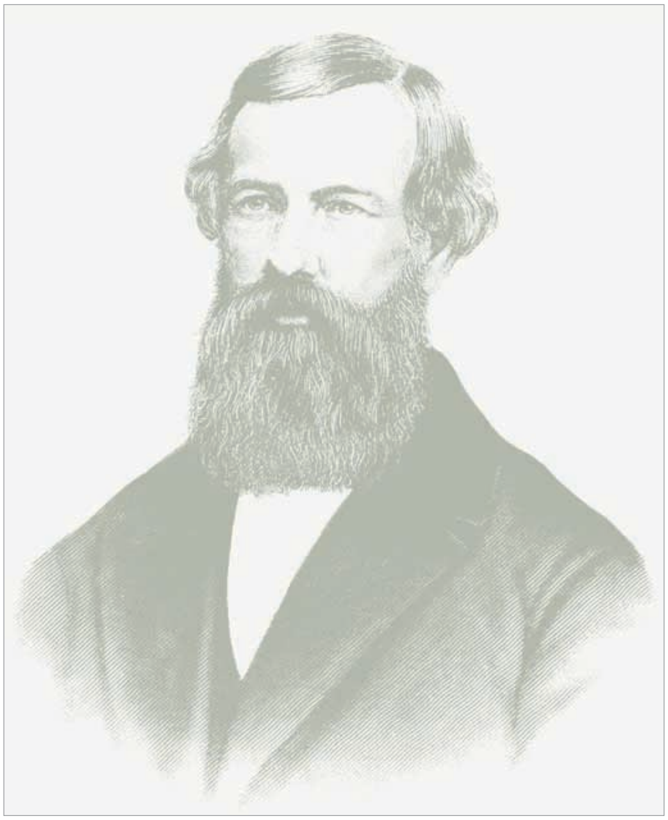
About Elevators

Moving the world

Imagine the skyline of a modern city if the elevator did not exist. Buildings would be limited to five or six stories. Most of the architecture of the 20th and 21st century would be impossible. Office towers, hotels and high-rise apartments would hardly stand in their present form. But in 1852, one man helped change the face of the world's cities. That was the year Elisha Graves Otis invented the safety elevator, giving rise to the modern skyline. To gain some idea of the effect of this one advancement, consider that today, elevators move the equivalent of the world's population every 72 hours.

Otis Elevator Company has been safely and efficiently moving people for 150 years. Today, Otis is the world's largest company in the manufacture and service of elevators, escalators, moving walks and people-moving equipment. With more than 1.2 million installations and 61,000 employees, Otis can be found almost anywhere around the globe.

By creatively applying new technologies, Otis Elevator Company continues to set precedents for ride quality, reliability and safety throughout the industry. This spirit of innovation, combined with outstanding customer service, has earned Otis elevators a prominent place in 10 of the world's 20 tallest buildings.



Elisha Graves Otis was born in 1811 on a farm in Halifax, Vermont. As a young man, he tried his hand at several careers, all with limited success. But, in 1852, his luck changed when his employer, the Bedstead Manufacturing Company, asked him to design a freight elevator.

Determined to overcome a fatal hazard in lift design, unsolved since its earliest days, Otis invented a safety brake that would suspend the car safely in the shaft if an elevator cable snapped. And the world's first safety lift was born.

A history of lifts, hoists and early elevators

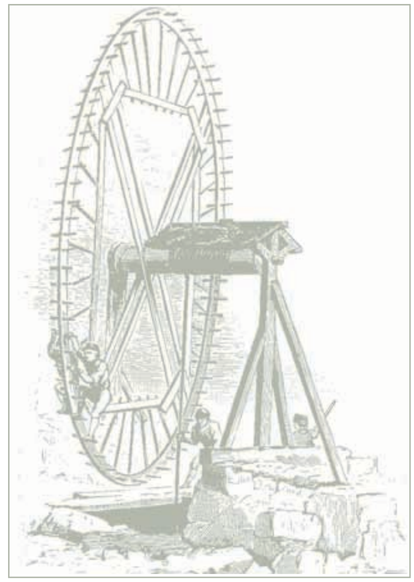
The need for vertical transport is as old as civilization. Over the centuries, mankind has employed ingenious forms of lifting. The earliest lifts used man, animal and water power to raise the load. Lifting devices relied on these basic forms of power from the early agricultural societies until the dawn of the Industrial Revolution.

