One of the foremost figures in the complex history of television is Vladimir Zworykin, who invented the "iconoscope," "kinemascope," and "storage principle" that became the basis of TV as we know it.

Born in 1889 in Murom, Russia, 200 miles east of Moscow, Vladimir Kosma Zworykin began his career in electrical engineering at the age of nine, repairing equipment on his father’s riverboats. His formal career began at the Imperial Institute of Technology in St. Petersburg (1908), where he had the good fortune to work with Boris Rosing, the Director of the school’s labs.

The idea of sending images by wire had been tantalizing scientists since 1839. The earliest mechanical television systems, like the one patented by the German Paul Nipkow in 1884, projected light onto a light-sensitive area through a series of holes cut near the rim of a spinning disc. In 1897, another German, Karl Braun, invented the cathode ray oscilloscope, in which magnetic fields directed the rays onto a fluorescent material at the end of a tube. By the time Zworykin graduated with honors in Electrical Engineering (1912), he had assisted Rosing in developing (1907) and exhibiting (1910) a primitive but successful hybrid television system that used the mechanical Nipkow disc as a camera and Braun's electronic cathode ray tube as a receiver.

Further improvements to the pair’s system were soon interrupted by the incipient Russian Revolution. Rosing went into exile and died. Zworykin made his way to Paris (1912), where he did work in x-rays and theoretical physics before emigrating to the US (1919). For ten years, he worked at Westinghouse's labs in Pittsburgh. In 1923, Zworykin won his first television system patent; but his superiors at Westinghouse told him to stop wasting his time on such impractical pursuits. Zworykin continued his television work on his own time, and produced both the "kinescope," a more sophisticated cathode-ray picture tube, and the "iconoscope," the first all-electronic camera tube.

He demonstrated his all-electronic system at a convention of radio engineers in 1929. In attendance was David Sarnoff, an RCA executive who since the early 1920s had been predicting that "every farmhouse" would soon have a television. Hearing from Zworykin that he would need $100,000 and 18 months to produce a marketable television, Sarnoff recruited him on the spot, to be Director of RCA's Electronic Research Lab in Camden, New Jersey.

In the event, it took Zworykin and RCA $50 million and ten years. Meanwhile, companies the world over were developing cathode-ray-based television. The most formidable competitor was Philo Farnsworth, whose 1930 patent for an all-electronic TV would force RCA to pay $1 million in licensing fees in the 1940s. But by that time, Zworykin's system had won the race to the public. RCA introduced television to the masses at the World's Fair in New York City in 1939; in fact, the Fair's opening ceremonies, with President Franklin D. Roosevelt presiding, were telecast locally ten days later by the newly formed National Broadcasting Company (NBC).

The Second World War (1939-45) effectively halted the spread of television: in 1946, there were only about 7,000 TV sets in American homes. By 1950, however, there were 10,000,000; and most of them, whether manufactured by RCA or others, used the same basic technology as Vladimir Zworykin's 1939 model. Even today, each of the 605 million TV sets in use world-wide gets its picture from what is essentially the "kinescope."

http://web.mit.edu/invent/index.html
LEGOs

Danish carpenter Ole Kirk Christiansen created in the first half of the 20th century one of the most beloved toys of all time, enjoyed the world over by millions of children and quite a few adults as well. Those toys are the building blocks known as LEGO's.

Christiansen was born in 1891 in Filskov, Denmark, a small village north of the Danish town of Billund. He was educated as far as high school, and then began working in a factory, eventually becoming a woodworker and master carpenter. He set up his own business in Billund in 1932. Among the products he made were stepladders, ironing boards and wooden toys – which would become his specialty. Toys, especially wooden blocks, were, in fact, the business’s most successful product. In 1934, the company adopted the name “LEGO,” from the Danish words “Leg Godt,” or “play well.” ( Appropriately, Lego also means “I study,” or “I put together” in Latin).

In 1944, Christiansen’s factory burned down, but he rebuilt in 1947 and picked up where he left off. This time, however, his business was dedicated to toys. The company became the first in Denmark to buy a plastic molding machine. By 1949, it was producing some 200 different wooden and plastic toys. LEGO’s Automatic Binding Bricks, however, were still made of wood at that time, and they were available only in Denmark. They became very popular there, but they really took off once Christiansen began making them out of brightly colored plastic.

Christiansen’s son, Godtfred Kirk Christiansen, had begun working alongside his father in 1942. In 1950, he was named Junior Vice President of the company. It was he who conceived of the idea of developing Lego blocks into a total “system of play.” By 1953, LEGO started marketing complete plastic block sets and in 1954, they obtained a trademark for the product, which they renamed “LEGO Mursten” or “LEGO Bricks.”

The company officially launched the “LEGO System of Play” in 1955, which comprised 28 different sets and eight toy vehicles. LEGO patented the bricks’ “stud-and-tube coupling system” in 1958. That year, founder Christiansen died. His son Godtfred immediately took the LEGO helm.

Legos continued to gain popularity, with more themed toy sets and building-block variations added all the time. The first LEGO sets were sold in the United States in 1961. By 1966, offerings included bricks that could form all sorts of buildings, vehicles and backdrops. A larger version of the blocks, DUPLO, was added in 1967, designed for younger children and toddlers. In 1977, LEGO introduced TECHNIC projects for older kids and teens. Over the years the company added all sorts of themed Lego sets, even robotic building sets branded LEGO Mindstorms, model vehicle kits and computer games.

Additionally, LEGO opened a series of theme parks based on the Lego toy concept, the first in Billund in 1968. Others opened in Windsor, England in 1996 and in Carlsbad, California in 1999. Most recently, a fourth park opened in 2002 in Günzburg, Germany. The parks continue to be immensely popular with people of all ages, especially parents and their children.

Ole’s grandson, Kjeld Kirk Kristiansen, later became CEO of the company and maintained that position until October 2004 when he was replaced by the company’s first non-family chief executive. LEGO has been a pioneer in using its products to advance research in learning and play. Initiatives include the LEGO Learning Institute, the LEGO Educational Division, collaboration with MIT’s Media Lab, and LEGO Serious Play, a product designed to help business owners to develop innovative strategies and solutions. The company has sold Lego toys in 130 countries, with sales totaling more than $1.5 billion.

http://web.mit.edu/invent/index.html
The fine details surrounding the invention of one of the United States' favorite snack foods are somewhat hazy, but all signs point to a man named George Crum, a cook and restaurateur who is said to have come up with the idea for the tasty crisp.

Born George Speck in 1822 in Saratoga Lake, New York, Crum was the son of an African American father and Native American mother, a member of the Huron tribe. He professionally adopted the name "Crum" as it was the name his father used in his career as a jockey. As a young man, Crum worked as a guide in the Adirondack Mountains and as an Indian trader. Eventually he came to realize he possessed exceptional talent in the culinary arts.

In the summer of 1853, he was working as a chef at Saratoga Springs' elegant Moon Lake Lodge resort, where French-fried potatoes were a favorite on the menu. This preparation for potatoes, in which the tubers are cut lengthwise, lightly fried, and eaten with a fork, is said to have become popular in the 1700s. Thomas Jefferson, having enjoyed them in France during his service as an ambassador to that country, is known to have introduced them to local folks at home and liked to eat and serve them frequently.

As the story goes, Crum, whose sister Kate worked alongside him as a prep cook, became agitated when a customer sent his French-fried potatoes back to the kitchen complaining that they were cut too thickly. Crum, by all accounts somewhat of an ornery and at times sarcastic man, reacted by slicing the potatoes as thin as he possibly could, frying them in grease, and sending the crunchy brown chips back out on the guest's plate that way.

The reaction was unexpected: The guest loved the crisps. In fact, other guests began asking for them as well, and soon Crum's "Saratoga Chips" became one of lodge's most popular treats.

In 1860, Crum opened his own restaurant, "Crumbs House," near Saratoga Lake where he catered to an upscale clientele. Guests are said to have included the likes of William Vanderbilt, Cornelius Vanderbilt and Jay Gould. One of the restaurant's attractions was that a basket of potato chips was placed on every table.

Crum never patented or attempted to widely distribute his potato chips; nevertheless they were soon on their way to becoming an international phenomenon via a number of aspiring snack food entrepreneurs around the country. Crum closed his restaurant in 1890. He died on July 22, 1914, at the age of 92.

Meanwhile, in 1895, a man by the name of William Tappendon began making potato chips for sale to local grocery stores, at first in his kitchen and later in a makeshift factory behind his house. This marked the first attempt by any person to put potato chips onto grocery store shelves. Others followed his lead, including the Hanover Home Potato Chip company out of Hanover Penn., established in 1921. Soon grocers in numerous areas around the United States were selling chips in bulk, from barrels, or out of glass display cases.

In 1926, Laura Scudder came up with the concept of putting potato chips into wax paper bags, and the "bag of chips" concept was born. In 1932, Herman Lay founded Lay's in Nashville, Tenn. His potato chips became the first successfully marketed national brand. Phenomenal success followed for him and for scores of other potato chip makers. Today, retail sales of potato chips in the United States alone top $6 billion per year.

http://web.mit.edu/invent/index.html
The computer mouse

Years before personal computers and desktop information processing became commonplace or even practicable, Douglas Carl Engelbart had invented a number of interactive, user-friendly information access systems that we take for granted today: the computer mouse, windows, shared-screen teleconferencing, hypermedia, groupware, and more.

Born in 1925, Engelbart grew up during the Great Depression near Portland, Oregon. He finished high school in 1942, and then studied electrical engineering at Oregon State University. During World War II, he took a break from his studies to serve in the Navy, which sent him to the Philippines for two years as an electronic/radar technician. In 1948 he received his B.S. degree in electrical engineering and went to work for NACA Ames Laboratory (forerunner of NASA). He then applied to the graduate program in electrical engineering at the University of California, Berkeley and obtained his Ph.D. in 1955. He stayed on at Berkeley as an acting assistant professor but a year later he left to work for Stanford Research Institute, or SRI Intl.

At SRI, Engelbart earned a dozen patents in two years, working on magnetic computer components, fundamental digital-device phenomena, and miniaturization scaling potential. In 1962 he published his seminal work, "Augmenting Human Intellect: A Conceptual Framework," under contract prepared for the Director of Information Sciences of the U.S. Air Force Office of Scientific Research. This outlined his visionary ideas for using computers to complement humans' intelligence. Many shrugged off his ideas at the time; for most it was too difficult to grasp what he was describing because the concepts were too futuristic.

At the Fall Joint Computer Conference in San Francisco in 1968, Engelbart astonished his colleagues by demonstrating a computer system called NLS (oNLine System) using a "primitive" 192-kilobyte mainframe computer located 25 miles away to demonstrate hypermedia, on-screen video teleconferencing, and a device he called an "X-Y Position Indicator for a Display System." This device would later become known worldwide as the indispensable computer mouse. Engelbart's presentation at the conference was met with a standing ovation.

Now, years later, his inventions have been integrated into mainstream computing as industry capabilities have increased. It was not until 1984 that the Apple Macintosh popularized the mouse; but today it is difficult to imagine a personal computer without one. And the huge success of Microsoft's Windows system proves that Engelbart's original windows concept has also become a virtual necessity.

Engelbart continued to direct SRI's Augmentation Research Center until 1978 when the lab was closed down for lack of funding. NLS then became the principal line of business in Tymshare's Office Automation Division under the name Augment. In 1984, Tymshare was acquired by McDonnell Douglas Corporation, which terminated Engelbart's laboratory in 1989.

That year Engelbart founded the Bootstrap Institute in Palo Alto, Calif. with his daughter, and he has worked for the non-profit research and development organization ever since. He devotes his time to R&D, consulting, publications, speaking engagements, seminars and workshops, and he is working with a team of volunteers on designing of a prototype open-hyperdocument system (OHS), which he hopes may one day replace paper record keeping entirely.

Engelbart has authored over 25 publications, earned more than 20 patents, and received many honors, including the 1997 Lemelson-MIT Prize. In 2000, he was awarded the National Medal of Technology from President Clinton. In a talk delivered at MIT in 1996 Bill Gates praised Engelbart for his pioneering work, and Byte magazine, in an article honoring the 20 persons who have had the greatest impact on personal computing (September 1995), compared him to Thomas Edison.

http://web.mit.edu/invent/index.html
Aspirin

No doctor's office or medicine cabinet is complete without a supply of aspirin, the world's most popular and in many ways miraculous painkiller. This multi-purpose drug was first stabilized and patented during a three-year span from 1897-1900 by Felix Hoffman, a chemist with Friedrich Bayer & Co. in Germany.

Born on January 21, 1868, in Ludwigsburg, Germany, Hoffman studied pharmacy and chemistry at the University of Munich from where he graduated in 1893 with a doctoral degree. In 1894 he began working as a chemist for Bayer in Elberfeld, Germany. His father's suffering from the pain of arthritis inspired him to seek a chemical substance that could safely treat everyday pain.

Hoffman began studying historical records and research related to pain treatment, including works by Hippocrates, a Greek physician who lived approximately 400 B.C. Documentation showed that medicines made from the bark and leaves of willow trees had been used since that time to treat pain and fever, and much later, in the early 19th century, a substance known as salicin found in willow plants was identified as the compound that had the power to relieve pain.

Between 1800 and 1835, chemists in Germany, France and Italy were able to extract salicin, convert it into salicylic acid, and purify it for human consumption, but in this form it was very harsh on people's stomachs. Later, in 1853, French researcher Charles Frederic Gerhardt is known to have found a way to neutralize it to some extent by combining it with sodium and acetyl chloride. His research stopped there, however. No resulting product was ever fully developed.

In 1897, Hoffman rediscovered Gerhardt's experiments and studied them carefully. He conducted similar experiments of his own. He sought a stable, buffered version of salicylic acid that his company would be able to commercialize on a grand scale. On August 10, 1897, he succeeded with this endeavor: By combining acetylsalicylic acid with acetic acid, he created acetylsalicylic acid, or ASA, with the right characteristics for consumer use. The substance had the ability to relieve fever, pain and inflammation, all without upsetting the patient's stomach. Hoffman is said to have tested versions of the product on his father to find the safest and most effective solution. ASA worked best.

Bayer trademarked the name "Aspirin" in 1899 and quickly began a worldwide marketing campaign. Hoffman was promoted to director of pharmaceutical marketing. Bayer named the product using "A" for acetyl chloride, "spir" for spiraea ulmaria, the latin name for the plant they derived salicylic acid from, and "in" as a popular suffix for medicines.

First Bayer began distributing aspirin to doctors to give to their patients in a powdered formula. In 1900 Bayer introduced water-soluble tablets, representing the first-ever medication to be sold in this form. In 1915, prescriptions for aspirin became unnecessary. Before long, aspirin was the most popular drug in the world.

Germany refused to award a patent for the development of ASA, but the United States disagreed, granting a patent to Hoffman and the Bayer Co. on Feb. 27, 1900 (Patent No. 644,077). This gave Bayer a monopoly on aspirin from 1900 to 1917, after which rights were given up as part of Germany's concessions included in the Treaty of Versailles following World War I. Hoffman, meanwhile, lived a quiet life in spite of his groundbreaking discovery. He never made significant financial gains from it, but aspirin changed millions of lives around the world and fast became a staple in the over-the-counter drug market. Hoffman died in Switzerland on Feb. 8, 1946.

