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Thomas Edison

American inventor



Also known as: *Thomas Alva Edison*, *Wizard of Menlo Park*

Written by [Robert E. Conot](#), [Matthew Josephson](#) | [See All](#)

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Thomas Edison (born February 11, 1847, [Milan, Ohio](#), U.S. —died October 18, 1931, [West Orange](#), New Jersey) was an American [inventor](#) who, singly or jointly, held a world-record 1,093 [patents](#). In addition, he created the world's first industrial research [laboratory](#).

[Edison](#) was the quintessential American [inventor](#) in the era of Yankee ingenuity. He began his career in 1863, in the adolescence of the [telegraph](#) industry, when virtually the only source of electricity was primitive [batteries](#) putting out a low-voltage [current](#). Before he died, in 1931, he had played a critical role in introducing the modern age of [electricity](#). From his laboratories and workshops emanated the [phonograph](#), the carbon-button transmitter for the [telephone](#) speaker and [microphone](#), the [incandescent lamp](#), a revolutionary generator of unprecedented [efficiency](#), the first commercial electric light and [power](#) system, an experimental electric [railroad](#), and key elements of [motion-picture apparatus](#), as well as a host of other inventions.



Thomas Edison

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In full: Thomas Alva Edison

Born: February 11, 1847, [Milan, Ohio](#), U.S.

Died: October 18, 1931, [West Orange, New Jersey](#) (aged 84)

Awards And Honors: [Hall of Fame \(1960\)](#)

Inventions: [carbon transmitter](#) • [incandescent lamp](#) • [Kinetograph](#) • [Kinetoscope](#) • [phonograph](#)

On the Web: [National Academy of Sciences - Biographical Memoirs - "Thomas Alva Edison" \(Apr. 19, 2024\)](#)

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Edison was the seventh and last child—the fourth surviving—of Samuel Edison, Jr., and Nancy Elliot Edison. At an early age he developed [hearing](#) problems, which have been variously attributed but were most likely due to a familial tendency to [mastoiditis](#). Whatever the cause, Edison's [deafness](#) strongly influenced his behaviour and career, providing the motivation for many of his inventions.

Early years

In 1854 Samuel Edison became the [lighthouse](#) keeper and carpenter on the Fort Gratiot military post near [Port Huron, Michigan](#), where the family lived in a substantial home. Alva, as the inventor was known until his second marriage, entered school there and attended sporadically for five years. He was imaginative and inquisitive, but, because much instruction was by rote and he had difficulty hearing, he was bored and was labeled a misfit. To compensate, he became an [avid](#) and omnivorous reader. Edison's lack of formal schooling was not unusual. At the time of the [Civil War](#) the average American had attended school a total of 434 days—little more than two years' schooling by today's standards.



Britannica Quiz

Pop Quiz: 15 Things to Know About the Industrial Revolution

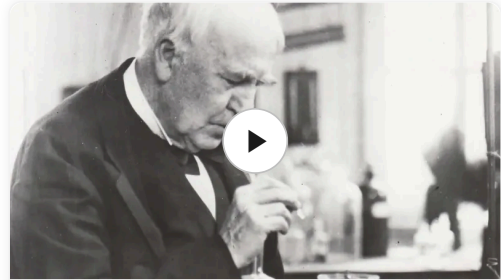
In 1859 Edison quit school and began working as a trainboy on the railroad between [Detroit](#) and Port Huron. Four years earlier, the Michigan Central had initiated the commercial application of the [telegraph](#) by using it to control the movement of its trains, and the Civil War brought a vast expansion of [transportation](#) and [communication](#). Edison took advantage of the opportunity to learn telegraphy and in 1863 became an apprentice telegrapher.