In ancient Greece, Archimedes developed an improved lifting device operated by ropes and pulleys, in which the hoisting ropes were coiled around a winding drum by a capstan and levers.

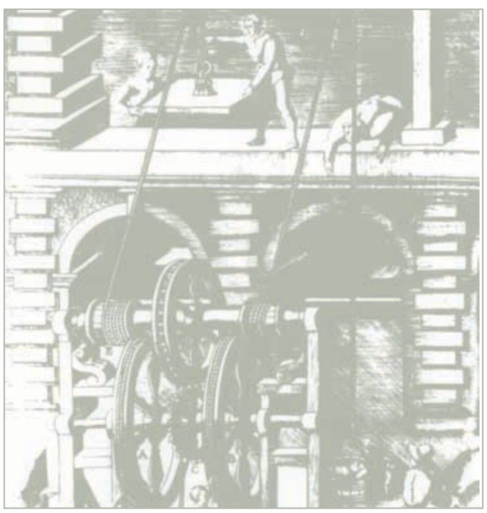
By A.D. 80, gladiators and wild animals rode crude elevators up to the arena level of the Roman Coliseum.

Medieval records contain numerous drawings of hoists lifting men and supplies to isolated locations. Among the most famous is the hoist at the monastery of St. Barlaam in Greece. The monastery stood on a pinnacle approximately 61 meters (200 ft) above the ground. Its hoist, which employed a basket or cargo net, was the only means up or down.

At an abbey on the French seacoast, a hoist was installed in 1203 that used a large tread wheel. A donkey supplied the lifting power. The load was raised by a rope wound on a large drum.



Manpower supplied the lifting force in many early devices.



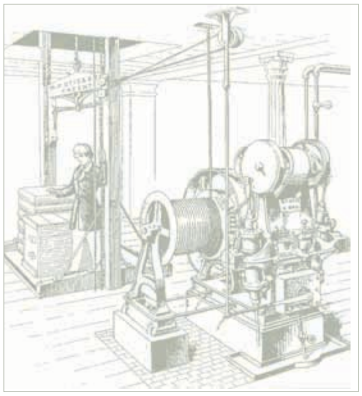
Gears and rachets were employed as more complex machinery became available, but the hazard posed if the lifting rope broke was always present.

By the 18th century, machine power was being applied to the development of the lift. In 1743, a counterweighted personal lift was commissioned by Louis XV in France for his personal chambers in Versailles. By 1833, a system using reciprocating rods raised and lowered miners in Germany’s Harz Mountains. A belt-driven elevator called the “teagle” was installed in an English factory in 1835. The first hydraulic industrial lift powered by water pressure appeared in 1846. As machinery and engineering improved, other powered lifting devices quickly followed.

Founded on safety

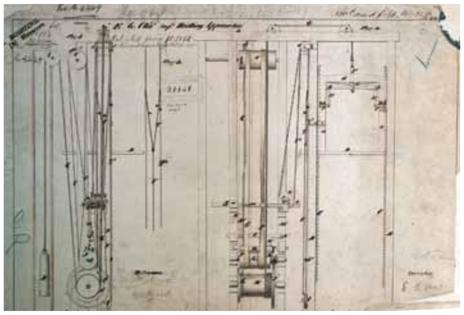
Despite these advances, one problem continued to trouble the elevator as it had since ancient times. There was no effective way to prevent the hoist from plummeting to earth if the lifting cable parted. This ever-present danger made elevators a risky proposition.

In 1852, Elisha Otis was working as a master mechanic at the Bedstead Manufacturing Company in Yonkers, New York. He was given the assignment to design a freight elevator to haul the company's products. Otis was aware of the inherent problem of cable failure and sought a solution that would eliminate the hazard.