It wasn't until 1971 that the secrets of some of aspirin's mysterious powers finally came to light. That year, scientist John Vane concluded that a chemical in aspirin blocked pain by inhibiting the development of prostaglandins, which play a role in stimulating processes in the body that lead to inflammation and the brain's telling a site to feel pain. Vane was awarded the Nobel Prize for Medicine for work related to this discovery in 1982.

Additionally, aspirin was shown to help prevent heart attacks via research presented by Dr. Lawrence Craven in 1948, leading to the FDA's decision 50 years later, in 1998, to expand the use of aspirin to include reducing risk of death during a suspected heart attack, as well as for preventing a recurrent stroke. Aspirin today finds a multitude of uses, including the treatment of migraines, muscle pain and inflammation, arthritis and even some cancers. In the United States alone, men, women and children are estimated to ingest at least 15 million aspirin tablets per year.

http://web.mit.edu/invent/index.html
Trampoline

Blairstown, Iowa native George Nissen invented a device loved by tumblers, athletes, adults and children around the world—the trampoline. He holds more than 40 patents related to sports and fitness and has been a tireless promoter of the trampoline and its myriad uses throughout his life.

Born in 1914, Nissen began training in gymnastics as a child, tumbling on his junior high school tumbling team and a local YMCA team when he was in high school. At the Y he also became adept at diving. These experiences followed him to circus performances he attended with his family. There he saw that the trapeze artists would fly through the air, dropping at the end of an act into safety netting that would send them rebounding up into somersaults or other stylish moves. Nissen realized that a similar setup for gymnasts would allow them to perform complex moves like that too similar to the moves that divers do, only they would be able to rebound again and again and do more and more tricks.

At 16 yrs. old, Nissen finished high school and set out to develop a bouncing apparatus. Working in his parents’ garage using steel materials he found at a junkyard, he built a rectangular frame with a piece of canvas stretched across it. While in college at the University of Iowa, he built his first successful rig and brought it to a summer camp, where he and his friends had jobs as camp counselors. It was an instant hit. Nissen was sure he could commercialize it.

Meanwhile, he began competing for his college in gymnastics and was a three-time winner of the intercollegiate national championship. He completed his bachelor’s degree in business in 1937. Shortly thereafter, he and two friends began a traveling acrobatics act called the Three Leonardos. Using Nissen’s bouncing machine, they performed in Texas and in Mexico, and it was there that Nissen learned of the Spanish word for diving board: el trampolin. He registered “Trampoline” as a trademark for his bouncing rig.

The Three Leonardos became popular attractions at school assemblies and used these opportunities to introduce people to the trampoline and attract interest in it. Orders began coming in, slowly at first. Nissen was soon on his own with the company. When World War II began, resources were scarce and orders were scarcer. But he thought this might also be an opportunity: he began pitching his trampolines as training tools for the military. He convinced officials that this device could help parachutists, pilots, and divers in particular to help them learn to physically control themselves and orient themselves in space. He sold more than 100 trampolines, most of them with an improved design using nylon instead of canvas.

In 1943, Nissen joined the Navy. After the war, he incorporated his business, the Nissen Trampoline Corporation, and began heavily promoting the trampoline. National “rebound tumbling” competitions began to take place in 1947. He married Annie, a Dutch acrobat, in 1950, and established a branch of his company in England in 1956. He traveled all over the world to promote the sport of rebound tumbling and watched the trampoline market grow—soon there were more than 50 manufacturers of devices similar to his.

Nissen created games incorporating the trampoline such as Spaceball, which became very popular in the 1960s. He also broadened his product line, including gymnastic equipment such as balance beams and parallel bars. He acquired a number of patents on improvements to these types of items. His company was sold and eventually ceased to exist in the 1980s, but he continued to invent, with creations such as the Bunsaver Air Cushion, an inflatable cushion designed for spectators to use on the bleachers at sporting events; and the Laptop Exercycle, for passengers to use for exercise while traveling on long airplane flights. He currently lives in San Diego, Calif.

http://web.mit.edu/invent/index.html
The Digital Compact Disc

The digital compact disc, now commonplace in stereos and computers, was invented in the late 1960s by James T. Russell.

Russell was born in Bremerton, Washington in 1931. At age six, he invented a remote-control battleship, with a storage chamber for his lunch. Russell went on to earn a BA in Physics from Reed College in Portland in 1953. Afterward, he went to work as a Physicist in General Electric's nearby labs in Richland, Washington.

At GE, Russell initiated many experimental instrumentation projects. He was among the first to use a color TV screen and keyboard as the sole interface between computer and operator; and he designed and built the first electron beam welder. In 1965, when Columbus, Ohio-based Battelle Memorial Institute opened its Pacific Northwest Laboratory in Richland, Washington, Russell joined the effort as Senior Scientist. He already knew what avenue of research he wanted to pursue.

Russell was an avid music listener. Like many audiophiles of the time, he was continually frustrated by the wear and tear suffered by his vinyl phonograph records. He was also unsatisfied with their sound quality; his experimental improvements included using a cactus needle as a stylus. Alone at home on a Saturday afternoon, Russell began to sketch out a better music recording system --- and was inspired with a truly revolutionary idea.

Russell envisioned a system that would record and replay sounds without physical contact between its parts; and he saw that the best way to achieve such a system was to use light. Russell was familiar with digital data recording, in punch card or magnetic tape form. He saw that if he could represent the binary 0 and 1 with dark and light, a device could read sounds or indeed any information at all without ever wearing out.

If he could make the binary code compact enough, Russell saw that he could store not only symphonies, but entire encyclopedias on a small piece of film.

Battelle let Russell pursue the project, and after years of work, Russell succeeded in inventing the first digital-to-optical recording and playback system (patented in 1970). He had found a way to record onto a photosensitive platter in tiny "bits" of light and dark, each one micron in diameter; a laser read the binary patterns, and a computer converted the data into an electronic signal --- which it was then comparatively simple to convert into an audible or visible transmission.

This was the first compact disc. Although Russell had once envisioned 3x5-inch stereo records that would fit in a shirt pocket and a video record that would be about the size of a punch card, the final product imitated the phonographic disc which had been its inspiration. Through the 1970s, Russell continued to refine the CD-ROM, adapting it to any form of data. Like many ideas far ahead of their time, the CD-ROM found few interested investors at first; but eventually, Sony and other audio companies realized the implications and purchased licenses.

By 1985, Russell had earned 26 patents for CD-ROM technology. He then founded his own consulting firm, where he has continued to create and patent improvements in optical storage systems, along with bar code scanners, liquid crystal shutters, and other industrial optical instruments. His most revolutionary recent invention is a high-speed optical data recorder / player that has no moving parts. Russell earned another 11 patents for this "Optical Random Access Memory" device, which is currently being refined for the market.

James T. Russell has many interests beyond optical data devices. In fact, he has claimed, "I've got hundreds of ideas stacked up --- many of them worth more than the compact disc. But I haven't been able to work on them." Digital engineers and consumers alike will be lucky if he does find the time.

http://web.mit.edu/invent/index.html
Aviation pioneer Igor Ivanovich Sikorsky was born May 25, 1889 in Kiev, Russia. He created the first successful helicopter in 1939, and is credited with many other outstanding accomplishments in the field of aircraft design.

Educated as an engineer and designer, Sikorsky developed an interest in man-powered flight in his youth. He was fascinated by the work done up to that point by the Wright Brothers and by Count Ferdinand von Zeppelin. After graduating from the Petrograd Naval College, he traveled to Europe to study engineering and aviation in Paris. In 1907, he went home to Kiev where he completed his studies at the Mechanical Engineering College of the Polytechnical Institute.

He returned to Paris with plans to build a helicopter. Engineers had been attempting to build such a device for years, the first flown unsuccessfully in 1907 by Frenchman Paul Cornu. Others had limited success as well. But there were still too many problems with existing designs to make them truly viable. Sikorsky bought a 25-horsepower Anzani engine in Europe and took it home to Kiev to get to work. His first helicopter model failed. He decided to try a fixed-wing craft. His first attempt, the S-1, also failed, for he had used an inadequately powered engine. But his second, the S-2, was a success. He continued to acquire information and make improvements to his airplane models. He also acquired his pilot’s license. His fifth plane, the S-5, gained national attention. His sixth, the S-6-A, won him the highest award at the 1912 Moscow Aviation Exhibition, and first prize in a military competition in Petrograd.

This success lead to his appointment as head of the aviation division of the Russian Baltic Railroad Car Works. There Sikorsky began conceiving the first multi-engine airplane, “The Grand,” a luxurious passenger plane, revolutionary for its time. Next he designed the Ilya Mourometz, which served as a model for more than 70 versions of bombers used during World War I.

The Russian Revolution of 1917 stalled Sikorsky’s career. He left for France to build bombers for the War, which ended just a year later. Plans thwarted, he then traveled to the United States in 1919, where he began teaching mathematics. By 1923 he had raised enough money to establish his own aviation company, the Sikorsky Aero Engineering Corporation, in Long Island. First the company produced the all-metal S-29-A, followed by S-38 twin-engine amphibians in 1929, which Pan American Airways employed to fly routes to Central and South America. That year, the Sikorsky Aviation Corporation became a subsidiary and then a division of the United Aircraft Corporation, moving to Stratford, Connecticut. In 1931, the company produced the first S-40s, or “American Clippers,” which were later used to fly trans-Atlantic and trans-Pacific passenger flights.

Sikorsky built a series of these “flying boats,” his last version the S-44, which for years provided the fastest available means of trans-Atlantic transport.

Sikorsky continued to dream of building a successful helicopter. He had never stopped jotting down his design ideas. He had even patented some of them. In 1939, he achieved his goal: he completed the VS-300, piloting the craft during its first flight himself that summer. The VS-300 would come to be known as the United States’ first successful helicopter and by 1940 would serve as the model for all single-rotor helicopters. One of the most significant design details in Sikorsky’s helicopter was its use of a tail rotor to provide thrust in the opposite direction of the torque created by the top rotor. This model was the first that did not require two counter-rotating rotors to cancel out the torque. Sikorsky’s innovative design made the craft lighter, simpler, and easier to control.

Military contracts took the helicopter into large-scale production, starting with the XR-4. By the end of World War II, the U.S. Army had purchased more than 400 Sikorsky helicopters. These aircraft provided significant advantages in many types of military situations, life-saving missions in particular.

Sikorsky was recognized with countless honors and awards during the course of his life, such as the National Medal of Science, the Wright Brothers Memorial Trophy, and induction into the International Aerospace Hall of Fame, and the Aviation Hall of Fame. He was said to be a kind and spiritual man who was interested in philosophy and the effect of science on humanity. He wrote two books, “The Message of the Lord’s Prayer,” and “The Invisible Encounter.” Sikorsky officially retired in 1957, but he continued to work as a consultant until his death in 1972 at the age of 83. The Sikorsky Aircraft Corporation continues to operate in Stratford, as a division of United Technologies. It is the oldest helicopter manufacturer in the world.

http://web.mit.edu/invent/index.html
When Miami native Ivan Yaeger was a youngster, he designed an artificial limb for a school science project. That was just the beginning of what would become a long-term commitment to innovation and to helping people with disabilities to lead happier, more productive lives.

Yaeger is a thirty-something entrepreneur and inventor who has won numerous awards for science, engineering, leadership, entrepreneurship and public speaking. He graduated in 1988 from the University of Miami with a degree in business management and organization, and soon after he established Yaeger Innovative Products Corporation and invented its initial line of products. He holds a number of patents on products including the DeskMaster school desk bookstand, the Cassette Lok videocassette childproofing lock, and the Yaeger Prosthetic Arm — his most impressive creation to date.

Yaeger designed a pair of artificial arms using off-the-shelf parts for a little girl in Florida named Diamond Excell who was born without arms. Yaeger was responsible for the technology and the physical construction of the arms. He worked with Eugenio R. Silva, a prosthetist at Advanced Motion Control in Miami, to build, test and fit them. Yaeger took some of the design elements directly from his first design, which he patented while still in college.

Yaeger aimed to build limbs that would give Diamond the basic functions of an elbow, wrist and hand so that she could manipulate and carry objects and eat by herself. He modeled Diamond's hands after those of one of her cousins and covered them with molded latex textured to simulate a real hand, with fingernails and tone that match Diamond's skin color. The arm was then covered with stocking-net material which has padding underneath to protect the electronics and cables inside.

Diamond can open the arms' joints by twitching her back muscles; she closes them by flexing her chest muscles. Two sensors mounted on the harness that holds the arms to her torso allow her to switch between each joint. The wrist can turn nearly all the way around and the elbows are designed so that they swing freely when Diamond walks. While the electronics in the arms may not need to be replaced for four to five years, the arms will need to be lengthened periodically as she grows. While it will take a great deal of practice before she masters them, her arms are already enabling Diamond to hug her family and friends and do many other things she could never do on her own before.

Next, Yaeger plans to approach manufacturers in the artificial limb industry to develop the arms' design so that others like Diamond may also benefit from this magnificent invention. Yaeger currently serves as CEO of The Yaeger Companies, a group of corporations that include Y.I.P. Corporation, The Yaeger Foundation, Inc. and The Yaeger Clinic, Inc. These companies specialize in product development, consulting, educational programming and health care.

In addition to his business activities, Mr. Yaeger has served as motivational speaker, a University of Miami adjunct professor, and as a human resources consultant to several large corporations. As executive director of The Yaeger Foundation, Inc., he created The Technology Leaders Initiative for students and educators, which is designed to stimulate interest in inventing, technology and entrepreneurship. Yaeger is also a member of the King of Clubs and Vocational Service chair of the Rotary Club of North Dade, Florida. He also sits on the boards of organizations such as College Assistance Program, Academy of Finance, and Magnet Educational Choice Association.

http://web.mit.edu/invent/index.html
Rubber Bandits®

A seemingly simple idea sometimes can become an incredibly successful, mass-market product that makes life a little bit easier for millions. Such is the case with Rubber Bandits®, oversized rubber bands equipped with tear-resistant, waterproof labels, created by self-described “idea czar” Adrian Chernoff in 2004.

Chernoff was born in 1971 and grew up in Albuquerque, New Mexico. He earned a B.S. in Mechanical Engineering in 1996, followed by an M.S. in Manufacturing Engineering, as well as an M.B.A., in 1999, all from the University of New Mexico. He began a career in product development, first working for NASA as a mechanical engineer, with one-year stints at Walt Disney Imagineering, Sandia National Laboratories, and Los Alamos National Labs before landing at General Motors Corp. in 2000, where he spent five and a half years working as Chief Vehicle Architect. At GM, Chernoff developed a variety of innovative vehicle designs, including several powered by alternative forms of energy.

In 2004, he received a phone call from his mother who had heard of a competition held by the office supply store chain Staples®. The competition, called Invention Quest, invited entrants to submit ideas for products from which judges (including Staples founder Tom Stemberg and Post-It Note® inventor Art Fry) would choose several to go into production. Cash prizes would be awarded, along with licensing agreements.

