919 as the first woman faculty member at Harvard University. Her remarkable life is recorded in her autobiography, *Exploring the Dangerous Trades.*

Hugo Münsterberg (1863–1916), a European by birth, spent most of his academic life at Harvard University, where he helped develop the laboratory for experimental psychology. He pioneered in applied psychology and was one of the first to apply psychology to industry. His *Psychology and Industrial Efficiency* was published in 1916.

Victor Vance Anderson (1878–), an American psychiatrist and early contributor to the field of industrial psychiatry, was appointed medical director of the R. H. Macy Department Store in 1924. He was the first psychiatrist to hold such a position in industry.

Frank B. Gilbreth (1868–1924) and Lillian M. Gilbreth (1873–) brought time study, efficiency engineering and management analysis to industry. After Frank Gilbreth's death, his widow continued his work.

Münsterberg's first psychological laboratory.

TOWARD THE MASS SOCIETY

New stresses have appeared in the transition from mechanized industrial society to automated mass society. Increasing fragmentation of all work processes now is characteristic not only of the factory, but also of the large white collar organizations, and of the formerly exempt spheres of agriculture, mining, forestry and fishing. Work, itself, in consequence, has lost much of its meaning for the worker, but not solely because of his loss of identification with a completed product. The tool itself was originally an extension of the craftsman's arm. Later, the machine was simply a larger, more powerful extension of his body. With the advent of automation, man is transformed finally from tool-user to machine-watcher. His separation from the act of creation is complete, as is his sense of involvement in what is created. His response is often a retreat from meaningless work into an obsession with equally unsatisfying recreation.

Industry's attempts to re-enlist the worker's commitment to his job have ranged from the stop-watch school of industrial psychology to more sophisticated wage-incentive and profit-sharing plans, counseling, and coffee-breaks. Too often, however, these activities have consisted of efforts to oil the organizational system much as delicate machinery is oiled. They have failed to be convincing because they have ignored the underlying problem—that personal effort is valued less than "teamwork," and that the organization takes priority over individual skills and honest human relationships. Inevitably, the worker regards his efforts as trivial.

Plant safety was not achieved by adjusting people to lead poisoning. Neither will mental health in industry be accomplished by attempting to adjust workers to stresses which they clearly regard as intolerable. The worker will be restored to himself and to his work exactly as he was finally protected from toxic exposures: by determining his needs and adjusting the work environment accordingly . . . whether through job rotation, through including him in the making of decisions which affect him, or through other means. This process itself is merely an extension of the historic philosophy of occupational medicine, ". . . the promotion of optimal health, productivity, and social adjustment."

The great depression of the 30's was a period of stress for the worker, management, and the government. The roles of all three would never be the same.

The American version of *laissez-faire* was at an end. Trade-unionism would become a unified force. Most important of all, the Federal Government would take an active role in the economic and welfare aspects of American life as it never had before. Urbanization increased during the 30's and 40's. The small farm went into decline as workers turned to the cities.

Industrial expansion frequently was bloody. Violence represented one of the major stresses of work in this transition period.

"Conquerors of Yellow Fever" by Dean Cornwell.

Mass vaccination—another achievement in environmental health.

Occupational medicine, nurtured by advances in environmental health, was attaining a new stature in clinical medicine and public health.

William C. Gorgas (1854–1920) was able to eradicate yellow fever from Cuba. In Panama, Gorgas not only freed the Isthmus of yellow fever, but also introduced sanitation measures which curbed many other dangerous infections.

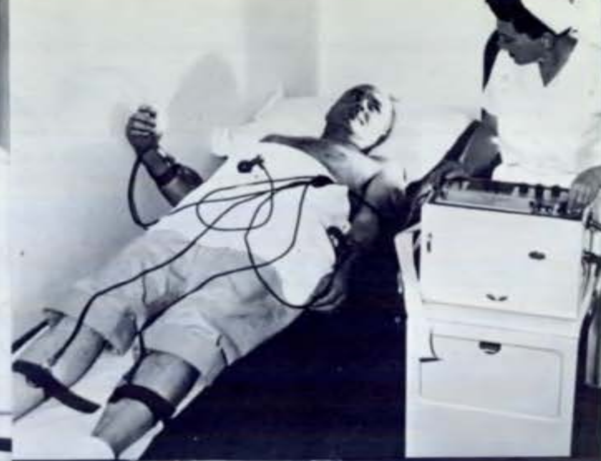
Note the word HEALTH instead of hospital, emergency, or dispensary.