The first Otis steam-powered elevator was installed in 1857.

In 1854, Elisha Graves Otis publicly demonstrated his safety elevator for the first time at the Crystal Palace Exposition in New York City.



The U.S. patent diagram for the Otis device that revolutionized the elevator industry—the world's first elevator safety brake. Since its invention, the core design of the safety brake has remained essentially unchanged.

He realized that some sort of safety brake was required. The brake had to function automatically the instant the cable broke if it were to save lives and property. Otis experimented by placing a wagon spring above the hoist platform. He then attached a ratchet bar to the guide rails on each side of the hoistway. The lifting rope was fastened to the wagon spring in such a way that the weight of the hoist platform exerted just enough tension on the spring to keep it from touching the ratchet bars. If the cable snapped, however, the tension would be released from the spring and it would immediately engage the ratchets, preventing the platform from falling.

In the meantime, financial problems had forced the Bedstead Company to close its doors. Otis was about to head west to take part in the Gold Rush when an unsolicited order for two of his "safety hoisters" arrived from a furniture manufacturer in New York. It seems two of its employees had been killed when a hoist rope had broken. The company wanted to prevent further tragedies.

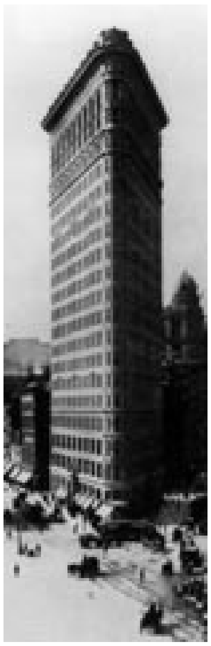
On September 20, 1853, Otis opened his own shop in part of the bankrupt Bedstead plant. In order to promote his new venture, Otis decided to stage a dramatic demonstration of his new safety elevator at the Crystal Palace Exposition in New York.

In the main exhibition hall, Otis constructed a complete safety elevator equipped with guide rails, ratchets, spring, platform and hoisting machinery. Otis had the hoist fully loaded with freight. As a crowd gathered, he climbed on board and ordered the platform raised to full height. The hoisting rope was cut with an axe. The crowd gasped. But before the platform could fall, the safety spring locked the lift in place as Otis reassured the startled crowd with the cry, "All safe, gentlemen. All safe."

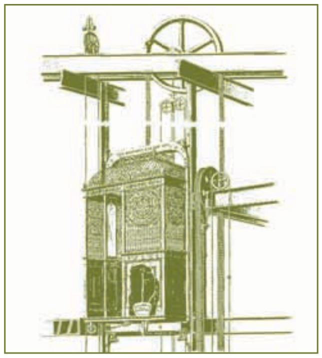
From that point on, sales climbed as customers began to associate the Otis Elevator Company with safety.

Innovation and refinement

Buildings in major American cities began rising above the sixth floor, taking advantage of the new opportunities provided by the safety elevator.



Built in 1902, New York's Flatiron Building was a landmark example of the rising urban skyline.



Early Otis passenger elevator car with toggle grip safety mechanism, steel safety frame and girdle.

E.V. Haughwout & Company store at Broadway and Broome Street in New York City, site of the world's first passenger safety elevator.

An engineering marvel of its day, the Eiffel Tower rose to a height of 300 meters (984 ft), served by elevators operating at a rate of more than 2 meters (6.5 ft) per second.

On March 23, 1857, the world's first passenger safety elevator went into service in a store at Broadway and Broome Street in New York City. The elevator was powered by steam through a series of shafts and belts.

As the safety and efficiency of the early elevators continued to improve, space in buildings' upper floors soon became more desirable, reversing a long-standing trend in commercial and residential leasing. By 1870, Otis Brothers & Company had revenues in excess of US$1 million. A couple of years later, there were no less than 2,000 Otis elevators in use.