Messages received on the initial [Morse](#) telegraph were inscribed as a series of dots and dashes on a strip of [paper](#) that was decoded and read, so Edison's partial deafness was no handicap. Receivers were increasingly being equipped with a sounding key, however, enabling

Watch a silent short of Thomas Edison, who invented the phonograph and incandescent electric light

Thomas Edison, seen late in life in this video, was the most fam...(more)

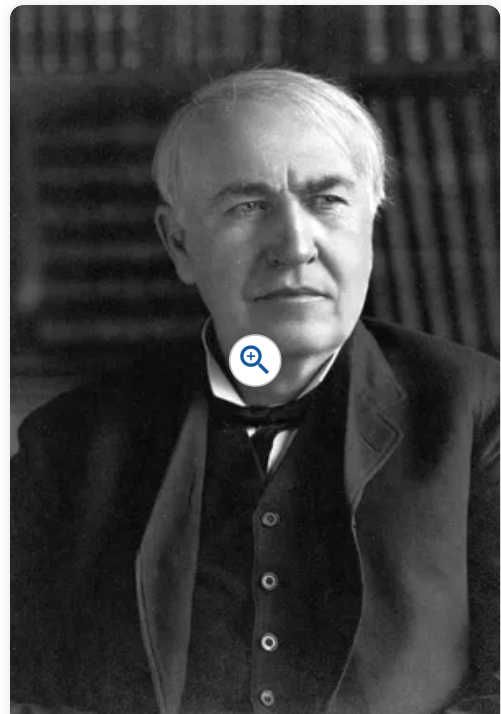
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The role of chemistry in Thomas Edison's inventions

How Thomas Edison changed the world.

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Thomas Edison

telegraphers to “read” messages by the clicks. The transformation of telegraphy to an auditory art left Edison more and more disadvantaged during his six-year career as an itinerant telegrapher in the Midwest, the South, [Canada](#), and [New England](#). Amply supplied with ingenuity and insight, he devoted much of his energy toward improving the inchoate equipment and inventing devices to [facilitate](#) some of the tasks that his physical limitations made difficult. By January 1869 he had made enough progress with a duplex [telegraph](#) (a device capable of transmitting two messages simultaneously on one wire) and a printer, which converted electrical signals to letters, that he abandoned telegraphy for full-time [invention](#) and entrepreneurship.

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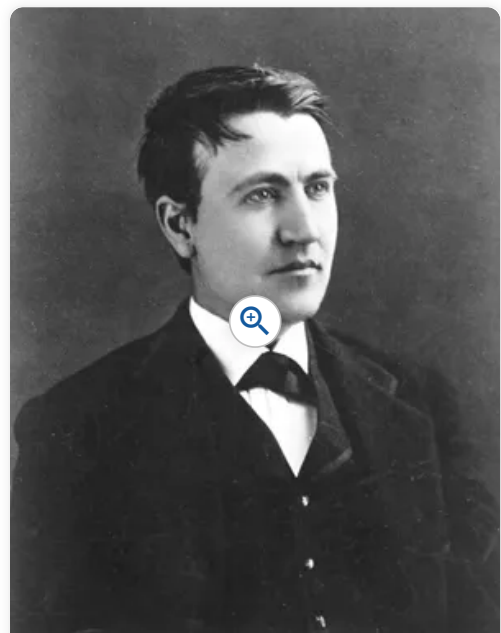
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Edison moved to [New York City](#), where he initially went into partnership with Frank L. Pope, a noted electrical expert, to produce the Edison Universal Stock Printer and other printing telegraphs. Between 1870 and 1875 he worked out of [Newark](#), [New Jersey](#), and was involved in a variety of partnerships and complex transactions in the fiercely competitive and [convoluted](#) telegraph industry, which was dominated by the [Western Union Telegraph Company](#). As an independent [entrepreneur](#) he was available to the highest bidder and played both sides against the middle. During this period he worked on improving an automatic telegraph system for Western Union’s rivals. The automatic telegraph, which recorded messages by means of a [chemical reaction](#) engendered by the electrical transmissions, proved of limited commercial success, but the work advanced Edison’s knowledge of [chemistry](#) and laid the basis for his development of the electric pen and [mimeograph](#), both important devices in the early office [machine](#) industry, and indirectly led to the discovery of the [phonograph](#). Under the [aegis](#) of Western Union he devised the quadruplex, capable of transmitting four messages simultaneously over one wire, but railroad baron and [Wall Street](#) financier [Jay Gould](#), Western Union’s bitter rival, snatched the quadruplex from the telegraph company’s grasp in December 1874 by paying Edison more than \$100,000 in cash,



Thomas Edison

Thomas Edison as a young boy.