Chernoff didn’t have much time, but he told his mother he would enter. Just one week before the deadline, while sitting on a bus in Colorado on the way to visit his brother, he began brainstorming ideas. He thought about the challenges he faced himself when it came to organizing files and media at work and remembered that he had once tried to attach a sticky note to a rubber band, but that the sticky note had fallen off and gotten lost. That’s when he had the idea of adding a label to a rubber band. He began sketching illustrations of how it could work, simply wrapping a rubber band around bunches of documents, disks, scrolls, tools, even flowers, and having a foolproof label attached to the band for easy identification.

Chernoff submitted his idea and made it through several rounds of competition, continually improving his design with each round. In the end, Staples chose his Rubber Bandits from among more than 8,000 entries; they awarded Chernoff $5,000 and signed him to an exclusive two-year agreement. In 2005, the company began selling the colorful bands in retail stores across the country. The bands were sold through late 2007.

Meanwhile, Chernoff left GM to start his own ideas company, 2 Smart + 1, where he serves as CEO. Later he founded a think tank called Ideation Genesis, where he is Chief Innovation Officer. He serves a variety of clients through these entities in industries ranging from entertainment and consumer goods to manufacturing and automobiles.

Chernoff holds over 75 patents with more than 20 others pending and has been recognized with a number of honors for his achievements. He was recipient of a General Motors Chairman’s Award during his tenure there and was named a Distinguished Engineer in 2007 by his alma mater. In addition to his startup ventures and consulting work, he runs the website Muzz.com, devoted to inspiring individuals who have each, in some way, changed the world.

http://web.mit.edu/invent/index.html
Basketball (Game)

Canadian-born James Naismith, inventor of the game of basketball, was born November 6, 1861 in Almonte, Ontario. He and his three siblings were orphaned when both parents died of typhoid fever in 1871. They lived with their grandmother until she passed away, then moved in with an uncle who had a farm in Bennie's Corners, Ontario.

As a youngster, Naismith was an outstanding athlete, and clearly showed leadership qualities. When he entered McGill University in Montreal, he pursued athletics including rugby and gymnastics, winning the Silver and Gold Wickstead Medals for "Best All-Around Athlete" in 1885 and 1887, respectively. He graduated with honors with his B.S. in philosophy and Hebrew in 1887; he was one of the top ten in his class.

Naismith continued his education, studying theology at Presbyterian College. He took a job at McGill as Physical Education director in order to finance his schooling. In 1890 Presbyterian awarded him his Master of Divinity degree. Meanwhile, the Young Men's Christian Association, which had been founded in London nearly 50 years earlier, had been established in Boston and Montreal in 1851. Naismith had visited often and thought he could help young people through athletics at such an organization. He learned of the Y.M.C.A International Training School in Springfield, Massachusetts and that summer he enrolled there, where he took and taught classes, and participated in sports.

For one of the classes he instructed, Naismith was charged by the superintendent to come up with new games that could help bring recreational sports into the gymnasium. He needed to come up with a game that could be played indoors during the winter months between the football and baseball seasons that would keep athletes in top shape over this period. The game that resulted, which was reminiscent of a childhood game Naismith had played called "Duck on a Rock," used two peach baskets and a soccer ball.

Naismith taught his class, with 18 students in it, to play the game, dividing them into two teams of nine, each with a goal keeper, two guards, three centers, two wings, and a home-man. Each team would try to toss a soccer ball into the peach baskets. Eventually they decided to cut the bottoms out of the baskets so they didn’t have to climb up and grab the ball out each time someone scored. In 1893 the metal rim was invented, and in 1895, the backboard appeared. The first official basketball arrived in 1909.

The popularity of basketball spread very quickly. Soon it was played in all the YMCA gymnasiums in the eastern United States. Within seven years, the first intercollegiate game was played, in 1897. In 1898, the first Collegiate Association was formed. The National Basketball League (NBL) was formed in 1937. In 1949, a competing league, the Basketball Association of America (BAA), joined the NBL to form the National Basketball Association (NBA).

Basketball has changed somewhat—today it is less brutal than it was in its early days, and is now played by five players from each team on the court at a time—two forwards, two guards and a center. Now men’s professional basketball has two conferences (Eastern and Western) made up of four regional divisions.

In 1936, basketball became an Olympic sport. In 1976, women’s basketball was added to the Olympics roster. The Women's Professional Basketball League was established in 1978. Naismith, who had been ordained as a minister in 1914, never pursued self-recognition, honors, or riches for his invention. He died on November 28, 1939. Today, the Basketball Hall of Fame in Springfield, Massachusetts is dedicated to Naismith, as well as to basketball’s greatest players, coaches and teams. An estimated 300 million people play the game worldwide.

http://web.mit.edu/invent/index.html
The Barbie Doll

Ruth Handler invented something in 1959 which became so quintessentially American as to be included in the official "America's Time Capsule" buried at the celebration of the Bicentennial in 1976: the Barbie doll.

In the early 1950s, Handler saw that her young daughter, Barbara, and her girlfriends enjoyed playing with adult female dolls as much or more than with baby dolls. Handler sensed that it was just as important for girls to imagine what they themselves might grow up to become as it was for them to focus on what caring for children might be like.

Because all the adult dolls then available were made of paper or cardboard, Handler decided to create a three-dimensional adult female doll, one lifelike enough to serve as an inspiration for her daughter's dreams of her future. Handler took her idea to the ad executives at Mattel Corp., the company that she and her husband, Elliot, had founded in their garage some years before: the (all-male) committee rejected the idea as too expensive, and with little potential for wide market appeal.

Soon thereafter, Handler returned from a trip to Europe with a "Lilli" doll, modeled after a character in a German comic strip. Handler spent some time designing a doll similar to Lilli, and even hired a designer to make realistic doll clothes. The result was the Barbie doll (named in honor of the Handlers' daughter), a pint-sized model of the "girl next door."

Mattel finally agreed to back Handler's efforts; and the Barbie doll debuted at the American Toy Fair in New York City in 1959. Girls clamored for the doll, and Barbie set a new sales record for Mattel its first year on the market (351,000 dolls, at $3 each). Since then, Barbie's popularity has rarely flagged; and today, with over one billion dolls sold, the Barbie product line is the most successful in the history of the toy industry.

From the beginning, Barbie has also had her critics: the major accusation, from feminists and others, has been that she reinforces sexism, representing a young woman with questionable intelligence and a near-impossible physique. The late 60s even saw the creation of the "Barbie Liberation Organization," after Mattel introduced "Ken" (named after the Handlers' son), as Barbie's "handsome steady." Despite such criticisms, playing with Barbie dolls seems as a rule to enhance girls' self-image and expand their sense of their potential rather than the opposite. This has become more true over the years, as Barbie herself has expanded her horizons: she has now appeared as a doctor, astronaut, businesswoman, police officer, UNICEF volunteer, and athlete.

Ruth Handler undeniably invented an American icon that functions as both a steady cynosure for girls' dreams and an ever changing reflection of American society. This can be seen in the history of Barbie's clothes, and even her various "face lifts" to suit the times; in her professional, political and charitable endeavors; and more recently in the multi-culturalizing of her product line. There is little doubt that Barbie will accompany America into the new millennium.

http://web.mit.edu/invent/index.html
It's difficult to imagine a world without Coca-Cola, the most popular soft drink on earth. Pharmacist John Stith Pemberton created the original formula in 1885. Born in 1831 in Knoxville, Georgia, Pemberton earned his medical degree at age 19 and practiced some medicine and surgery early in his career. He later opened his own drug store in Columbus, Georgia. During the Civil War, Pemberton fought for the South, rising to the rank of lieutenant colonel. He moved to Atlanta after the war where he began selling patent medicines and operated his own laboratory, the Pemberton Chemical Co. One of the products he sold was called “Pemberton’s French Wine Coca,” a drink made of wine and coca extract that was prescribed as a cure for nervous disorders, headache and other ailments. The beverage was very similar to Vin Mariani, an extremely popular coca-based drink developed in 1863 in Paris. When Atlanta forbade the sale of alcohol in 1885, Pemberton changed the formula and began selling only the coca syrup. That year, Pemberton mixed a version of the syrup in a brass kettle in his backyard that would later become Coca-Cola. It contained extracts of cocaine and kola nuts, a rich source of caffeine, and sugar for sweetening instead of wine. Pemberton took the concoction to Jacob’s Pharmacy nearby for tasting. There it was mixed with carbonated water as a soda. It was to be sold as a “brain tonic” and offered as an ideal temperance drink. His bookkeeper, Frank Robinson, came up with the name Coca-Cola, and also developed the script style that remains the company’s logo. At first, interest in the tonic was relatively low.

Though Pemberton had attracted investors and devoted some time to promoting the drink, he seemingly saw no real potential in the formula. When Atlanta repealed its Prohibition laws in 1887, he resumed his focus on his original wine coca drink. In 1888 he sold his rights to Coca-Cola for the sum of $1,750. Later that year, Pemberton died. Through a series of transactions, another Atlanta pharmacist, Asa Griggs Candler, gained ownership of the entire enterprise by 1891. He hired Robinson to direct advertising. They began selling Coca-Cola in bottles and also selling syrup to independent bottling companies through licensing agreements. By the end of the decade, Coca-Cola had become one of the nation’s most popular fountain drinks, sold all over the United States, as well as in Canada. During the company’s early years, the Coca-Cola formula was altered several times. Until 1905, it contained extracts of cocaine and the kola nut. Candler removed the cocaine and added citric acid and a variety of fruit flavors. Today billions drink Coca-Cola every day in nearly every nation in the world. Pemberton is remembered for his invention of the drink as well as for his contributions to medical reform and chemistry. He was a trustee of the former Emory University School of Medicine, served on the first Georgia pharmacy licensing board, and his laboratory became the first state-run facility to conduct tests of soil and crop chemicals. It continues to be operated by the Georgia Department of Agriculture.

http://web.mit.edu/invent/index.html
Regardless of one’s views on the use of firearms by private citizens, it is important to know about these powerful devices, and perhaps no other American brand name of firearm is better known than Colt, which began in 1836 with the creation of the Colt revolver.

Its inventor, Samuel Colt, was born July 19, 1814, in Hartford, Connecticut. His father ran a small silk and woolens factory, and young Colt began working very early among the machines and bolts of fabric. He was talented with all things mechanical, though not terribly successful as a student. At age 15, he set off as a deckhand on a ship to India where he is said to have first worked up the idea for a gun that could fire multiple times without reloading. Upon his return he studied chemistry briefly with his father’s dyeing staff, then he left on a long, three-year trip that took him from Canada to Louisiana, during which he developed skills as a showman and master marketer while lecturing on chemistry and science.

In 1836, at the age of 22, Colt obtained a U.S. patent for Colt revolver. The weapon contained a revolving cylinder that could hold six bullets, allowing the user to fire more times without reloading than any other firearm before. Earlier pistols were available with one- and two-barrel designs, but Colt’s design, which he may have conceived of while observing the workings of the capstan on a sailing ship, was the first of its kind, and earned an important place in munitions history.

Shortly after obtaining his patent, Colt found financial support in an uncle for a manufacturing business. He set up shop in 1837 in Paterson, New Jersey, establishing Patent Arms Manufacturing, but the Colt revolver was at first unsuccessful. Adoption of this new type of revolving cartridge was slow in coming. He tried to sell his revolvers to the U.S. government, but the Army was said to have objected to the gun’s use of a percussion cap, which had been invented 20 years earlier but was just beginning to come into use. Officials were concerned with the device’s safety in emergencies. Colt was forced to close down his factory in 1842.

Meanwhile, however, the industrious Colt had also created several other revolver models including the belt, pocket and holster revolvers, as well as two kinds of longarmor rifles. He had also developed ideas for waterproof ammunition, underwater mines, and technologies unrelated to the firearms business, including an underwater telegraph line and contributions to what would become inventor Samuel F.B. Morse’s telegraph.

Then, in 1846, the Mexican War began, and the U.S. War Department came to Colt for help. They had heard reports about the Colt revolver from the Texas Rangers, who had bought and used the guns during battles in 1845 that they fought against Indians in Texas with U.S. Dragoon forces. Capt. Samuel H. Walker of the U.S. Army worked with Colt on improved designs for the guns and ordered 1,000 of the new model, which Colt dubbed the “Walker” pistol. Colt—who suddenly found himself with a large order but no factory—enlisted the help of Eli Whitney, Jr., son of the cotton gin inventor, who had a factory in Connecticut. The shipment was complete by mid-1847.

In 1848 Colt re-established his business, working out of a rented facility in Hartford. Five years later, he was well on his way to becoming one of the most prosperous arms manufacturers in the world. In 1851, he became the first American to open a plant in England, which advanced his international reputation. In 1855, he incorporated Colt’s Patent Fire Arms Manufacturing Company in Hartford. By 1856, he was among one the wealthiest businessmen in the U.S., famous for advanced firearms performance as well as intricate, exquisite design and craftsmanship.

He died at the young age of 47 on January 19, 1862. His wife, Elizabeth, continued to run Colt Firearms with great success until 1901, when the company was sold to investors. The Penn-Texas Corporation bought the company in 1955. It was resold to investors in 1959 and became Fairbanks Whitney.

In 1964, the parent company reorganized under what was called Colt Industries, and the firearms division became Colt’s Inc., Firearms Division.

http://web.mit.edu/invent/index.html
Dishwashing Machine

Josephine Cochrane, inventor of the first commercially successful dishwashing machine, was born in Shelbyville, Illinois in 1839. Her father was a civil engineer, her great grandfather an inventor, John Fitch, who was known for steamboat-related innovations. Cochrane thus may have had creative tendencies in her family. However she was not formally educated in the sciences.

Cochrane was a socialite. She and her husband, William, often entertained guests at their home. Accustomed to having servants do much of her housework for her, Cochrane did not set out to create the dishwasher to relieve her of the hard work of manually doing the dishes. Rather, the idea came to her when she grew frustrated that her fine china was chipping, mostly by the harsh handling it suffered by the servants as they scrubbed it in the sink. At first Cochrane tried washing the dishes herself. But she found the task burdensome, and thought to herself, there must be a better way.

She worked out a design, one that employed water jets and a dishrack that would hold the soiled tableware in place. Soon after she first began working on the design, her husband passed away, and she was left with debt. This tragedy gave Cochrane a push—she became driven in her desire to create a successful model of her machine. Though others had attempted to create similar devices—a hand-cranked model was patented, for example, in 1850—none had become commercially viable. She was determined that her machine could meet a real consumer need.

Working in a shed behind her home, Cochrane got to work. She measured the dishes and constructed wire compartments to fit plates, cups and saucers, and placed these inside a wheel that lay flat within a copper boiler. The wheel turned, powered by a motor, and soapy water would squirt up over the dishes to clean them. In 1886, she patented her design, and began making them for friends, calling the machine the "Cochrane Dishwasher." She also advertised the machines in local newspapers. She established Cochrane's Crescent Washing Machine Company. Soon restaurants and hotels became interested. In 1893, Cochrane presented her machine at the Chicago World's Fair, where she won an award for its design and durability.