The company continued to make technological advancements. In 1878, Otis introduced a hydraulic elevator that increased speeds to 244 meters (800 ft) per minute. That same year Otis installed its first hydraulic passenger elevator at 155 Broadway in New York City. The company also introduced a governor-operated safety device that would bring the car to a gradual stop in an emergency.

In 1889, Otis innovation produced another first with the direct-connected electric elevator machine. This worm-gear electric unit was primarily used for carrying freight. As better gearing arrangements were developed, the speed of the geared electric elevator increased from 30 to 120 meters (100 to 400 ft) per minute. This brought the electric elevator into passenger service in medium height buildings. Although it offered the advantage of a more compact installation, it was not yet fast enough to compete with the steam-powered hydraulic systems in the taller buildings. But major breakthroughs were not far off.

The rise of the modern elevator

As buildings began to rise to ever-greater heights, so did the need for elevators to meet these new demands. Otis continued to keep pace by meeting these challenges with ongoing innovation.

Gearless traction electric elevators

In 1903, Otis introduced the design that would become the standard in the elevator industry. The gearless traction electric elevator could be employed in buildings of any height and operated at much higher speeds than steam-powered elevators. The first ones were installed in the Beaver Building in New York City, and the Majestic Building in Chicago.

This design has proven so durable that even now, when a building is modernized—while the elevator control system is replaced with the most up-to-date electronics—it is rarely necessary to replace a well-maintained gearless machine. These elevators typically operate at speeds greater than 500 feet per minute.

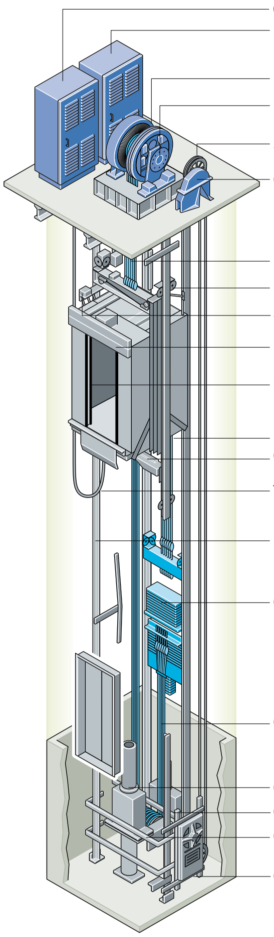
In a gearless traction machine, six to eight lengths of wire cable, known as hoisting ropes, are attached to the top of the elevator and wrapped around the drive sheave in special grooves. The other ends of the cables are attached to a counterweight that moves up and down in the hoistway on its own guiderails.

The combined weight of the elevator car and the counterweight presses the cables into the grooves on the drive sheave, providing the necessary traction as the sheave turns.

To reduce the load on the motor, the counterweight is calculated to match the weight of the car and a half-load of passengers. As the car rises, the counterweight descends, balancing the load. This reduces energy consumption because the motor is required to lift no more than the weight of half a car load at any time.

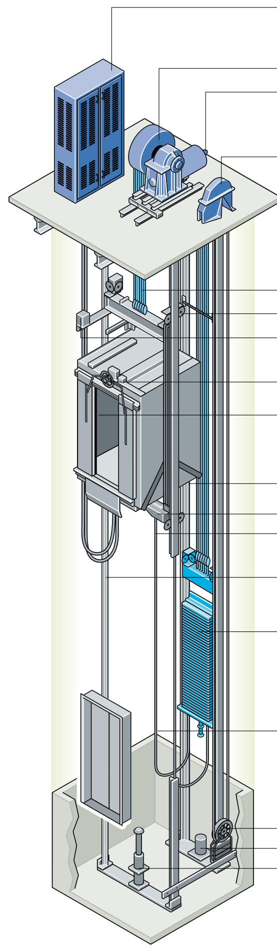
The grooved sheave in this traditional gearless system is quite large, from 0.6 to 1.2 meters (2–4 ft) in diameter. The electric motor that runs it must be powerful enough to turn this large drive sheave at 50–200 revolutions per minute in order to move the elevator at the proper rate.