Thomas Edison

Thomas Edison as a young man.

bonds, and stock, one of the larger payments for any invention up to that time. Years of litigation followed.

Menlo Park

Although [Edison](#) was a sharp bargainer, he was a poor financial manager, often spending and giving away [money](#) more rapidly than he earned it. In 1871 he married 16-year-old Mary Stilwell, who was as improvident in household matters as he was in business, and before the end of 1875 they were in financial difficulties. To reduce his costs and the temptation to spend money, Edison brought his now-widowed father from [Port Huron](#) to build a 2 1/2 -story [laboratory](#) and [machine](#) shop in the rural environs of [Menlo Park](#), New Jersey—12 miles south of Newark—where he moved in March 1876. Accompanying him were two key associates, Charles Batchelor and John Kruesi. Batchelor, born in Manchester in 1845, was a master mechanic and draftsman who [complemented](#) Edison perfectly and served as his “ears” on such projects as the [phonograph](#) and telephone. He was also responsible for fashioning the drawings that Kruesi, a Swiss-born machinist, translated into models.

Edison experienced his finest hours at Menlo Park. While experimenting on an underwater cable for the automatic [telegraph](#), he found that the [electrical resistance](#) and conductivity of [carbon](#) (then called [plumbago](#)) varied according to the pressure it was under. This was a major theoretical discovery, which enabled Edison to devise a “pressure relay” using [carbon](#) rather than the usual magnets to vary and balance electric currents. In February 1877 Edison began experiments designed to produce a pressure [relay](#) that would amplify and improve the audibility of the [telephone](#), a device that Edison and others had studied but which [Alexander Graham Bell](#) was the first to [patent](#), in 1876. By the end of 1877 Edison had developed the [carbon-button transmitter](#) that was used in telephone speakers and [microphones](#) for a century thereafter.

The phonograph

Edison invented many items, including the carbon transmitter, in response to specific demands for new products or improvements. But he also had the gift of serendipity: when some unexpected phenomenon was observed, he did not hesitate to halt work in progress and turn off course in a new direction. This was how, in 1877, he achieved his most original discovery, the [phonograph](#). Because the telephone was considered a variation of [acoustic](#) telegraphy, Edison during the summer of 1877 was attempting to devise for it, as he had for the automatic telegraph, a machine that would transcribe signals as they were received, in this instance in the form of the human voice, so that they could then be delivered as telegraph messages. (The telephone was not yet conceived as a general person-to-person means of communication.) Some earlier researchers, notably



Thomas Edison and phonograph

French inventor Léon Scott, had theorized that each sound, if it could be graphically recorded, would produce a distinct shape resembling shorthand, or phonography (“sound writing”), as it was then known. Edison hoped to reify this concept by employing a stylus-tipped carbon transmitter to make impressions on a strip of paraffined paper. To his astonishment, the scarcely visible indentations generated a vague reproduction of sound when the paper was pulled back beneath the stylus.