Initially, the machines sold well to businesses, but not to individual consumers. Some homemakers admitted that they enjoyed washing dishes by hand, and the machines reportedly left a soapy residue on the dishes. They also demanded a great deal of hot water, and many homes did not have hot water heaters large enough to supply the machine sufficiently. The machines' popularity skyrocketed in the 1950s, when technology, women's attitudes toward housework, and dishwashing detergent, changed in the dishwasher's favor. Today, the dishwasher is a part of the typical American household.

Cochrane's company eventually became KitchenAid, part of the Whirlpool Corporation. She died in 1913, at the age of 74.

http://web.mit.edu/invent/index.html
The Ferris Wheel

George Ferris conceived, designed and built an engineering marvel, which astonished the world at its debut and became a mainstay of American recreation. George Washington Gale Ferris was born in Galesburg, Illinois in 1859 and he and his family moved to Nevada when Ferris was five years old. He attended high school in Oakland, California before enrolling at Rensselaer Polytechnical Institute in Troy, New York, where he graduated in 1881 with a degree in engineering. Ferris found civil engineering work in Pittsburgh, where he specialized in constructing steel frameworks for bridges and tunnels.

When the World's Columbian Exhibition of 1893 was being planned in Chicago, the 33-year old Ferris arrived hoping to help build a structure to outdo the Eiffel Tower, the centerpiece of the Paris Exhibition of 1889. The Exhibition's planners wanted something "original, daring and unique." Inspired, Ferris sketched a huge, revolving "observation wheel" on some scrap paper that same night, in detail down to the ticket price. The next day, he presented his idea to the committee. They had heard of the smaller, wooden "pleasure wheels" that had begun to appear at various vacation spots about twenty-five years before; but, seeing the sheer size of Ferris' wheel, the committee dismissed him as a crackpot. A few weeks later, Ferris returned to the committee. He had convinced several fellow engineers to endorse his structure as both buildable and safe; more importantly, he had found local investors to cover the $400,000 cost to construct. This time, Ferris' plan was approved.

Ferris' wheel was modeled on a bicycle wheel: as spokes to maintain the wheel's shape and balance, it had heavy steel beams; the "forks" in which the axle was set were two steel girder pyramids. The wheel was 264 feet high, the supporting towers were 140 feet high, and the axle - the largest piece of steel ever forged in the US - weighed 46 1/2 tons. The wheel carried 36 elegantly outfitted passenger cars, each of which could fit 40 people sitting or 60 people standing. The wheel was spun by either of two 1,000 horsepower steam engines, and stopped by an oversized air brake.

Ferris' innovative design, a model of efficiency, let the wheel withstand Chicago's infamous winds while being able to hold about five times the 1,200 tons that it did carry fully loaded. At its opening on June 21, 1893, the Ferris Wheel became the irresistible centerpiece of the Exhibition. As one reviewer put it, "You cannot advertise the wheel, anyway, any more than you can advertise the fair, or the Atlantic ocean. They are all too big."

Operating without a hitch throughout the Exhibition, Ferris' wheel operated carried an estimated 1 1/2 million visitors, each paying 50 cents (equal to the Exhibition's general admission charge) for a 20-minute ride. After the Exhibition ended, the owners of resorts like Coney Island stole Ferris' idea. Worse yet, Ferris thought the Exhibition management had robbed him and his investors of their rightful portion of the nearly $750,000 profit that his wheel brought in.

Unfortunately, George Ferris, the author of this uniquely beautiful, and modern, amalgam of spirit, form and function, spent the next two years in litigation, then died prematurely in late 1896. However, his name lives on, in the "observation wheels" that can now be found in virtually every amusement park in the world.

http://web.mit.edu/invent/index.html
Breathable, yet waterproof. When it comes to fabric these two qualities would seem to be at odds with one another and indeed they were, until 1969. That's when the father-son team of Wilbert L. and Robert W. Gore developed a process resulting in the miraculous product known as GORE-TEX, the world's first breathable, waterproof fabric. The material is used in a wide and growing variety of products from outdoor equipment and apparel, to insulation, sealants and medical implants, to clothing that people can wear at home or at the office and more.

Wilbert L., who was known to all as "Bill" Gore, was an engineer with Dupont until 1957, when he left the company to launch his own business. He planned to explore innovative uses for fluorocarbon polymers. At that time, Robert, one of Bill's five children, was a sophomore at the University of Delaware studying chemistry. Robert had discovered that a material known as PTFE, or fluoropolymer polytetrafluoroethylene – which is also known as Dupont's Teflon—could be used as a versatile and effective insulation for electronic wires.

Bill refined his son's idea and decided to offer PTFE cables as his firm's first commercial product. A year later, he and his wife Genevieve began making and packaging the cables under the name of W.L. Gore & Associates in the basement of their home. Their "Multi-Tet" insulated wire and cable brought them significant success, and by 1961 they moved the business into a plant in Newark, Delaware.

Salt Lake City, Utah-born Robert, meanwhile, continued with his studies and completed M.S. and Ph.D. degrees in chemical engineering at the University of Minnesota. After graduating in 1963, he turned his full attention to the family business, which was growing rapidly, with presence in West Germany and Japan, and a new plant in Flagstaff, Ariz., by 1967. In 1969, Gore cable was included in equipment that traveled to the moon with NASA's Apollo 11 mission.

The company's most significant breakthrough, however, came in 1969 when Robert developed a process for stretching PTFE into a thin, porous membrane and lining it with a urethane coating, then bonding it to a nylon or polyester fabric. The membrane's pores were small enough for air to pass through, but too small for droplets of water to penetrate, making it both breathable and waterproof. He and his father perfected the material and dubbed it GORE-TEX. Needle holes created by sewing pieces of the GORE-TEX fabric together would be covered with the company's GORE-TEX tape, to make the seal perfect. They began marketing the product in 1971.

Success would prove difficult to achieve, however, because people had a hard time believing such a product could work as its makers said it would. A Seattle, Wash.-based maker of outdoor equipment was willing to take a chance. In 1976, Early Winters, Ltd., began making and selling GORE-TEX tents and the next year, GORE-TEX rainwear. The 1977 Early Winters' catalog advertised GORE-TEX rainwear as "possibly the most versatile piece of clothing you'll every wear." GORE-TEX quickly proved its worth and many other manufacturers and retailers began selling GORE-TEX products, while other industries began finding new uses for the material. By 1981, GORE-TEX clothing and equipment could be found in retail stores around the world as well as in a variety of implantable medical products including artificial arteries for heart patients.

By the mid-1980s GORE-TEX was a household name brand. W.L. Gore & Associates, meanwhile, continued to grow its product line, with Bill, Robert and others on their team creating more and more products and finding ever more innovative uses for the firm's inventions. The company launched its Windstopper fabric in 1991, a windproof, breathable fabric that is similar to GORE-TEX but is not waterproof; in 1992, the firm launched Glide brand dental floss; and in 1997, it began selling its Elixir guitar strings. The company built up four divisions—fabrics, medical, industrial, and electronic products—and continues to open itself to new possibilities, such as fuel cells.

Still based in Newark, Delaware, Gore operates in 45 locations worldwide and has annual revenues in excess of $1.5 billion.

Robert served as president of W.L. Gore & Associates from 1976 to 2000 and continues to serve as chairman of the company's board of directors as of this 2006 writing. His father Bill died in 1986. Both were honored with numerous awards and distinctions over the course of their careers. Most recently, Robert was awarded the 2003 Winthrop-Sears Medal and the 2005 Perkin Medal. He was inducted into the National Inventors Hall of Fame in 2006.

http://web.mit.edu/invent/index.html
Kellogg's Corn Flakes

What would breakfast be without Kellogg’s corn flakes? The inventor of this classic cold cereal, eaten around the world every day for nearly a century, was Will Keith Kellogg, born on April 7, 1860, in Battle Creek, Michigan.

Kellogg was educated as far as the sixth grade. He was a hard worker who, as a youth, held jobs as a stockboy and then as a traveling salesman of household brooms for his father's broom-making business. His older brother John Harvey Kellogg was a doctor, rising to the rank of physician-in-chief at a world-famous local hospital and health spa called the Battle Creek Sanitarium. Will Kellogg eventually went to work at the sanitarium alongside his brother. He began as a clerk and later became a bookkeeper and file manager.

At the sanitarium, Will became acutely interested in the world of medicine and learned a great deal from his brother, a vegetarian, about good nutrition and wholegrain foods. He began helping John conduct research and develop healthy diets for patients. He was in the process of boiling wheat in 1894 in an attempt to create an easily digestible bread substitute when he came across a discovery that would lead to Kellogg’s Corn Flakes.

He had boiled some wheat with the intention of making dough with it and accidentally let it stand for several hours. The wheat became softened, tempered. He decided to put it through the regular rolling process anyway for baking. When he rolled it out, however, he noticed that the individual wheat berries in the mash would roll out into flat, wide flakes. He figured he’d bake them and see what happened. The result was a crisp, tasty, easy-to-eat cereal product. He and his brother decided to serve the flakes to patients to see what they thought.

The patients loved them – so much, in fact, that they began asking the brothers to ship packages of the flakes, which the Kelloggs called “Granose,” to them after they left the sanitarium. They did so on a small scale, but meanwhile the younger Kellogg had tried the technique with corn and refined what he believed to be a superior tasting, crunchy product. In 1898 he and John started the Sanitas Food Company as a mail-order operation to develop and sell corn flakes cereal. But Will had bigger plans – to turn his corn flake business into a large-scale, international, packaged food enterprise.

In 1906, he established the Battle Creek Toasted Corn Flakes Company -- the world’s first ready-to-eat cereal company. He was a gifted marketer and promoter, and in his first year, he shipped 175,000 cases of corn flakes. Within just a few years, Kellogg’s Corn Flakes were a household name and could be found in nearly every kitchen in the United States.

He quickly began adding to his product line, with Kellogg’s Bran Flakes in 1915, Kellogg’s All-Bran in 1916 and Kellogg’s Rice Krispies in 1928. He renamed his business the W.K. Kellogg Company in 1922 and expanded operations to Canada and Australia in 1924, followed by Europe and Asia.

Today the company operates under two divisions, Kellogg USA and Kellogg International, with manufacturing operations in 20 countries and distribution in 160. In addition to its broad cereal line, today Kellogg’s also sells Pop-Tarts, Eggo waffles and pancakes, the Nutri-Grain cereal bar line, and a variety of other snacks.

Kellogg retired as the company’s president in 1929 but stayed on as chairman of the board until 1946. At this stage in his life, he turned his focus to philanthropic activities, establishing one of the nation’s most renowned charitable institutions, the W. K. Kellogg Foundation, in 1934 with an initial donation of $66 million. He was a true believer in empowering individuals to help themselves, and had begun his charity work in 1925 with the formation of the Fellowship Corporation, which helped to build an agricultural school, experimental farm and reforestation project. In 1930, he was named a delegate to the White House Conference on Child Health and Protection by President Herbert Hoover, and established later that year the W.K. Kellogg Child Welfare Foundation. He died in Battle Creek on Oct. 6, 1951.

http://web.mit.edu/invent/index.html
Microphone

David Edward Hughes was born in London, England in 1831. His family was musically talented—he and his sister and two brothers were considered prodigies, and the family performed together around the world. In 1838 the Hughes family emigrated to the United States.

Hughes became a professor of music at St. Joseph's College in Bardstown, Kentucky, in 1850. He also developed an interest in electrical engineering and brought his two main interests together when he began studying the transmission and amplification of sound. In 1855 he was awarded a U.S. patent for a printing telegraph, which he designed nearly by accident while attempting to create a machine to copy extempore music. His system used a keyboard in which each key would correspond to a letter that would be printed at a distant receiver. The invention, which came to be known as the Hughes Printer, was commonly used until the 1930s, after it was adopted and installed worldwide by the Western Union Telegraph Company.

Hughes had moved back to London during this time and had become well known around the world for his telegraph machine. He now had the means and the time to continue experimenting on his own. During his research, he discovered that a loose contact in a circuit containing a battery and a telephone receiver, would give rise to sounds in the receiver corresponding to the vibrations impinging upon the diaphragm of the mouthpiece or transmitter. This discovery lead to the development of the carbon microphone, which he unveiled in 1878. However, he refused to patent it. Hughes revived the term microphone, which was first used by Sir Charles Wheatstone in 1827, for his creation. He chose to give it to the broadcast and recording industries with no strings attached.

Hughes continued to study and experiment, eventually inventing the induction balance (which is used often as a type of metal detector), experimenting with aerial photography, and working with the theory of magnetism. His research papers on magnetism were presented at many scientific and technical society gatherings and contributed much to the field of electrical science.

Hughes was the recipient of many international honors and awards for his work, including a Fellowship of the Royal Society, a Grand Gold Medal in 1867 awarded at the Paris Exhibition, the Royal Society gold Medal in 1885, and The Albert Gold Medal, Society of Arts in 1897. In 1886, he filled the presidential chair of the Institution of Electrical Engineers. Hughes died in London on January 22, 1900.

http://web.mit.edu/invent/index.html
Super Glue

The incredibly stable adhesive known as Super Glue™ was invented by accident in 1942 by Dr. Harry Coover. Today the substance is somewhat of a household necessity, with uses ranging from simple woodworking and appliance repair to industrial binding and medical applications.

Born in Newark, Delaware on March 6, 1919, Coover received his B.S. from Hobart College and continued his studies at Cornell University, where he earned an M.S. in chemistry 1942 and Ph.D. in 1944. Shortly thereafter he began working for Eastman-Kodak’s chemical division in Rochester, New York.

During World War II, Coover was part of a team conducting research with chemicals known as cyanoacrylates in an effort to find a way to make a clear plastic that could be used for precision gunsights for soldiers. While working with the chemicals, the researchers discovered that they were extremely sticky, and this property made them very difficult to work with. Moisture causes the chemicals to polymerize, and since virtually all objects have a thin layer of moisture on them, bonding would occur in virtually every testing instance. They rejected them and moved on with their research.

Six years later, in 1951, Coover was transferred to Kodak’s chemical plant in Kingsport, Tennessee. That’s when he re-discovered the cyanoacrylates and recognized in them a new potential. He had been overseeing the work of a group of Kodak chemists who were researching heat-resistant polymers for jet airplane canopies. They tested cyanoacrylate monomers and this time, Coover realized these sticky adhesives had unique properties in that they required no heat or pressure to bond. He and his team tried the substance on various items in the lab and each time, the items became permanently bonded together.

Coover — and his employer — knew they were on to something. Coover received patent number 2,768,109 for his “Alcohol-Catalyzed Cyanoacrylate Adhesive Compositions/Superglue” and began refining the product for commercialization. His company packaged the adhesive as “Eastman 910” and began marketing it in 1958. Later it became known as Super Glue, and Coover became somewhat of a celebrity, appearing on television in the show “I’ve Got a Secret,” where he lifted the host, Garry Moore, off the ground using a single drop of the substance. He also appeared in a TV commercial for the product.