Occupational medicine is now preventive rather than correctional.

Medical director reviews building plans from the viewpoint of workers' welfare and health.

Going beyond the rehabilitation of the worker made ill or injured in the course of work, occupational medicine has made tremendous contributions in the employment of the physically handicapped, whatever the source of trauma or disease.

A CASE STUDY OF OCCUPATIONAL HEALTH IN ACTION



A steelworker has a mild heart attack.

He is taken to the plant physician.

A thorough diagnosis is made.

The plant physician consults the family physician and discusses the patient's health problem.

After consulting with both physicians, the patient returns to work. He and his foreman understand his limitations. Both the plant physician and his foreman will keep close surveillance over his health.

Occupational medicine today faces some of its greatest challenges in the rapid spread of automation and its effects on the worker. . . .

In the census of 1890, the first tabulating machine was used to compile data. Though regarded with awe, it did not eliminate the worker. Totals reached on the counting and adding devices had to be read from the dials at the top and copied by hand. Cards had to be placed manually in the compartments of the sorting box on the right to complete the sorting operation.

The first tabulating machine in industry was used in 1903 in the payroll department of a plant in Connecticut.

Today the word "automation" encompasses not only data processing, but also automatic handling operations, self-correcting control devices, and automatic assembly.

The machine works . . . the worker watches.

Television enables this engineer to manipulate intensely radioactive materials with remotely controlled mechanical hands.

Twenty-five years ago, radiation hazards did not exist. As the uses of atomic energy increase, occupational medicine must keep pace with the risks involved in working with radioactive materials.

To meet the needs of an increasingly complex technology, industry is constantly developing clothing to protect workers from the effects of high and low temperatures, toxic fumes, radiation, and supersonic shock rays.

Wearing a hooded asbestos cape, a welder's helmet, and asbestos gloves, this maintenance man is cleaning a furnace in a glass manufacturing plant. The equipment permits maintenance operations while the furnace is in use. Compare this glass worker with those of the 17th century.

Medicine is an important partner in the effort to conquer space, for man must be kept alive as he explores. . . .

A 24-kt. gold-covered, plastic suit may be used by the man who fuels America's first moon rocket. The suit is airtight and unaffected by virtually all known chemicals. Air supply and radio system are built into the suit. Personnel who work with exotic and dangerous missile and rocket fuels are protected from flash temperatures up to 3000° F.

This capsule is the result of years of research directed toward adapting human beings to a completely different environment, by modifying that environment.

ACKNOWLEDGMENTS

We are indebted to the various business and publishing concerns, museums, authors, and photographers who have given us permission to reproduce photographs and illustrations for this publication. In addition to material from the following sources, we have drawn from files of private individuals, governmental agencies and others to compile this pictorial history of occupational medicine.