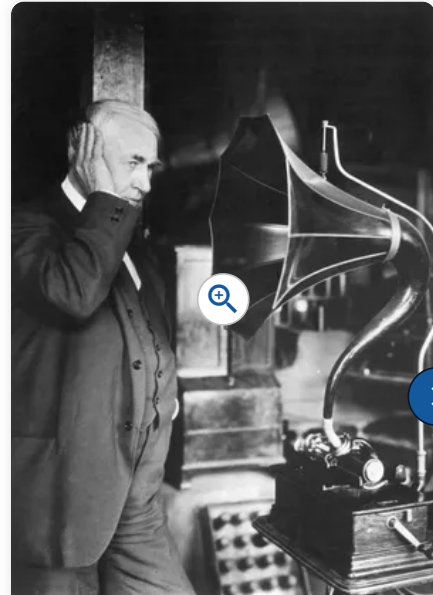
Edison unveiled the [tin foil](#) phonograph, which replaced the strip of paper with a cylinder wrapped in tinfoil, in December 1877. It was greeted with incredulity. Indeed, a leading French scientist declared it to be the trick device of a clever ventriloquist. The public’s amazement was quickly followed by universal acclaim. Edison was projected into [worldwide](#) prominence and was dubbed the Wizard of [Menlo Park](#), although a decade passed before the phonograph was transformed from a laboratory curiosity into a commercial product.

The electric light

Another offshoot of the carbon experiments reached fruition sooner. Samuel Langley, [Henry Draper](#), and other American scientists needed a highly sensitive instrument that could be used to measure minute [temperature](#) changes in [heat](#) emitted from the [Sun](#)’s [corona](#) during a solar [eclipse](#) along the [Rocky Mountains](#) on July 29, 1878. To satisfy those needs Edison devised a “microtasimeter” employing a [carbon](#) button. This was a time when great advances were being made in [electric arc lighting](#), and during the expedition, which Edison accompanied, the men discussed the practicality of “subdividing” the intense [arc lights](#) so that [electricity](#) could be used for lighting in the same fashion as with small, individual gas “burners.” The basic problem seemed to be to keep the burner, or [bulb](#), from being [consumed](#) by preventing it from overheating. Edison thought he would be able to solve this by fashioning a microtasimeter-like device to control the [current](#). He boldly announced that he would invent a safe, mild, and inexpensive electric light that would replace the gaslight.

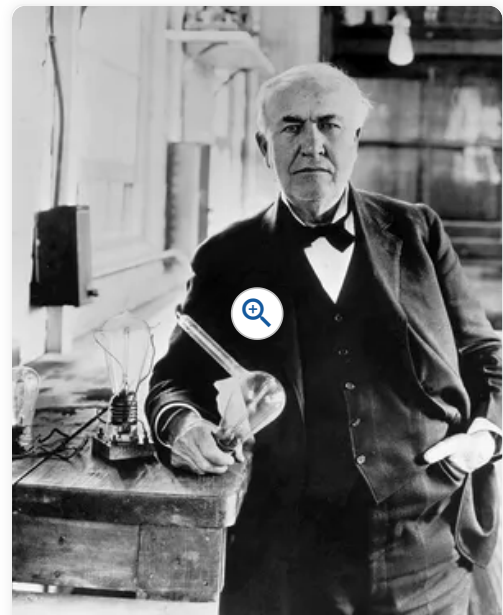
The [incandescent electric light](#) had been the despair of inventors for 50 years, but Edison’s past achievements commanded respect for his boastful prophecy. Thus, a

Thomas Edison demonstrating his tinfoil phonograph, c. 1877.



Thomas Edison

Thomas Edison listening to a phonograph.



Thomas Edison

Thomas Edison, 1925, holding a replica of the first electric lightbulb.

syndicate of leading financiers, including [J.P. Morgan](#) and the Vanderbilts, established the Edison Electric Light Company and advanced him \$30,000 for [research and development](#). Edison proposed to connect his lights in a [parallel circuit](#) by subdividing the current, so that, unlike arc lights, which were connected in a series [circuit](#), the failure of one [lightbulb](#) would not cause a whole circuit to fail. Some eminent scientists predicted that such a circuit could never be [feasible](#), but their findings were based on systems of lamps with low resistance—the only successful type of electric light at the time. Edison, however, determined that a bulb with high resistance would serve his purpose, and he began searching for a suitable one.