During the Vietnam War, it became apparent that cyanoacrylates could be used to treat war wounds. Field surgeons began using the substance by spraying it over open wounds, which stopped bleeding instantly and allowed hurt soldiers to be transported to medical facilities for conventional treatment. This saved many lives during the war and lead to the eventual approval by the FDA of cyanoacrylates for certain medical uses. Some of these include rejoining veins and arteries during surgery, sealing bleeding ulcers, punctures or lesions, stopping uncontrollable bleeding of some soft organs, and use during dental surgery.

Over the course of his career, Coover was awarded more than 460 patents, wrote at least 60 papers, and was responsible for many advances in his field, in areas ranging from graft polymerization, olefin polymerization, and organophosphorus chemistry. After Coover retired as vice president of Eastman Kodak and director of research and development and new venture management at Eastman Chemical Division, he formed his own consulting firm for a time before being named president of new business development for Loctite Corp. in Newton, Conn. in 1985. From there he moved to the board of Reilly Industries in Indianapolis for nine years, while continuing to run his consulting business until his retirement in 2004.

Coover’s numerous awards include the Industrial Research Institute Medal Achievement Award, the Maurice Holland Award, the ACS Earl B. Barnes Award, and the AIC Chemical Pioneers Award. In 2004, he was inducted into the National Inventor’s Hall of Fame.

http://web.mit.edu/invent/index.html
Video Games

The smashing success of home video games, one of the world's fastest growing and most popular forms of entertainment, was made possible with the advent of a number of technological developments, such as TV sets, computer technology, and graphic design software. It took some groundbreaking creativity, unusual innovation and exceptional vision for this multi-billion-dollar business to come into existence. Ralph Baer, often called the "father of home video games," clearly demonstrated each of these qualities, when he developed the first home video game console in 1972.

Born in Germany on March 8, 1922, Baer emigrated to the United States with his family in 1938 and attended the National Radio Institute from where he graduated in 1940 as a radio service technician. He operated three radio service stores in New York City from 1940-1943, before being drafted into the U.S. Army to serve in WWII. He continued his education in 1946 at the American Institute of Technology in Chicago. He graduated with a B.S. in Television Engineering in 1949.

Baer worked on electromechanical equipment including military systems while employed by Wappler, Inc., then Loral Electronics, and next Transitron, Inc., where he became VP of Engineering and moved with the firm from New York to Manchester, N.H., in 1955. In 1956 he joined Sanders Associates (now part of BEA Systems) in Nashua, N.H., where he remained until his official retirement in 1987 and where he held posts such as Chief Engineer for Equipment Design; Manager of Sanders' Flexprint Division, Chief Engineer of the Electro-Optics division, and Engineering Fellow.

In the early 1950s, television sets were quickly gaining popularity. As Baer worked on technology for these devices he began to dream of opportunities in this budding marketplace. He thought it would be fun to add some kind of interactive, game-playing element to TV sets and mentioned it to his superiors at Loral in 1951, but few showed any interest.

Fifteen years later, though, Baer found himself thinking more seriously about the concept. He began drawing up plans for a chase game that would be playable on a TV screen. He demonstrated a working prototype to his Sanders superiors in October of 1966, and they agreed to fund further research. A few months later, one of Baer's associates created a "light-gun" that allowed players to shoot the TV screen. This, plus Baer's game idea, began to get others excited about the possibilities.

By mid-1967, Baer and his team had created a two-player multiple-choice game incorporating a light gun. Over the next two-and-a-half years they worked on concepts for a ping-pong game, gun games, football games and volleyball games, all playable on a single switch-programmable video game unit. Baer filed for his first patent on gaming technology in January of 1968. He began calling his console the "Brown Box," and demonstrated it to a number of television manufacturers, including RCA, Zenith, Sylvania, GE, and Magnavox.

Magnavox (now Phillips, North America) made a commitment to Baer in July of 1970 and followed through with a license agreement to the "Brown Box" in 1971. The company fine-tuned and rebranded the box "Odyssey," and began demonstrating it to Magnavox dealers around the U.S. Reception was impressive to say the least. The firm began manufacturing consoles immediately. In its first year on the market, Magnavox sold around 100,000 Odyssey 1TL200 consoles; more than 350,000 were sold by 1975.

Meanwhile, also in 1972, another video game innovator, Nolan Bushnell, created a game similar to the ping-pong game created by Baer known as "Pong." With his launch of the coin-operated Pong video game that year, the arcade, or coin-op, video game industry was introduced alongside the home video game business. Bushnell would later form Atari, a key competitor to the Odyssey, and make home video games a competitive business beginning in 1975. Not long after, of course, the likes of Nintendo, Sony, and Microsoft would follow.

Baer became involved throughout the next decade with other firms that wished to break into the video game industry, including Coleco, and Warner Communications. He also worked alongside Magnavox as that firm engaged in a number of patent infringement lawsuits related to video game technology. Sanders and Magnavox are said to have won nearly $100 million in resulting settlements in their favor.

Despite the success of his video game concept, Baer turned his focus to unrelated toys and games and subsequently invested a variety of successful electronic games such as "Simon," "Maniac," and "Computer Perfection." Over the course of his career he was granted more than 50 U.S. and 100 international patents. He established his own consulting firm, R.H. Baer Consultants, in 1987 and continues to work on toys and games as of this 2006 writing. In 2005 he was awarded a National Medal of Technology for his achievements, presented by President George W. Bush.
A 1996 Gallup poll found that two thirds of American teenagers would like to found a company. Kathryn (K-K) Gregory, a ninth-grader from Bedford, Massachusetts, has been living that dream: she became an inventor-entrepreneur in 1994, at the age of 10. After a New England snowstorm, K-K was in her yard building a snow fort with her younger brother. Although she had dressed for the cold, K-K was frustrated, because snow kept finding its way up the sleeve of her coat. When she came in the house later, K-K's concerned mother suggested that K-K sew something that would bridge the gap from sleeves to gloves. K-K rose to the occasion: with her mother's help, she sewed some synthetic fleece into cylinders that would fit snugly over her forearms and hands. Because she wanted to leave her fingers free, K-K designed the detachable sleeves to extend only as far as the palm of the hand, and she cut a slit for the thumb, to anchor the sleeves in place. K-K intended for her invention to be worn under sleeves but over gloves; however, in her first field tests, snow was now sneaking under the lower edge of her new sleeve and piling up over her palm.

So K-K remodeled her invention, contracting its diameter so that it could be worn under mittens or gloves: her next tests were a complete success. A few weeks later, K-K made copies for her Girl Scout troop, where they were an instant hit.

Now that she knew she had a winning idea, K-K moved on to the next stage. A great deal of research and a consultation with a patent attorney confirmed that her idea was original. So she gave her invention a name, "Wristies," applied for a trademark (granted) and patent (still pending), and founded a company, Wristies®, Inc.

To promote her invention, K-K has aimed high. From her office in her house, she has signed purchase and marketing agreements with the Girl Scouts, Federal Express, and McDonald's, among others; in the fall of 1997, K-K became the youngest person ever to promote a product on QVC, where just a 6-minute spot earned her $22,000 in sales. K-K has won numerous awards, including induction into the Kids' Hall of Fame (1997), and has been profiled on the Today Show (Weekend Edition) and in the Boston Globe and New York Times. She often shares her entrepreneurial experiences at schools and invention workshops. K-K's story provides a classic example of the inventing and entrepreneurial process, step-by-step: novel idea, design of prototype, field testing and refinement, market testing, general research and patent search, patent and trademark application, incorporation, promotion and sales, profits.

K-K is not just a teenage entrepreneur: her other interests include rock climbing, in which she has also enjoyed prodigious success; and of course, K-K is returning to school (10th grade) this fall. Meanwhile, Wristies®, Inc. continues to thrive.

http://web.mit.edu/invent/index.html
The SuperSoaker®

For years, Lonnie G. Johnson has been inventing thermodynamics systems for NASA and other organizations; but he has won his greatest fame for reinventing the squirt gun.

Johnson capped a childhood of tinkering with appliances in his senior year of high school, when he won a national inventing competition for "Linex," a remote-control robot he had built out of junkyard scraps. He went on to more formal training at Tuskegee University, where he earned first a B.S. in Mechanical Engineering (1972) and then an M.S. in Nuclear Engineering (1974).

Soon thereafter, Johnson joined the U.S. Air Force, where he became an Advanced Space Systems Requirements Officer at the headquarters of the Strategic Air Command in Omaha, Nebraska. After directing many projects and earning several decorations, as well as a Nomination for Astronaut Training, Johnson moved on to NASA's Jet Propulsion Laboratory in California. Here he helped develop thermodynamic and controls systems for space projects, including award-winning work for the Galileo Jupiter probe and the Mars Observer project; his crowning achievement at JPL was the Johnson Tube, a CFC-free refrigeration system with a hydraulic heat pump, which later earned Johnson his seventh patent (#4,724,683; 1988).

While with the USAF and JPL, Johnson continued to invent at home. In 1985, he founded his own company, later renamed Johnson Research and Development. Johnson had first conceived his most famous invention in 1982: when a homemade nozzle at his bathroom sink shot a spray of water across the room, Johnson resolved to invent the world's first high-performance, pressurized water gun.

Johnson with partner Bruce D'Andrade finally created a workable prototype of the now famous SuperSoaker® in 1989. They filed for a joint patent (granted 1991) and found a manufacturer, Larami Corp. (now a subsidiary of Hasbro, Inc.). The SuperSoaker® uses an air pump to pressurize its water supply, allowing for tremendous distance and accuracy in water-marksmanship. Those unfamiliar with this product cannot appreciate its popularity: since 1990, over 40 million SuperSoakers® have generated over $200 million in sales; today, dozens of websites are devoted to them.

Meanwhile, Johnson has earned over 40 patents, and continues to invent in the realms of thermo- and fluid dynamics as well as toys. In addition to ongoing controls work for NASA, Johnson and his company are developing an improved home radon detector, a rechargeable battery, and a heat pump that uses water instead of freon, among other projects. Lonnie Johnson has won numerous honors for his success in inventing and entrepreneurship, and his constant encouragement of young people to invent. He is a legendary businessman and public figure in his hometown of Marietta, Georgia—whose Mayor declared February 25, 1994 "Lonnie G. Johnson Day" in his honor—and, thanks to the SuperSoaker®, he is a hero to kids nationwide.

http://web.mit.edu/invent/index.html
Videotape Recorder

Inventor Charles Paulson Ginsburg, otherwise known as the "father of the video cassette recorder," was born in San Francisco in 1920. He received his bachelor's degree from San Jose State University in 1948 and worked as a studio and transmitter engineer at a San Francisco area radio station. He stayed there until 1951, when he received a telephone call from Alexander M. Poniatoff, founder and president of the Ampex Corporation in Redwood City, Calif., who believed Ginsburg could help him with an important project.

In 1952, Ginsberg began working for Ampex. It was there that Ginsberg got the opportunity to lead the research team that developed the first broadcast-quality videotape recorder (VTR), U.S. patent number 2,956,114.

The VTR is said to have revolutionized television broadcasting. Tape recording of television signals dates to just after World War II, when audio tape recorders were used to record the very high frequency signals needed for television. These early machines were pushed to their limits, running the tape at very high speeds of up to 240 inches per second to achieve high-frequency response.

Ginsburg and his team came up with a design for a new machine that could run the tape at a much slower rate because the recording heads rotated at high speed, allowing the necessary high-frequency response. The Ampex VRX-1000 (later renamed the Mark IV) videotape recorder was introduced on March 1956. The machine sold for $50,000. With the advent of the VTR, recorded programs that could be edited replaced most live broadcasts. CBS was the first network to employ VTR technology, starting in 1956. With that, today's multimillion dollar video business was born.

Ginsberg held the position of vice president of advance development at Ampex from 1975 until his retirement in 1986. The first video cassette recorder, or what is popularly known as the VCR, was sold by Sony in 1971. Its existence was made possible by the advances Ginsberg and his team made in the 1950s.

Ginsberg was a Fellow of both the Society of Motion Picture and Television Engineers and of the Institute of Electrical and Electronics Engineers. Over the course of his career he received the David Sarnoff Gold Medal of the Society of Motion Picture and Television Engineers, (1957); the Vladimir K. Zworykin Television Prize of the Institute of Radio Engineers, (1958); the Valdemar Poulsen Gold Medal by the Danish Academy of Technical Sciences, (1960); the Howard N. Potts Medal of The Franklin Institute, (1969); the Master Designer Award of Product Engineering Magazine, (1969); and the John Scott Medal of the Board of Directors of City Trusts of The City of Philadelphia, (1970). In 1957, he also received an Emmy Award presented to Ampex by the Academy of Television Arts and Sciences.

In 1990 Ginsburg was inducted into the National Inventors Hall of Fame, where he was credited with "one of the most significant technological advances to affect broadcasting and program production since the beginning of television itself." He died in 1992 in Eugene, Oregon at the age of 71.

http://web.mit.edu/invent/index.html
Robert Koffler Jarvik, inventor of the first permanently-implantable artificial heart, was born in Michigan on May 11, 1946. He demonstrated his mechanical aptitude early, having invented such useful devices as a surgical stapler and other medical tools when he was just a teenager.

In 1964, Jarvik was a student at the University of Utah. His father became ill with heart disease and had to have open heart surgery. That’s when Jarvik learned that many heart disease patients need heart transplants. In some cases, however, heart disease is so severe that a patient may not survive the wait for a donor heart. In an effort to help those patients live as long as possible with the heart they have, medical scientists had begun to develop electronic devices such as defibrillators, pacemakers, and artificial heart models.

Jarvik became very interested in medicine at that point, and he began to think about possible designs for artificial hearts that could help people like his father. He decided to go to medical school. He graduated with his MD in 1976 from the University of Utah.

By the mid-70s, several artificial heart designs had already come into existence. In the mid-1950s, Dr. Paul Winchell patented an artificial heart. In 1957, a team of scientists, led by Willem Kolff, a Dutch-born physician, tested the model in animals to identify problems. Another model tested in 1969 by a team led by the Texas Heart Institute’s Denton Cooley kept a human patient alive for more than sixty hours. Physicians and scientists then began to consider the possibility of creating a permanent, rather than temporary, implantable heart model.

In 1982, Jarvik’s permanent design was the first of its kind. He called the artificial heart the Jarvik-7. Made of dacron polyester, plastic, and aluminum, the Jarvik-7 had an internal power system that regulated the pump through a system of compressed air hoses that entered the heart through the chest. The air hoses were connected to the chambers. The heart’s power system drove the pumps, which pumped blood through the patient’s body. Jarvik and his team tested the device on cows and other animals, making sure the heart could consistently beat at least 100,000 times a day. Soon, it was ready to be tested on a human being.

In 1982, the first patient, Seattle dentist Barney Clark, lived for 112 days after the Jarvik 7 was implanted into his chest cavity during an operation that last 7 1/2 hours. Surgeon William DeVries of the University of Utah performed the surgery. Clark, who for various medical reasons had not been a candidate for a transplant operation, was never able to leave the hospital. The system was open to infection, so Clark, and subsequent Jarvik 7 recipients, got sick. Patients had to be kept on blood thinners to prevent clots and strokes. Clark died from multiple organ failure, but the Jarvik 7 was still beating when he passed away.