Safety is provided by a governing device that engages the car's brakes, should the elevator begin to fall. A powerful clamp clutches the steel governor cable, which activates two safety clamps located beneath the car. Moveable steel jaws wedge themselves against the guiderails until sufficient force is exerted to bring the car to a smooth stop.



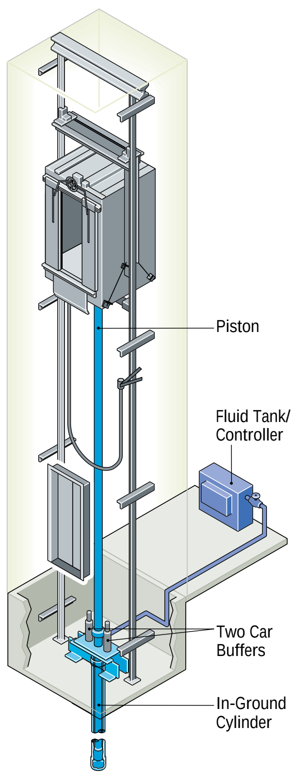
Geared traction elevators

As the name implies, the electric motor in this design drives a worm-and-gear-type reduction unit, which turns the hoisting sheave. While the lift rates are slower than in a typical gearless elevator, the gear reduction offers the advantage of requiring a less powerful motor to turn the sheave. These elevators typically operate at speeds from 38 to 152 meters (125-500 ft) per minute and carry loads of up to 13,600 kilograms (30,000 lb). An electrically controlled brake between the motor and the reduction unit stops the elevator, holding the car at the desired floor level.

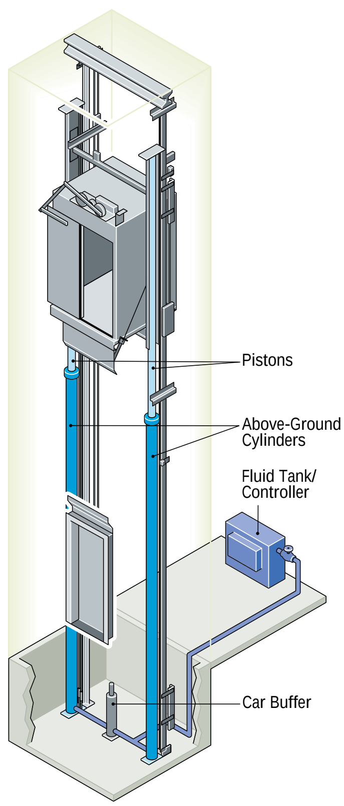


Hydraulic elevators

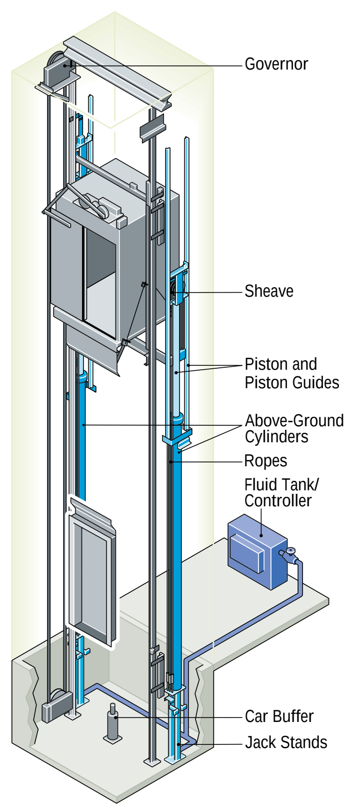
Hydraulic elevators are used extensively in buildings up to five or six stories high. These elevators—which can operate at speeds up to 46 meters (150 ft) per minute—do not use the large overhead hoisting machinery the way geared and gearless systems do. Instead, a typical hydraulic elevator is powered by a piston that travels inside a cylinder. An electric motor pumps oil into the cylinder to move the piston. The piston smoothly lifts the elevator cab. Electrical valves control the release of the oil for a gentle descent.