He had the assistance of 26-year-old [Francis Upton](#), a graduate of [Princeton University](#) with an M.A. in [science](#). Upton, who joined the laboratory force in December 1878, provided the mathematical and theoretical expertise that Edison himself lacked. (Edison later revealed, “At the time I experimented on the [incandescent](#) lamp I did not understand Ohm’s law.” On another occasion he said, “I do not depend on figures at all. I try an experiment and reason out the result, somehow, by methods which I could not explain.”)

By the summer of 1879 Edison and Upton had made enough progress on a [generator](#)—which, by reverse action, could be employed as a motor—that Edison, beset by failed incandescent lamp experiments, considered offering a system of electric distribution for [power](#), not light. By October Edison and his staff had achieved encouraging results with a complex, regulator-controlled [vacuum](#) bulb with a [platinum](#) filament, but the cost of the platinum would have made the incandescent light impractical. While experimenting with an insulator for the platinum wire, they discovered that, in the greatly improved vacuum they were now obtaining through advances made in the vacuum pump, carbon could be maintained for some time without elaborate regulatory apparatus. Advancing on the work of [Joseph Wilson Swan](#), an English physicist, Edison found that a carbon [filament](#) provided a good light with the [concomitant](#) high resistance required for subdivision. Steady progress ensued from the first breakthrough in mid-October until the initial demonstration for the backers of the Edison Electric Light Company on December 3.

It was, nevertheless, not until the summer of 1880 that Edison determined that carbonized [bamboo](#) fibre made a satisfactory material for the filament, although the world’s first operative lighting system had been installed on the steamship *Columbia* in April. The first commercial land-based “isolated” (single-building) incandescent system was placed in the [New York](#) printing firm of Hinds and Ketcham in January 1881. In the fall a temporary,



Thomas Edison; lightbulb

Men making Thomas Edison's lightbulbs, illustration from *Scientific Americ...*[\(more\)](#)



demonstration central power system was installed at the Holborn Viaduct in [London](#), in [conjunction](#) with an exhibition at the [Crystal Palace](#). Edison himself supervised the laying of the mains and installation of the world's first permanent, commercial central power system in lower [Manhattan](#), which became operative in September 1882. Although the early systems were plagued by problems and many years passed before incandescent lighting powered by [electricity](#) from central stations made significant inroads into gas lighting, isolated lighting plants for such enterprises as [hotels](#), theatres, and stores flourished—as did Edison's reputation as the world's greatest inventor.

One of the accidental discoveries made in the Menlo Park laboratory during the development of the incandescent light anticipated British physicist [J.J. Thomson's](#) discovery of the [electron](#) 15 years later. In 1881–82 William J. Hammer, a young engineer in charge of testing the light globes, noted a blue glow around the positive pole in a vacuum bulb and a blackening of the wire and the bulb at the negative pole. This phenomenon was first called “Hammer's [phantom](#) shadow,” but when Edison patented the bulb in 1883 it became known as the “Edison effect.” Scientists later determined that this effect was explained by the [thermionic emission](#) of electrons from the hot to the cold electrode, and it became the basis of the [electron tube](#) and laid the foundation for the [electronics](#) industry.

Edison had moved his operations from Menlo Park to [New York City](#) when work commenced on the Manhattan power system. Increasingly, the Menlo Park property was used only as a summer home. In August 1884 Edison's wife, Mary, suffering from deteriorating health and subject to periods of mental derangement, died there of “congestion of the brain,” apparently a [tumour](#) or [hemorrhage](#). Her death and the move from Menlo Park roughly mark the halfway point of Edison's life.