After Clark's operation the Jarvik 7 heart was implanted many times. The record for being sustained by an artificial heart is held by William Schroeder, who was hooked to a Jarvik-7 in 1985. He lived for 18 months though he suffered strokes, sudden hemorrhages, and infections during his final days.

By the end of the ’80s, about 70 Jarvik devices had been implanted to sustain patients waiting for transplants. Since then, development of an improved artificial heart has continued. Today, devices made by companies such as Thoratec, Medquest, Baxter Novacor, Abiomed, and others have assisted thousands with heart disease. Scientists continue to work on designs for an artificial heart that could provide a realistic, permanent option for survival. Jarvik is now working on the Jarvik 2000, a thumb-sized heart pump.

http://web.mit.edu/invent/index.html
James Hillier was born in Brantford, Ontario, Canada on August 22, 1915. He was interested in art as a youngster, and first believed he would pursue a career as an artist, but his natural talent for math and physics won him a scholarship to the University of Toronto. That's where he and fellow student Albert Prebus would build the world's first practical electron microscope.

Hillier received his B.A. in Mathematics and Physics in 1937 and stayed on at the University of Toronto to pursue graduate studies. He and Prebus were students when in 1937 they assembled a model of a microscope that could magnify 7,000 times—much greater than the 2,000 times magnification produced by optical microscopes used at that time. This machine passed a beam of electrons, rather than a beam of light, through a specimen. The beam would then be focused on a photographic plate. A theory developed 15 years earlier by a German physicist had suggested that an electron microscope could have a resolving power much better than a light microscope, and Hillier and Prebus' machine proved this to be true. Since electrons' wavelength is smaller than the wavelength of light, greater magnification and depth of focus was indeed possible. The images created by this new type of microscope were as clear as an image on a modern television screen.

In 1938 Hillier received his M.A. from the University of Toronto, and in 1941 he completed his Ph.D. He was hired immediately by Radio Corporation of American (RCA) in Camden, New Jersey, which employed him to work with a group to build the company's first commercial electron microscope. He worked on developing the microscope for more than a decade, expanding its application, improving its resolution, and helping to make the electron microscope standard equipment in labs, hospitals, and universities around the world. Eventually magnification would improve to 10,000 times.

Hillier, who became a U.S. citizen in 1945, worked as a research engineer at RCA until 1953. He briefly joined Malpar, Inc., as research director, then returned to RCA in 1954 where he became the general manager of RCA Laboratories in Princeton, New Jersey in 1957. He was eventually promoted to executive vice president and senior scientist of RCA Labs.

In addition to his work on the electron microscope, Hillier also accomplished major developments related to the fields of medicine and biology, including his discovery of the principle of the stigmator for correcting astigmatism of electron microscope objective lenses; his invention of the electron microprobe microanalyser; and his being the first to picture tobacco mosaic viruses and an ultra-thin section of a single bacterium. He retired from RCA in 1977.

Over the course of his career Hillier was awarded 40 patents and numerous accolades, including the American Public Health Association's Albert Lasker Award in Medical Research in 1960, the IEEE David Sarnoff Award in 1967, the Industrial Research Institute Medal in 1975, induction into the U.S. National Inventors Hall of Fame in 1980, and the IEEE Founders Medal in 1980.

Hillier, who, as of this writing (May 2003), lives in New Jersey with his wife, Florence, is a Fellow of the American Physical Society, the American Association for the Advancement of Science, and the Institute of Electrical and Electronics Engineers. He is also a member of Sigma Xi and the National Academy of Engineering. In addition, he established the James Hillier Foundation, which awards scholarships to promising science students from his hometown of Brantford.

http://web.mit.edu/invent/index.html
Colin S. Twitchell has transformed his own love of outdoor activities into a distinguished career in the development of products that make such activities accessible to the physically challenged. Growing up in New England, Twitchell displayed both enthusiasm and excellence in outdoor sports. His specialties were (and still are) cross country skiing and cycling, in both of which he has been a regional champion. But the young Twitchell had an active mind as well as an active lifestyle: by the time he was in high school, he had worked on designing both human-powered aircraft (1974-78) and customized wheels for road racing wheelchairs (1979).

Twitchell continued his work in universal design and adaptive technology at Hampshire College. To his already proven engineering instincts he added formal study of the needs and abilities of the body, earning a BA in Exercise Physiology and Mechanical Design in 1986. Twitchell's thesis project (which he has been refining ever since) was the design of a multi-terrain wheelchair, with a lightweight but sturdy frame, knobby tires, and a small, trailing wheel for increased stability. After graduating, Twitchell joined the Institute on Applied Technology at Boston Children's Hospital as an Adaptive Equipment Designer. Here, he designed wheelchairs and related equipment, as well as developing adaptive communication systems. Meanwhile, Twitchell also consulted in the design and construction of a wheelchair-accessible house, in his current hometown of Guilford, Vermont (1992).

The next year (1993), in Guilford, Twitchell founded Ergosport, Inc., whose President he remains today. At Ergosport, Twitchell made it possible for outpatient physical therapy to take place not in the hospital, but outdoors. At that time, canoeing and especially kayaking were enjoying a boom in popularity. Twitchell designed and manufactured a D.I.Y. (*do it yourself*) modular seating system, which persons without the full use of their legs could install, and then go canoeing or kayaking safely and conveniently, by themselves. Twitchell has in fact written the American Canoe Association's guide to seating adaptation.

In 1994, Twitchell returned to Hampshire College, as faculty member and Director of the Lemelson Assistive Technology Development Center. Twitchell founded, organized, and integrated the Center, which provides formal and informal instruction, as well as manufacturing facilities, to any member of Hampshire's broad community who is interested in adaptive design. One of the Center's recent successes is the Accessible Snowboard, which was displayed at the Smithsonian's National Museum of American History in 1999-2000. Designed by two Hampshire students with Twitchell's help, this snowboard allows persons to sit with their legs tucked under them on an elevated platform above the board itself. The snowboard was a logical progression from Twitchell's earlier work on sit-down skateboards and cross country sit-skis.

In 1999, Twitchell served as Mentor to the first annual Lemelson-MIT Invention Apprentice, Krysta Morlan. That summer, the two of them developed an invention of hers: a water-bike that (like so many of Twitchell's own inventions) makes physical therapy a form of outdoor recreation. Today, Colin Twitchell, as inventor, engineer and instructor, continues to provide remedial and recreational activities to those formerly cut off from the outdoors.

http://web.mit.edu/invent/index.html
Automotive air bags

Allen K. Breed is an inventor, entrepreneur, and pioneer in one of the most significant advances in automotive safety of recent times, the air bag. After earning a B.S. in Mechanical Engineering from Northwestern University in the years following World War II, Breed first worked in product design for RCA. After rising to a managerial post there, and directing a joint venture with Gruen Watch Company, he founded his first company, Waltham Engineering, in 1957.

In 1961, Breed founded another company, Breed Corp., in order to develop safety and arming devices under contract to the US military. Like Jacob Rabinow, Breed later applied to a broader realm the expertise in fuzes and timing and sensor technology that he gained from military work. Specifically, Breed envisioned a beneficent application for sensor-triggers and controlled explosions, in the realm of automobile safety.

Breed invented his first sensor and safety system in 1968: this was the world’s first electromechanical automotive air bag system of its kind. Even then, the air bag was not, in theory, entirely new to the automotive industry; but it took some time to gain broad acceptance. Breed was still well ahead of the game when, in 1987, he founded Breed Automotive (now Breed Technologies, Inc.) to refine and market his safety systems.

The principles on which air bags operate are fairly well known. The keys to their success are reliable crash sensors (which detect an impact either violent or in combination with drastic deceleration), instantaneous triggering and deployment of the cushion, and the prevention of "secondary injuries"—i.e., injuries from the passenger's contact with the air bag.

Air bags have not proved completely successful in meeting this last challenge; but already in 1991, Breed co-patented an air bag that vents air as it inflates, reducing the risk of secondary injuries by reducing the inflated bag’s rigidity. This (#5,071,161) is just one of over two dozen auto safety inventions that Breed has co-patented over the years. Today, Breed continues to oversee the improvement of auto safety mechanics and design, including the successful introduction of side-impact air bags.

Meanwhile, Breed’s company has expanded its scope to include seat belt, steering and other automotive safety technology. Once located in Lakeland, Florida, Breed Technologies is now known as Key Safety Systems, Inc. with headquarters in Detroit, Mich. It does research, manufacturing and consulting work worldwide, and its products are now used in over 400 models of cars. Breed himself has earned a number of honors for his work. In 1998, he was included in the Ernst & Young Entrepreneur of the Year 500; in 1996, he was inducted into the Tampa Bay Business Hall of Fame; in 1995, he was elected National Entrepreneur of the Year. And besides being admirable for his business success, Allen Breed, like William Bolander, who won the inaugural Lemelson-MIT Prize for his inventions in automotive safety, has applied his innovative instincts to a truly good cause.

http://web.mit.edu/invent/index.html
Diesel Engine

Rudolf Diesel, born March 18, 1858 in Paris, created the pressure-ignited heat engine known commonly as the diesel engine. After graduating from Munich Polytechnic, he began working as a refrigerator engineer for the Linde Ice Machine Company in Paris, moving in 1890 to Berlin to manage the company’s technical office. But his passion for engine design was never far from his mind. Diesel worked on an idea for an efficient thermal engine in his free time, completing a design by 1892 for which he received a patent a year later.

Diesel's design aimed for greater efficiency than was available with existing engines at the time. The diesel engine does not require an externally applied ignition to the mixture of air and fuel inside. Rather, this is accomplished through compressing the air inside the cylinder and heating it such that the fuel, which would be brought into contact with the air just before the end of the compression period, would ignite on its own. As a result the diesel engine would be smaller and lighter than the traditional engine used in most road vehicles and would not require the use of an additional fuel source for the ignition.

Diesel wanted to see his design become a real, working machine. To accomplish this he sought assistance from major machine manufacturers. Eventually he was hired to produce a test engine and completed a prototype in 1893. Early tests had dangerous results; Diesel was nearly killed when one of his engines exploded. But this test proved that fuel could be ignited without a spark. He worked diligently to improve his engine model, running his first successful test in 1897.

Just one year later, Diesel became a very rich man. His engine, which ran with a theoretical efficiency of 75 percent compared to a theoretical efficiency of 10 percent for traditional steam engines, was employed immediately to power cars, trucks and boats, as well as power pipelines, electric and water plants, and in mining, factories and oil fields. Even today’s diesel engines are based on the inventor’s original concept.

The diesel engine had a major impact during the industrial revolution, delivering power more efficiently, thus less expensively, for a variety of industries all over the world. Because its use did not require burning coal, train transport and shipping companies were able to save a great deal of money. This, however, was not a boon to the coal industry, which stood to lose a large portion of its business.

On Sept. 29, 1913, Diesel disappeared from a steamer en route to London. His body was recovered on the shore days later. The circumstances surrounding his death are still a mystery; some believe he may have committed suicide, while others speculate that he was murdered by coal industrialists.

http://web.mit.edu/invent/index.html
The most sensational contribution of patriot and inventor David Bushnell to the American Revolutionary War effort was the world's first functioning submarine. David Bushnell was born in 1740 in West Saybrook, Connecticut, where the Connecticut River meets Long Island Sound. He worked on his family's farm until the age of 31, when he entered nearby Yale College. By the end of that summer, Bushnell had solved his problem by inventing a vessel he called the "Turtle": the first submarine. The Turtle did not resemble that animal, but rather a huge walnut, seven 1/2 feet tall and six feet wide at the center, made of oak reinforced by iron bands. A single operator entered through the now familiar type of airtight hatch at the top, sat on a stool inside the vessel, and maneuvered the machine with hand-cranked propellers --- a large one at the front and a smaller one at the top --- and a rudder at the back. The Turtle could float on the water's surface and pump in fresh air through a special, leak-proof intake valve before submerging; the operator could only keep the vessel under water until that fresh air became stale. Although Bushnell had some help with the various apparatus of his craft, the overall design and many of the details were entirely of his own creation. The Turtle also had an oversized wood screw sticking straight up from its top, with its handle inside the vessel's chamber. Attached to this screw was a waterproof fuse that led to the mine, which was buoyant but fastened to the outer hull. Bushnell's plan of attack was for the operator to steer in secret under an enemy ship, drill the screw deep enough into the keel of the enemy ship to anchor it, then detach both the screw and the mine, set the fuse burning, and drive away as quickly as possible. The mine, held by the drill-bit and its own buoyancy against the bottom of the enemy ship, would explode and sink the ship. Among the admirers of Bushnell's first successful trial runs at Saybrook in the summer of 1775 was another inventor, Benjamin Franklin. The Turtle finally saw action in 1776. The British navy was blockading New York City, intending ultimately to invade along the Hudson River. Bushnell had his invention ferried down from Connecticut by ship. He targeted the British flagship, the HMS Eagle, as the Turtle's first victim. However, Bushnell himself was too frail to pilot the craft, and his usual captain, his brother Ezra, was ill with a fever. A volunteer was quickly trained to operate the machine, and the mission began. The Turtle moved with perfect accuracy and stealth; but the operator could not drill the screw through the copper-plated hull of the British ship, and had to abandon the mission. At most the Turtle's efforts may have spooked those on board the ship, who could tell that something was attacking the bottom of the ship but could not see what it was. In two subsequent battles at Fort Lee on the Hudson River, the Turtle again swam splendidly but failed to bite. Nevertheless, George Washington appointed Bushnell to a commission in the Corps of Engineers, hailing him as "a man of great mechanical powers, fertile in invention and a master of execution." After 1776, Bushnell abandoned the Turtle and returned to inventing variations on the standard naval mine, including a "drift" model that exploded on contact. Bushnell's mines helped hamper and harass, as well as destroy, British ships throughout the War. In 1787, Bushnell disappeared from his home in Saybrook. Only after his death, in 1826, did it become known that he had moved to Georgia and become a doctor and professor, under the name of David Bush. It is not clear whether Bushnell had fled his former career, or disappointment with the Turtle, or something else entirely. But he hopefully did take pride in the fact that he built the world's first functioning submarine and helped establish the American spirit of innovation. A 1976 replica of the Turtle is on permanent display at the Connecticut River Foundation in Essex, Connecticut. Contact the Foundation at P.O. Box 261, Essex, CT 06426.
Atomic Bomb

Julius Robert Oppenheimer is likely the first name that comes to mind when one mentions the atomic bomb. He is credited with the creation of the devastating device in the early 1940s, a version of which was used in two instances during World War II. In the summer of 1945 bombs were dropped on two Japanese cities and Japan surrendered shortly thereafter.

Oppenheimer was born in New York City on April 22, 1904. He grew up in New York and attended the Ethical Culture School there. Early on, he became especially interested in languages and would learn one quickly just so he could read a text in its original form. He was also very interested in math and science, and considered a serious student and a rather intense person by his peers.