With holed hydraulic systems, the elevator car is mounted on a piston that travels inside a cylinder. The cylinder extends into the ground to a depth equal to the height the elevator will rise. As hydraulic fluid is pumped into the cylinder through a valve, the car rises. As the fluid returns to the reservoir, the car descends.



In some instances, bedrock, a high water table or unstable soil conditions can make digging the hole required for a conventional hydraulic elevator impractical. The holeless hydraulic elevator solves this problem with pistons mounted inside the hoistway to raise and lower the car.



The roped hydraulic elevator extends the rise of the holeless elevator to 18 meters (60 ft), without the need for a below-ground cylinder.

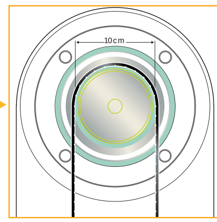
Machine roomless elevators

This revolutionary elevator system is based on the first major breakthrough in lifting technology in nearly 100 years. Designed initially for buildings between 2 and 20 stories, this system employs a smaller sheave than conventional geared and gearless elevators. The reduced sheave size, together with a redesigned motor, allows the machine to be mounted within the hoistway itself—eliminating the need for a bulky machine room on the roof.

Otis' machine roomless elevator features unique, flat polyurethane-coated steel belts instead of the heavy woven steel cables that have been the industry standard since the 1800s. The belts are about 30 mm wide (1 inch) and only 3 mm (0.1 inch) thick, yet they are as strong as woven steel cables while being far more durable and flexible. The thinness of the belts makes for a smaller winding sheave, reducing the space required for the machine in the hoistway.

The traditional rope wraps steel cords around a flexible core.

The new flat belt wraps a flexible polyurethane coating around steel cords...



...which allows for a smaller sheave diameter...

...making possible a more compact elevator system...

...and a range of important benefits.

Since its founding, Otis has continued to meet the needs of architects and building owners with an increasing array of elevator options.

Observation elevator

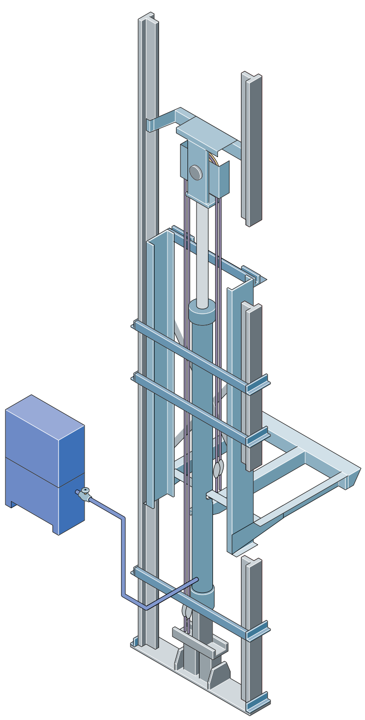
The observation elevator puts the cab on the outside of the building. Glass-walled elevator cars allow passengers to view the cityscape or the building's atrium as they travel. By eliminating the hoistways, the observation elevator also offers owners, architects and builders valuable space-saving advantages.

Double-deck elevator

Double-deck elevators save time and space in high-occupancy buildings by mounting one car upon another. One car stops at even floors and the other stops at the odd floors. Depending on their destination, passengers can mount one car in the lobby or take an escalator to a landing for the alternate car.

Sky lobby

In very tall buildings, elevator efficiency can be increased by a system that combines express and local elevators. The express elevators stop at designated floors called sky lobbies. There, passengers can transfer to local elevators that will take them to their desired floor. By dividing the building into levels served by the express elevators, the local elevators can be stacked to occupy the same shaft space. That way, each zone can be served simultaneously by its own bank of local elevators.



Freight elevators

These elevators are specially constructed to withstand the rigors of heavy loads. Standard capacities range from 1360 kilograms (3000 lb) up to 5440 kilograms (12,000 lb). These elevators are rated according to load categories, with Class “A” being for hand trucks, Class “B” for carrying automobiles and Class “C1” for elevators with the capacity to carry a commercial truck.