The Edison laboratory

A widower with three young children, Edison, on February 24, 1886, married 20-year-old Mina Miller, the daughter of a prosperous [Ohio](#) manufacturer. He purchased a hilltop estate in [West Orange, New Jersey](#), for his new bride and constructed nearby a grand, new laboratory, which he intended to be the world's first true research facility. There, he produced the commercial [phonograph](#), founded the motion-picture industry, and developed the [alkaline](#) storage [battery](#). Nevertheless, Edison was past the peak of his productive period. A poor manager and organizer, he worked best in [intimate](#), relatively unstructured surroundings with a handful of close associates and assistants; the West Orange laboratory was too sprawling and diversified for his talents. Furthermore, as a significant portion of the inventor's time was taken up by his new role of industrialist, which came with the commercialization of incandescent [lighting](#) and the phonograph, electrical developments were passing into the domain of university-trained



Thomas Edison

Thomas Edison with a model for a concrete house, c. 1910.

mathematicians and scientists. Above all, for more than a decade Edison's energy was focused on a magnetic ore-mining venture that proved the unquestioned disaster of his career.

The first major endeavour at the new laboratory was the commercialization of the phonograph, a venture launched in 1887 after [Alexander Graham Bell](#), his cousin Chichester, and Charles Tainter had developed the graphophone—an improved version of Edison's original device—which used waxed cardboard instead of tinfoil. Two years later, Edison announced that he had “perfected” the phonograph, although this was far from true. In fact, it was not until the late 1890s, after Edison had established production and [recording](#) facilities [adjacent](#) to the laboratory, that all the mechanical problems were overcome and the phonograph became a profitable proposition.

In the meantime, Edison conceived the idea of popularizing the phonograph by linking it in synchronization a zoetrope, a device that gave the [illusion](#) of motion to photographs shot in sequence. He assigned the project to [William K.L. Dickson](#), an employee interested in [photography](#), in 1888. After studying the work of various European photographers who also were trying to record motion, Edison and Dickson succeeded in constructing a working [camera](#) and a viewing instrument, which were called, respectively, the [Kinetograph](#) and the [Kinetoscope](#). Synchronizing sound and motion proved of such insuperable difficulty, however, that the concept of linking the two was abandoned, and the [silent movie](#) was born. Edison constructed at the laboratory the world's first motion-picture stage, nicknamed the “Black Maria,” in 1893, and the following year Kinetoscopes, which had peepholes that allowed one person at a time to view the moving pictures, were introduced with great success. [Rival](#) inventors soon developed screen-projection systems that hurt the Kinetoscope's business, however, so Edison acquired a [projector](#) developed by Thomas Armat and introduced it as “Edison's latest marvel, the [Vitascope](#).”

Another derivative of the phonograph was the [alkaline](#) storage [battery](#), which Edison began developing as a power source for the phonograph at a time when most homes still lacked electricity. Although it was 20 years before all the difficulties with the battery were solved, by 1909 Edison was a principal supplier of batteries for [submarines](#) and electric vehicles and had even formed a company for the manufacture of [electric automobiles](#). In 1912 [Henry Ford](#), one of Edison's greatest admirers, asked him to design a battery for the self-starter, to be introduced on the [Model T](#). Ford's request led to a continuing relationship between these two Americans, and in



Thomas Edison

Thomas Edison (right) in his laboratory in West Orange, ...[\(more\)](#)



Vitascope

Advertisement for Thomas Edison's Vitascope.

October 1929 he staged a 50th-anniversary celebration of the incandescent light that turned into a universal [apothecosis](#) for Edison.



Britannica Quiz

Pop Quiz: 15 Things to Know About the Industrial Revolution

Most of Edison's successes involved [electricity](#) or [communication](#), but throughout the late 1880s and early 1890s the Edison Laboratory's top priority was the magnetic ore-separator. Edison had first worked on the separator when he was searching for [platinum](#) for use in the experimental [incandescent lamp](#). The device was supposed to cull platinum from [iron](#)-bearing [sand](#). During the 1880s iron ore prices rose to unprecedented heights, so that it appeared that, if the separator could extract the iron from unusable low-grade [ores](#), then abandoned [mines](#) might profitably be placed