After he graduated from Harvard University in 1925, Oppenheimer studied at Cambridge University in England and pursued a PhD in Germany. He returned to the U.S. in 1929 and began teaching at the University of California at Berkeley and at the California Institute of Technology.

Oppenheimer became deeply concerned by the rise of fascism in the 1930s and took a strong stand against it. In 1939, when it became known to the U.S. that Germans had split the atom, the implication was that the Nazis could develop extremely powerful weapons. This realization prompted President Roosevelt to establish the Manhattan Project in 1941. In June 1942, Robert Oppenheimer was appointed its director. Oppenheimer set up a new research station to develop atomic and other types of weapons at Los Alamos, New Mexico.

Meanwhile, research was also being done at Columbia University, the University of Chicago, and in Oak Ridge, Tennessee, Oppenheimer invited the most established physicists to Los Alamos to work on creating and atomic bomb. Eventually he was managing a team of more than three thousand people.

On July 16, 1945, Oppenheimer witnessed the first explosion of an atomic bomb in the New Mexico desert, and, some say, changed the world forever. Within a month, two atomic bombs were dropped on Japanese cities. Japan surrendered on August 10, 1945.

After the war, Oppenheimer chaired the U.S. Atomic Energy Commission. He opposed developing an even more powerful hydrogen bomb. When President Truman finally approved it, Oppenheimer did not argue, but partly due his initial reluctance the political climate turned against him. On December 21, 1953, Oppenheimer was accused of treason for delaying the naming of Soviet agents, and also for opposing the building of the hydrogen bomb. Although he was cleared of the charges, his security access was taken away and his contract as adviser to the Atomic Energy Commission was terminated.


http://web.mit.edu/invent/index.html
Mars Rover

Donna Shirley, the original leader of the team that built the Mars Pathfinder rover, grew up in Wynnewood, Oklahoma. As a teenager in the 1950s, she knew she wanted to become an engineer, despite the fact that few girls were entering the field at that time. Math was her worst subject, but she worked hard to learn it in pursuit of her dream.

At the young age of 16, Shirley earned her pilot's license. In 1963, she received her B.A. in technical writing and B.S. in aerospace engineering from the University of Oklahoma. In 1968, she earned an M.S. in aerospace engineering from the University of Southern California. In 1966, she had begun working on the Mars Program at NASA's Jet Propulsion Laboratory in Pasadena, California. She was an aerodynamicist assigned to solving the problem of how Mars landers could come through the atmosphere safely, without burning up or tumbling.

During more than 30 years at JPL, Shirley served in a variety of positions in engineering systems analysis for space missions. She worked on new space technologies with terrestrial applications, was the mission analyst for the Mariner Venus-Mercury mission in the early 1970s, and in the 1980s and 1990s she worked on the development of automation, robotics and mobile surface vehicles. Shirley is best known, however, as the first woman to head up a project for NASA, and for her work on the Sojourner rover, the first rover to explore the surface of Mars.

In 1979, Shirley headed a study of a Saturn orbiter and probe that led to Cassini, an international mission to Saturn that launched in October 1997. In the early 1990s, she was project engineer for the Cassini flight project. The spacecraft is expected to reach Saturn in 2004 and deploy a probe to Saturn's largest moon, Titan. In the 1980s, Shirley worked on an early version of NASA's space station and developed concepts for automated mobile vehicles to be used on planetary surfaces. She also led NASA teams developing systems engineering and management processes.

She was named manager of NASA's Mars Exploration Program Office, when it was established in August, 1994. She oversaw the development of the Mars Pathfinder's rover, Sojourner, which successfully touched down on Mars on July 4, 1997. The event fulfilled a dream that many had considered impossible. Since then Shirley has served as a spokesperson for the project, appearing on many local and international television and radio programs. Shirley received numerous NASA group achievement awards, including a NASA Outstanding Leadership Medal. She has also been honored with the American Society of Mechanical Engineers Holley Award, and membership in the American Academy of Achievement, the Women In Technology International Hall of Fame, and the Oklahoma Aviation and Space Hall of Fame. Her autobiography, "Managing Martians: The Extraordinary Story of a Woman's Lifelong Quest to Get to Mars—and of the Team Behind the Space Robot That Has Captured the Imagination of the World" was published in 1998. She also wrote the online book, "Managing Creativity: A Practical Guide to Inventing, Developing and Producing Innovative Products."

Shirley retired from JPL in 1998. She went on to serve as Assistant Dean of Engineering for Advanced Program Development at the University of Oklahoma, and was official spokesperson for the Mars Millennium Project, an international educational initiative sponsored by the White House Millennium Council, the Department of Education, the National Endowment for the Arts, the National Aeronautics and Space Administration, and the J. Paul Getty Trust. She is now working on a doctorate in human and organizational development at the Fielding Institute in Santa Barbara, CA.

http://web.mit.edu/invent/index.html
Seismograph

Geologist and engineer John Milne is known as one of the most significant contributors to the understanding and evaluation of earthquakes, having compiled a substantial body of observational research, developed the first international network for seismological data, and created what may be considered the world’s first modern seismograph. Born on December 30, 1850 in Liverpool, England, Milne attended King’s College and the Royal School of Mines where he earned the credentials to become a mining engineer. He first began working in Europe, performing mineral investigations for mines there and later, in Newfoundland. He also participated in an 1874 mining expedition to Sinai.

At the age of 25, he accepted a professorial post at the newly established Imperial College of Engineering in Tokyo. He took an adventurous 11-month overland journey to get there, traveling across Siberia and arriving in Japan in 1876. An earthquake occurred there on his very first night. The study of earthquakes was relatively new then, having become a field of its own only in the mid-18th century, when a series of major quakes that hit England in 1750 was followed by a quake and tsunami in 1755 that devastated Lisbon, Portugal, killing nearly 70,000. At this time scientists began compiling observational data on quakes around the world, and as international communications improved, more and more information could be combined.

After a quake hit Yokohama in 1880, Milne, with British colleagues James Alfred Ewing and Thomas Gray, initiated the founding of the Seismological Society of Japan, the world’s first seismological society. He was asked to lead the organization but he opted instead to edit and write for its journal. Among the society’s aims was the funding of seismograph development for earthquake measurement and detection. Working with Ewing and Gray, Milne invented in 1880 a simple horizontal pendulum seismograph, a machine that records vibrations that occur with sudden movement along a fault line in the earth. These waves of motion can be one of two varieties, primary or secondary (or, “P waves” and “S waves”), which move at different speeds. Primary waves move in a compression/expansion type of pattern, and appear as wavy lines on a chart. Secondary lines, which are generally detected later than primary ones, are more snake-like, moving in a ragged sort of fashion. Examining both types of waves together allow scientists to determine the distance of a quake’s epicenter from the measuring station.

Milne compiled many volumes of data on Japan’s earthquakes and wrote two of the field’s standard works, “Earthquakes,” and “Seismology.” In 1895, a fire destroyed his home, laboratory and library. He was devastated by the event, and decided to return to England to start anew with his Japanese wife, Tona. He set up a laboratory in his home on the Isle of Wight, called Shide Hill House, which became a world center for seismological research for the next 20 years. “Earthquake Milne,” as he came to be known, operated a seismograph station and conducted many other seismological experiments. He secured funding from the Royal Society to fund earthquake observatories around the world equipped with his seismographs. Locations grew from 20 to 40, and included England, Russia, the United States, Canada and Antarctica. The worldwide nature of this network was critical to providing a venue for collecting data to provide global patterns for earthquake activity, which could then be evaluated at a central location. It also allowed for “remote sensing,” or measuring earthquakes felt in one area of the earth in another region in uniform fashion.

In 1896, on vacation in the Isle of Wight, John Johnson Shaw paid Milne a visit that resulted in a lifelong partnership. The pair collaborated on a machine dubbed the Milne-Shaw Seismograph, launched in 1913. In subsequent years, improvements to the seismograph were made by others including Emil Wiechert and Boris Galitzin, whose electro-magnetic version changed the way they were built forever. Still, weighted bases, recording needles, and seismograms -- the drawings the machines make on paper -- remain key components of today’s seismological devices. Milne held the position of Secretary of the Seismological Committee of the British Association until his death from kidney disease on July 31, 1913. In 1919, his laboratory operations were transferred to Oxford University.

http://web.mit.edu/invent/index.html
Hovercraft

British inventor and engineer Christopher Sydney Cockerell invented in 1955 a swift water-transport vehicle that was not quite a boat, not quite a plane, but a hybrid of sorts: the hovercraft.

Cockerell was born on June 4, 1910, in Cambridge, England. His father, Sir Sydney Carlyle Cockerell, was a distinguished devotee of the arts who served as director of the Fitzwilliam Museum and later as private secretary to Sir William Morris. He reportedly expressed reservations when his son made the decision to study engineering, but he supported him nevertheless and would later finance some of young Cockerell’s early patents. Cockerell earned an engineering degree from Cambridge University’s Peterhouse College, and worked for the Radio Research Company until 1935. That year he joined the Marconi Wireless Telegraph Company. There he was deeply involved in developing radar systems for use during World War II. He was named on 36 patents during his tenure with Marconi and was credited with inventions such as an aerial direction finder used by airmen during the war, as well as equipment used to pinpoint locations of German radar stations on the northern coast of Europe, which were then bombed in preparation for the Allies’ Normandy invasion in 1944.

In 1950, Cockerell left Marconi to manage a marina that he and his wife had purchased in Norfolk, England. While living in Norfolk he began thinking about the concept of a heavy craft that could be supported on an air cushion and skim along the surface of a body of water without the drag produced by friction. He began experimenting with vacuum cleaner tubes and empty aluminum cans and found that when placing a small can inside a larger one and blowing air through the smaller can, it hovered above the bottom surface of the larger object. By 1955 he had a working prototype and pursued a patent on his creation, which he dubbed a "hovercraft." He obtained a patent in 1956.

That year he demonstrated his prototype craft, which used air blown out of the bottom of the craft under pressure, to British authorities, and showed that it was possible to enable such a vehicle to glide easily over water, land, even mud, and marshes. Meanwhile, American Charles J. Fletcher had invented a similar device called the "Glidemobile" during WWII; his design was classified by the U.S. Dept. of War, which denied Fletcher the right to patent the invention. Cockerell, however, having come up with his concept all on his own and having been the first to patent, is known as the father of the hovercraft that would come to be known and used around the world.

In 1958, shortly after Cockerell unveiled his prototype in England, the country’s National Research and Development Agency paid for an experimental vehicle based on his design to be built by a boat-building company called Saunders-Roe. The SR-N1 was launched on June 11, 1959 and later that year crossed the English Channel, from Dover, England, to Calais, France. The NRDA established Hovercraft Development, Ltd., to develop the craft for commercial use and signed five companies up to build them. Cockerell served as director and technical advisor until 1966. The first passenger-carrying hovercraft was introduced in 1962, called the Vickers VA-3. Cockerell earned more than 50 patents on the hovercraft, while working for Hovercraft Development and while working independently. He was knighted for his services to the engineering field in 1969.

From 1974 to 1982, he served as Chairman of Wavepower, Ltd., a UK effort devoted to research on converting the energy of seawaves into electricity. He died in 1999. Popularity of the hovercraft, meanwhile, has continued to grow while manufacturers have improved on Cockerell’s original concept. Since its introduction, the hovercraft has been used for human transport, for oil crew boats, for travel over mud and ice in challenging climates, by national coastguards, military personnel and fishery patrols.

Air cushion technology based on the hovercraft concept has also been used in fixed track systems, such as the Aérotrain, an experimental high speed hovertrain built and operated in France between 1965 and 1977; and the Dorfbahn Serfaus, an underground air cushion funicular rapid transit system which has been operating in Serfaus, Austria, since 1985.

http://web.mit.edu/invent/index.html
Samuel Finley Breese Morse, inventor of several improvements to the telegraph, was born in Charlestown, Mass. on April 27, 1791. As a student at Yale College, Morse became interested in both painting and in the developing subject of electricity. After his graduation in 1810, he first concentrated on painting, which he studied in England. He would later become a well-known portrait artist.

After moving to New York in 1825, he became a founder and the first president of the National Academy of Design. He also ran for office, but was defeated in both his campaigns to become New York mayor. Meanwhile, Morse maintained a steady interest in invention, taking out three patents for pumps in 1817 with his brother Sidney Edwards Morse. It wasn’t until 1832 that he first became interested in telegraphy. That year, Morse was traveling to the United States from Europe on a ship, when he overheard a conversation about electromagnetism that inspired his idea for an electric telegraph. Though he had little training in electricity, he realized that pulses of electrical current could convey information over wires. The telegraph, a device first proposed in 1753 and first built in 1774, was an impractical machine up until that point, requiring 26 separate wires, one for each letter of the alphabet. Around that time two German engineers had invented a five-wire model, but Morse wanted to be the first to reduce the number of wires to one.

Between 1832 and 1837 he developed a working model of an electric telegraph, using crude materials such as a home-made battery and old clock-work gears. He also acquired two partners to help him develop his telegraph: Leonard Gale, a professor of science at New York University, and Alfred Vail, who made available his mechanical skills and his family’s New Jersey iron works to help construct better telegraph models.

Morse’s first telegraph device, unveiled in 1837, did use a one-wire system, which produced an EKG-like line on tickertape. The dips in the line had to be de-coded into letters and numbers using a dictionary composed by Morse, this assuming that the pen or pencil wrote clearly, which did not always happen. By the following year he had developed an improved system, having created a dot-and-dash code that used different numbers to represent the letters of the English alphabet and the ten digits. (His assistant Vail has been credited by Franklin T. Pope—later a partner of Thomas Edison—with inventing this “dots and dashes” version). This coding system was significantly better, as it did not require printing or decoding, but could be “sound read” by operators. In 1838, at an exhibition of his telegraph in New York, Morse transmitted ten words per minute using the Morse code that would become standard throughout the world.

In 1842, Morse convinced Congress to provide $30,000 in support of his plan to “wire” the United States. Meanwhile, Morse also solicited and received advice from a number of American and European telegraphy experts, including Joseph Henry of Princeton, who had invented a working telegraph in 1831, and Louis Breguet of Paris. In 1844, Morse filed for a patent (granted 1849) of the printing telegraph. He had already proved that his device worked over short distances, and the Federal funds he raised had allowed him to string a wire from Baltimore to Washington. On May 11, 1844, Morse sent the first inter-city message. Soon thereafter, he gave the first public demonstration, in which he sent a message from the chamber of the Supreme Court to the Mount Clair train depot in Baltimore. The message itself was borrowed from the Bible by the daughter of the Commissioner of Patents and said, “What hath God wrought?” By 1846, private companies, using Morse’s patent, had built telegraph lines from Washington to Boston and Buffalo, and were pushing further. The telegraph spread across the US more quickly than had the railroads, whose routes the wires often followed. By 1854, there were 23,000 miles of telegraph wire in operation. Western Union was founded in 1851, and in 1866, the first successful trans-Atlantic cable link was established. Though Morse didn’t invent the telegraph and did not single-handedly create Morse Code, he may have been telegraphy’s greatest promoter, and undoubtedly contributed to its rapid development and adoption throughout the world.