ILLUSTRATIONS APPEARING ON:	SOURCES
Cover, p. 15, 22–26, and "cottage industry" on p. 19.	Diderot, Denis. *Encyclopédie ou Dictionnaire Raissoné des Sciences, des Arts et des Métiers, par une Société de gens de Lettres.* Paris, Braisson, 1751–65.
P. 2, *Cave Mån of the Neanderthal Race,* by Charles R. Knight.	American Museum of Natural History.
P. 5.	Carleton S. Coon from his book, *The Story of Man.* New York, Knopft, 1955.
P. 6 and 7, Egyptian paintings.	Oriental Institute, University of Chicago from: Davies, Nina M. *Ancient Egyptian Paintings.* Chicago, University of Chicago Press, 1936.
P. 9, "Greek women baking bread."	*Ciba Symposium.* 8:473, December 1946. Formerly published by CIBA Pharmaceutical Co., Summit, N.J.
P. 10, *The Harvesters,* by Pieter Bruegel the Elder.	The Metropolitan Museum of Art, Rogers Fund, 1919.
P. 12, "Monastic hospital of the 12th century," and p. 16, "The mathematician . . ."	*Horizon Book of the Renaissance.* New York, American Heritage Pub. Co., 1961. p. 12, Fracastoro attributed to Torbido. NGL—Hospital, ms. Gaddiano 24, BFL (ENIT). p. 16, Pacioli by Jaco . . . Bar . . . Galleria Nazionale, Naples (Parisio).
P. 17, "Ventilating devices" and "mine shafts," p. 18, "Demons of the mine" and "pump," and p. 19, "Smelting."	Agricola, Georgius. *De Re Metallica.* Trans. by Herbert and Lou Henry Hoover, New York, Dover Pub., Inc.
P. 17, "Georgius Agricola."	Rembrandt Verlag from: Gottlieb, Bernward. *Das Antlitz das germanischen Arztes in vier Jahrhunderten.* Berlin, Rembrandt, 1942.
P. 19, "Paracelsus."	Lederle Laboratories from: *Lederle Bulletin.* 16: November, 1951.
P. 27, "Percivall Pott."	*The American Journal of Surgery.* 7:433, September, 1929.
P. 27, "John Huxham."	*Clinical Medicine and Surgery,* 38:14, 1931.
P. 27, "Sir George Baker," and p. 44, *Conquerors of Yellow Fever* by Dean Cornwell.	Harper and Row, Inc. p. 27, from: *Annals of Medical History.* 3: Frontis. March, 1931. p. 44, from: Truby, Albert E. *Memoir of Walter Reed.* New York and London, Paul B. Hoeber, Inc., 1943.
P. 28, "Charles Thackrah."	University of Leeds from: Meiklejohn, A. *The Life, Work and Times of Charles Turner Thackrah* 1795–1833. Edinburgh, Livingstone, 1957.
P. 28, "Thomas Cadwalader, M.D."	W. B. Saunders, Co. from: Kelly, Howard A. *Cyclopedia of American Medical Biography.* Philadelphia, W. B. Saunders, 1912.
P. 38, "Phosphorus match worker" and "Chronic lead poisoning."	Lakeside Hospitals, University Hospitals of Cleveland. University Circle, Cleveland 6, Ohio.
P. 40, "Dr. Alice Hamilton"	*Industrial Medicine and Surgery.* 4:421, 1935.
P. 40, "Edwin Markham."	Virgil Markham from: Markham, Edwin. *New Poems; Eighty Poems at Eighty.* Garden City, Doubleday, 1932.
P. 41, "Münsterberg's first psychological laboratory."	Meredith Press from: Münsterberg, Margaret A. *Hügo Münsterberg: his Life and Work.* New York, Meredith, 1922.
P. 46, "Medical director reviews . . ." and p. 48, "A case study of occupational health . . ."	American Iron and Steel Institute from: *Steelways,* January, 1962.
P. 50, "The machine works . . ."	Cross Transfer-matic from: The Cross Company, Detroit, Michigan.
P. 50, "Wearing a hooded . . ."	Schaefer & Seawell—Black Star for Fortune from: *Fortune,* May, 1961.
P. 51, "Moon suit."	Synder Manufacturing Company, New Philadelphia, Ohio.
Back cover, quotation	Simon and Schuster from: Russell, Bertrand *Has Man a Future?* New York, Simon and Schuster, 1962.

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EPILOGUE

Along with the myth of Sisyphus, there is another tale—that of the sorcerer's apprentice: what he called forth he could not stop. The source of his disaster, of course, lay neither in the "automatic" broom nor in the ever-filled pail. Rather, it lay in the original expectation of both the apprentice and his master that these impersonal instruments could accomplish what was possible only to human beings: the control of environment, the creation of optimum conditions for work and the realization of satisfaction from work.

The pursuit of these aims remains within human province and constitutes the secret of humanness itself. Occupational medicine, through an acceptance of shared effort with many other groups, and a reaffirmation of its responsibilities to human workers, has an essential role to fill in the eventual achievement of all three.

Do not forget that we have but lately emerged from a morass of ancient ignorance and age-long struggle for existence. Most of what we know we have discovered during the last twelve generations . . . It is not only what to avoid that great men have shown us. They have shown us also that it is within human power to create a world of shining beauty and transcendent glory . . . a chance to emerge from ancient folly into a world of light and love and loveliness.

Bertrand Russell

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