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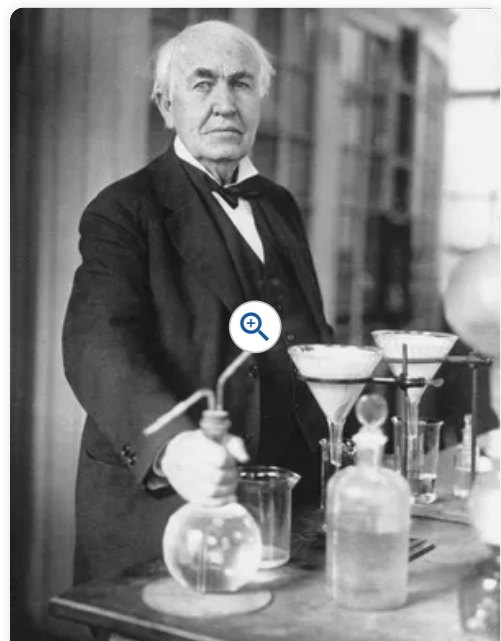
able to surmount the engineering problems or work the bugs out of the system, however, and when ore prices plummeted in the mid-1890s he gave up on the idea. By then he had liquidated all but a small part of his holdings in the [General Electric Company](#), sometimes at very low prices, and had become more and more separated from the electric lighting field.

Failure could not discourage Edison's passion for [invention](#), however. Although none of his later projects were as successful as his earlier ones, he continued to work even in his 80s.

Legacy

The thrust of Edison's work may be seen in the [clustering](#) of his patents: 389 for electric light and power, 195 for the [phonograph](#), 150 for the [telegraph](#), 141 for storage [batteries](#), and 34 for the [telephone](#). His life and achievements epitomize the ideal of applied research. He always invented for necessity, with the object of devising something new that he could manufacture. The basic principles he discovered were derived from practical experiments, invariably by chance, thus reversing the orthodox concept of pure research leading to applied research.

Edison's role as a [machine](#) shop operator and small manufacturer was crucial to his success as an inventor. Unlike other scientists and inventors of the time, who had limited means and lacked a support organization, Edison ran an inventive establishment. He was the [antithesis](#) of the lone inventive [genius](#), although his [deafness](#) enforced on him an isolation [conducive](#) to [conception](#). His lack of managerial ability was, in an odd way, also a stimulant. As his own boss, he plunged ahead on



Thomas Edison

Thomas Edison on his 75th birthday.

projects more prudent men would have shunned, then tended to dissipate the fruits of his inventiveness, so that he was both free and forced to develop new ideas. Few men have matched him in the positiveness of his thinking. Edison never questioned whether something might be done, only how.

Edison's career, the fulfillment of the American dream of rags-to-riches through hard work and [intelligence](#), made him a folk hero to his countrymen. In temperament he was an uninhibited egotist, at once a tyrant to his employees and their most entertaining companion, so that there was never a dull moment with him. He was [charismatic](#) and courted publicity, but he had difficulty socializing and neglected his family. His shafts at the expense of the "long-haired" fraternity of theorists sometimes led formally trained scientists to deprecate him as anti-intellectual; yet he employed as his aides, at various times, a number of eminent mathematical physicists, such as [Nikola Tesla](#) and [A.E. Kennelly](#). The contradictory nature of his forceful personality, as well as



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electronics



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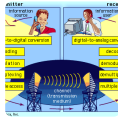
Multiplexing, [simultaneous](#) electronic transmission of two or more messages in one or both directions over a single transmission path, with signals separated in time or frequency. In [time-division multiplexing](#), different time intervals are employed for different signals. Two or more different signals may be transmitted in time sequence: the instantaneous amplitude of each signal is sampled and transmitted in sequence. When all signals have been sampled, the process is repeated. The sampling process is carried out rapidly enough to avoid loss of essential information in the signal.

In [frequency-division multiplexing](#), each message is identified with a separate subcarrier frequency; all of these subcarriers are then combined to modulate the carrier frequency. For wire transmission, the modulated subcarriers may be [transmitted](#) directly without the introduction of a carrier frequency.

Key People: [Thomas Edison](#)

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The subcarriers are separated at the receiver terminal by frequency selection and the original message signal recovered from the subcarrier.

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