Residential elevators

Residential elevators use modern hydraulics to produce a smooth, quiet ride while occupying a minimum amount of space. These hydraulic systems are quiet, producing about the same amount of sound as a typical refrigerator, which makes them well suited for residential use. They can be operated at any hour without causing disturbance. The compact design allows the elevator to be installed in the amount of space required for an average-sized closet.

Safety, quality and reliability

Safety and reliability have been the foremost concerns of the company since its earliest days.

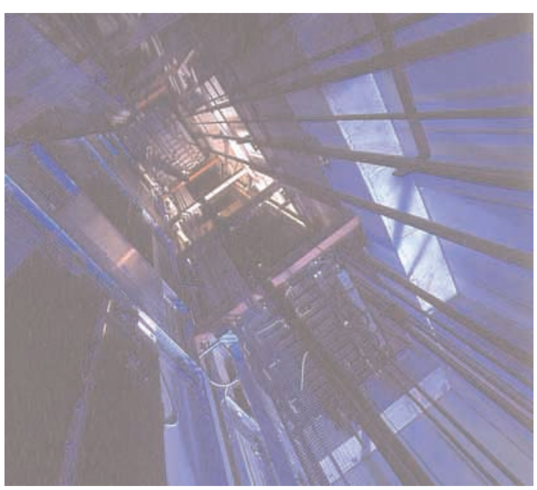
Today, Otis has one of the best safety records in the vertical transportation industry. The company works constantly to improve the safety of existing products and to develop safer technologies for new products. Otis emphasizes a corporate policy of “safety first” and implements standardized procedures to ensure that every installation and service task is performed the safest way, every time.

Otis products undergo stringent quality and safety testing at its testing facilities around the world.

Otis operates the world’s tallest elevator test tower in Shibayama, Japan. This test tower stands 154 meters (505 ft) above ground and 27 meters (89 ft) below ground.

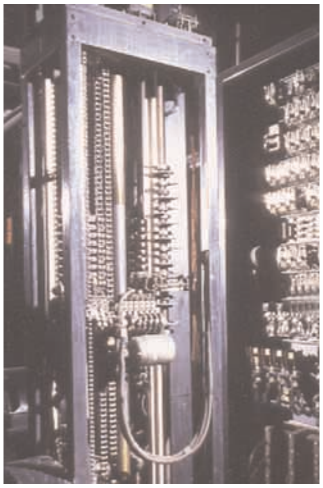
The Bristol Research Center in Bristol, Conn., USA is home to the Otis Quality Assurance Center and North America’s tallest elevator test tower—117 meters (383 ft) in height.

These facilities stand as another symbol of our commitment to quality and safety. Together, they offer unmatched testing capabilities that ensure the performance, safety and reliability of the entire line of current and future Otis products. We perform more than 20 advanced tests on every piece of Otis equipment, including tests that mimic worst-case operating conditions and ones that simulate the rough ride our products might have during the journey from Otis facilities to installation sites worldwide.



Continuing innovation

Otis was founded on the strength of a new idea and we haven't stopped developing new ideas since our founding 150 years ago. Our long list of firsts is a testament, not only to the company's innovative spirit, but also to our dedication to meeting the changing needs of our customers.



Mechanical selectors use analog controls and many moving parts to determine the car's position, requiring constant and often costly maintenance.

Breakthroughs in computer technology continue to enhance the quality and reliability of modern elevators. Beginning in 1979 with Otis' Elevonic® 101 system, the power of microprocessors has been increasingly employed to control every aspect of elevator operation.

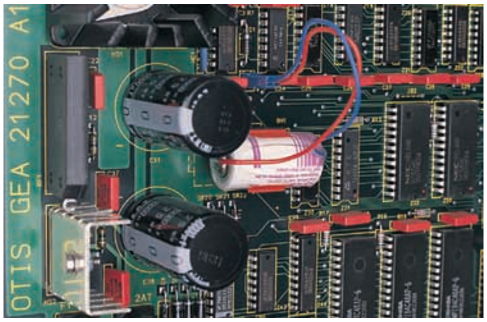
Automatic controls

As passengers step on and off an elevator, the load constantly changes, making it difficult to keep the platform level with the floor. Otis solved this problem as far back as 1915 with a self-leveling device called Microdrive. First developed for lifts in naval vessels, Otis introduced it as a safety device in passenger elevators. It also saved time and improved the ride quality for passengers as the leveling operation was automatic.

Judging when to slow the cab was easy enough for an operator when speeds were between 91–121 meters (300–400 ft) per minute. But when speeds increased to over 213 meters (700 ft) per minute, this became too difficult. The logical step was to automate the control system. In 1924, Otis installed its first Signal Control System in the new Standard Oil Building in New York City. The system automatically controlled acceleration, speed between floors and deceleration as the car approached the landing.

In 1937, the Peak Period Control was introduced to automatically schedule elevator service during high-demand periods. It helped reduce the waiting time on any given floor by coordinating the movement of the building's elevators.

Electric door safeguards and more sophisticated dispatching systems followed, allowing elevators to become fully automatic.

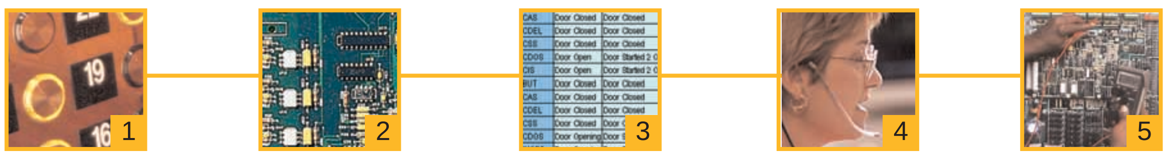


Electronic controls

Otis has steadily applied breakthroughs in computer technology to enhance the quality and reliability of its elevators. Beginning in 1979 with its Elevonic® 101 system, Otis has increasingly employed the power of microprocessors to control every aspect of elevator operation.

Remote elevator monitoring

The REM® system identifies many problems before they occur by detecting failing components and intermittent anomalies that might have gone undetected until they caused a service disruption. Intermittent problems can be addressed before they cause a loss of service. If the REM system detects an urgent issue, the system alerts the appropriate dispatching center and mechanics are sent to repair it and restore service. REM service has been continuously advancing in performance and capabilities since its introduction in the mid-1980s. The latest developments allow REM data to be transmitted directly over the Internet.



1. Diagnostic software monitors equipment continuously and sends data to the REM unit in the machine room.
2. The REM unit sends this information to the OTISLINE® center.
3. Data is prioritized and reviewed by OTISLINE specialist.
4. An OTISLINE specialist alerts the technician if necessary.
5. The technician arrives at the job site with specific information, tools and parts to work on the equipment.

Internet service

e*Service combines REM data with technicians' reports to give customers access to information about their elevators and escalators directly over the Internet. Internet monitoring through e*Service helps customers to better manage their buildings by giving them access to reports showing trends in uptime, service call types and technicians' documentation—anytime, anywhere.

Telecom links

Centralized communications services such as the OTISLINE® center create vital links among elevator service professionals, building managers and the equipment itself. These telecom services can wirelessly contact emergency technicians, immediately notifying them of a problem and its location. The centralized communications hub features a 24-hour service network available to customers regardless of location. With one call, a problem can be identified, a mechanic dispatched, and replacement parts located and rushed to the site.

‘Fast-forward’ to the future

Elevators have become an integral part of the world’s cities. As building technologies evolve and new issues emerge, Otis will continue to anticipate the future by focusing the resources of its worldwide research and development teams on the search for new solutions.

Right now, Otis is applying cutting-edge computer and communications technology to every aspect of its global service. REM® monitoring, e*Service and the OTISLINE® center are just the beginning.

Otis continues to modernize existing installations with the most up-to-date technology available. And our ongoing maintenance programs take full advantage of Otis innovations in data reporting, troubleshooting and inspection equipment.

Since its founding, Otis has pursued innovation. As we move forward, Otis will continue to engineer products that carry people into the future.