Morse died of pneumonia in New York on April 2, 1872. Late in his life, he shared his considerable wealth through grants to colleges such as Yale and Vassar, in addition to charities and artists.

http://web.mit.edu/invent/index.html
Modern Photocopier

The everyday actions of any office worker undoubtedly involve making a photocopy. Though we take this seemingly simple, yet extremely helpful, time-saving operation for granted, only through the ingenious work and perseverance of people like Robert W. Gundlach are we able to so carelessly rely on the technology.

Gundlach, born on Sept., 7, 1926, earned a B.A. in Physics from the University of Buffalo in his native New York State in 1949. He pursued graduate studies until 1951 when he joined Surez Plastics and Chemicals. The following year, he was hired by the Haloid Company, which, in 1944, had acquired rights to Chester Carlson's electrophotography technology. The company would later become Haloid Xerox, Inc., and finally, in 1961, Xerox Corp.

At the time Gundlach joined the firm he was just 26 years old and there were just under a 100 people working on a new process called "xerography" for making copies. The technology was just beginning to gain some acceptance in the business world, but the copies the machines were capable of producing were crude, and the equipment was slow, expensive and cumbersome.

As one of the first scientists hired by Haloid, Gundlach, who got a chance to work with and become well acquainted with Chester Carlson, was charged with improving xerography machines and making them smaller, faster and more affordable. Work he did during his first year at Haloid resulted in three patentable inventions, one of which made it possible to create metal masters for offset duplication. He also developed an idea that allowed photocopiers to reproduce solid shapes, rather than simple outlines, which made the idea of making copies more universally acceptable. The "Xerox Tone Tray" components he created for this purpose were leased en masse at great profit to Xerox; these first became available in the 1950s.

Gundlach's most lucrative patent for Xerox, however, was for "tri-level development," or creating two colored images in a single pass. He and his son, who also worked for Xerox, are said to have come up with the original concept, where a transparent toner would be used to undercoat the areas of a page that would be printed on, then the machine would print by inkjet over the coated areas and put the paper through a xerographic fuser to set the image.

A team lead by Gundlach designed a complete system that would develop a second color very softly without disturbing or contaminating the first color image. New software was needed to generate the program for the laser, which could write the two sets of images at just the right voltages. The technology was introduced in 1991 as the 4850 Highlight Color Laser Printing System. It has generated around a billion dollars a year for Xerox since its debut.

In all, Gundlach earned 155 of his more than 164 total patents while working for Xerox, from where he retired in 1995. He was named Xerox's first Research Fellow in 1966, and in 1978, Senior Research Fellow. His patents cover imaging methods and fusing processes, cleaning methods, optical systems and charging systems.

Gundlach's many honors and awards include the 1963 Charles E. Ives Award for "Best Paper of the Year," the Kosar Memorial Award in 1976, the Johann Gutenberg Prize from the Society for Information Display in 1993, and the Lifetime Achievement Award from the Electrostatics Society of America in 1997. He was elected to the National Academy of Engineering in 1994, and in 1995 he was recipient of the Xerox Presidents Award for Lifetime Achievement.

Since his retirement and as of this 2006 writing, Gundlach has been working for companies such as Aetas Technology, where he earned his 160th patent on a charging process for full color xerographic imaging; Xerox, where he occasionally serves as an expert witness in litigation projects; and as a Research Fellow with Torrey Pines Research of Rochester, New York.

He also works on his own projects related to energy conservation with an eye on curbing global warming. In this vein, he developed a new high efficiency heat pump system that he claims could help reduce energy required to heat and cool residential housing in urban areas by over 60 percent. In 2005, Gundlach was inducted into the National Inventors Hall of Fame.

http://web.mit.edu/invent/index.html
Scotsman Robert Watson-Watt was born April 13, 1892 in Brechin, Aberdeenshire. In 1912, he completed his BSc in engineering at University College, Dundee, which was then part of the University of St Andrews. Watson-Watt was especially interested in radio waves during his college years. Upon graduation he worked as an assistant to professor William Peddie, who encouraged his interest in the subject, but in 1915 he began a job as a meteorologist at the Royal Aircraft Factory. There he focused on using radio waves to locate thunderstorms to be able to warn pilots. When lightning ionizes in air, it gives off a radio signal. Watson-Watt planned to detect and use this signal as the basis for his warning system. During the course of his research, however, he realized there was a need for a quick way to record and display these signals. In 1916, he first proposed using cathode ray oscilloscopes for this purpose. These devices became available in 1923. Thus, storms several hundred miles away could be located accurately.

In 1924 Watson-Watts moved to the Radio Research Station in Slough, Scotland. He was named Superintendent of the National Physics Laboratory there in 1933, and, later that year, Superintendent of a new radio division of the NPL in Teddington. After hearing that the aggressive Nazis had developed what they called a "death ray," capable of destroying entire towns and cities by air, the government asked him to develop a radar (Radio Detection and Ranging) tracking system for detecting aircraft movement.

The concept of radar had been mentioned years earlier in science fiction books and many nations were working on similar technologies. Watson-Watt is credited with developing the first successful full-fledged working system. Presented in a report in 1935 entitled "The Detection of Aircraft by Radio Methods," his research preceded a successful test using a short-wave radio transmitter against a Heyford Bomber. The test was conducted in secret, reportedly with only three witnesses. Watson-Watt was subsequently named Superintendent of a new division of the Air Ministry, the Bawdsey Research Station, in 1936. By the end of 1938 a secret system was in place along the East and South coast of England, just in time for the outbreak of war in 1939.

During the war, Watson-Watt's invention proved invaluable in helping the British forces defend themselves against German aircraft. It helped the Royal Air Force win the Battle of Britain in 1940, and was instrumental in ending "The Blitz" in 1941. Eventually it was able to detect aircraft at up to 100 kilometers. Watson-Watt was knighted in 1942.

In 1939, Watson-Watt was named Scientific Advisor on Telecommunications (SAT) to the Air Ministry. He travelled to the United States to assist in setting up radar there as well. After World War II concluded he spent much of his time in Canada and the United States, and he published a book, "Three Steps to Victory," in 1958. He returned to Scotland in the 1960s, where he died December 5, 1973.

http://web.mit.edu/invent/index.html
Raymond Kurzweil (1948- ) is one of the world's true pioneers in the field of human-computer interfacing. Born in Queens, New York in 1948, Kurzweil grew up in an academic family. His grandmother, for example, was one of the first women in Europe to earn a PhD in chemistry. His parents were artists — his father a musician and conductor and his mother a visual artist — who encouraged young Kurzweil's creativity. At the age of five he began building his own model boats, cars, and rocket ships. He built a simple computing device when he was 12 and also learned how to program with the help of his uncle, an engineer at Bell Labs.

When Kurzweil was 15, he began his first project involving pattern recognition—teaching machines how to see and understand patterns in information. In high school, Kurzweil began corresponding with Marvin Minsky, an artificial intelligence guru at the Massachusetts Institute of Technology. Kurzweil chose to attend MIT partially because of his relationship with Minsky. There he double-majored in computer science and creative writing.

While he was taking classes, Kurzweil founded a company where he used a computer to match high school students with colleges. He later sold his company to Harcourt for $100,000 plus royalties. In 1970, he completed his BS at MIT and just a few years later he founded Kurzweil Computer Products, a software and hardware company. There Kurzweil and his team invented what would be one of the hallmarks of his entire career—the Kurzweil Reading Machine, which included the first CCD ("charge coupled device") flatbed scanner and first omni-font OCR ("optical character recognition") software. The machine used only 64K of RAM and was able to scan lines of text one at a time. The machine "recognized" each character as it passed regardless of typestyle; corrected the order of the characters in its memory; determined the pronunciation of the resultant words according to pre-programmed phonological rules; and articulated those words through a speech synthesizer, also created by the company.

The Kurzweil Reading Machine was introduced in 1976; it has been called the first commercial product to use artificial intelligence technology successfully. The machine also provided a foundation for all subsequent text-speech technology, including the automatic speech recognition systems developed by Kurzweil and his colleagues at Kurzweil Music Systems with Wonder as musical advisor. Kurzweil and his team set out to invent a method of capturing and recreating the true sounds and musical response of acoustic musical instruments such as the grand piano, violin, guitar and drums. The team created the K250 keyboard synthesizer in 1983, the first electronic instrument to reproduce successfully the sounds of acoustic instruments. Kurzweil sold Kurzweil Music Systems to Young Chang, a large Korean musical instrument company, in 1990.

Kurzweil has won a number of awards for his work, including the 2001 $500,000 Lemelson-MIT Prize, as well as the 1999 National Medal of Technology from President Clinton and Design News' Engineer of the Year award in 1990. He has been awarded 11 honorary doctorates and has received awards from 3 U.S. Presidents. He also wrote the award-winning book, "The Age of Intelligent Machines" in 1990, which was accompanied by an award-winning documentary film, and "The Age of Spiritual Machines" in 1999, which achieved #1 status in the category of science on Amazon.

Today, in 2001, Kurzweil serves as founder and president of Kurzweil Technologies in Wellesley Hills, Mass. There, he is working on his Accelerating Intelligence Network, a Web-based subsidiary of Kurzweil Technologies that showcases ideas of leading technologists. Among other creations, Kurzweil developed "Ramona", a photo-realistic, interactive lifelike avatar (virtual personality) that guides users through the KurzweilAI.net site.

His company's work also includes a joint venture with the American Board of Family Practice called the Medical Learning Company (MLC). MLC is the developer of FamilyPractice.com, a comprehensive online resource for family practice physicians which has also developed a virtual patient for use in medical training. Kurzweil Technologies' Kurzweil CyberArt Technologies division develops and markets artificially intelligent software with a creative bent, including Ray Kurzweil's Cybernetic Poet which helps users write poetry and song lyrics, and AARON, a "cybernetic" artist. Finally, Kurzweil's FatKat, Inc. is currently developing pattern recognition-based technology to make stock market investment decisions.

http://web.mit.edu/invent/index.html
The Walkie-Talkie

The pioneer nonpareil of wireless telecommunications is Al Gross. In 1938, he invented the walkie-talkie. In 1948, he pioneered Citizens' Band (CB) radio. In 1949, he invented the telephone pager. His other inventions include the basics of cordless and cellular telephony.

Gross was born in Toronto in 1918, but grew up in Cleveland, Ohio. He discovered his lifelong enthusiasm for radio on a steamboat trip on Lake Erie at age 9, after the ship's radio operator let him listen to the wireless. By age 12, Gross had turned his basement into a radio headquarters, with equipment patched together from junkyards. At age 16, he obtained his amateur radio license — still in effect today.

Gross’ interest and ability had increased by the time he entered the BSEE program at Cleveland's Case School of Applied Sciences (now part of Case Western Reserve University) in 1936. Determined to exploit the unexplored frequencies above 100 MHz, Gross set about inventing a mobile, lightweight, hand-held two-way radio. In two years, Gross had invented and patented the "walkie-talkie" (1938).

At that time, the Communications Group of the US Office of Strategic Services (OSS) was eager to develop a portable, two-way, air-to-ground communications system. The OSS recruited Gross, who worked for them throughout World War II. By 1941, Gross designed both a ground unit, "Joan," and an airborne unit, "Eleanor," which communicated with each other via Hertzian radio waves in a manner virtually impossible to monitor, even behind enemy lines.

The units had an effective range of about 30 miles. The transceiver of the ground unit weighed only 3 1/2 pounds, with a collapsible antenna, and was powered by two B and two D batteries. It could easily be carried and hidden by a soldier on hostile ground. The airborne unit, carried most often in British "Mosquito" bombers, was more complicated, heavier, and fitted with an adjustable, external antenna to transmit and receive at pre-arranged polarization. Although Gross’ Top Secret system was not declassified until 1976, the US Joint Chiefs of Staff have called it one of the most successful wireless intelligence gathering methods ever employed.

After the War, the FCC, which had become aware of Gross’ work, allocated the first frequencies for personal radio service, the Citizens Radio Service Frequency Band (1946). Gross formed a company, Citizens Radio Corporation, to produce two-way radios for personal use; in 1948, his company’s equipment was the first to receive FCC approval for use in the new "Citizens' Band." Gross sold about 100,000 units himself, most of them to farmers and to the US Coast Guard; he also licensed the technology to various electronics companies.

In 1949, Gross made another breakthrough: he adapted his two-way radios for cordless remote telephonic signaling. That is, he invented and patented the telephone pager, by building discriminating circuitry into a pocket-sized wireless receiver that responded selectively to specific signals. Gross intended for his invention to be used by doctors; and so he attended a medical convention in Philadelphia that year. Nearly all of those healthcare professionals worried the device would upset their patients or even interrupt their golf games. However, New York's Jewish Hospital did implement Gross' pager system the next year (1950).

In the 1950s, Gross tried — again, in vain — to interest US telephone companies in his inventions and ideas for mobile telephony. Bell Telephone was not interested, and other companies were afraid of Bell’s monopoly on transmission lines. The FCC, to which Gross had demonstrated his pager system in 1950, finally approved his transceivers in 1958.

Gross continued to invent, earning a total of 12 patents, through the 1950s and '60s. Eventually, he began working for large corporations, such as Sperry and General Electric, as a specialist in microwave and other electronic communications systems. Since 1990, he has been Senior Staff Engineer at Orbital Sciences Corp.'s Chandler, Arizona facility, where he directs analysis of various electromagnetic elements of aerospace, satellite and military systems.

Besides working full-time, Gross also pursues personal projects. But his greatest enthusiasm is for the presentations he frequently gives to local elementary and high school students on technology and invention. Thus, as Gross likes to put it, "People learn from the old guy who did it the hard way."

Gross was too far ahead of his time to cash in on his inventions: his patents expired long before the public was ready for CB radio, cell phones and pagers. But his love of the work outweighs any regrets: he always smiles when he says, "If I still had the patents on my inventions, Bill Gates would have to stand aside for me."

On the other hand, Al Gross has been rich in honors and awards. He has followed up Commendations from the US Defense Department (1969) and President Reagan (1981) with about a dozen awards from national organizations like the IEEE. Most recently, Al Gross won the 2000 Lemelson MIT Lifetime Achievement Award. Gross was honored at the sixth annual Lemelson-MIT Awards Ceremony, held at the American Museum of Natural History in New York on April 27, 2000.

http://web.mit.edu/invent/index.html
The World Wide Web

In the complex history of innovation flowing to and from the Internet, one major achievement is uncontested: in 1989-91, Tim Berners-Lee invented the World Wide Web.

Tim Berners-Lee was born in 1955 in London, England. His parents were both mathematicians, who worked on the Ferranti Mark I, the first computer to be sold commercially. Berners-Lee's childhood hobby was electronics. When he entered Queen's College at Oxford University in 1972, Berners-Lee chose to major in Physics, hoping to utilize his native talents in both scientific theory and practical application.

While at Oxford, Berners-Lee built his first computer. Soon after graduating in 1976, he became an independent software consultant. In this capacity, he spent the latter half of 1980 in Geneva, Switzerland, at CERN, the European Particle Physics Laboratory. While off-duty at CERN, Berners-Lee was pursuing a personal project: an information-storage program that encompassed random associations ("links") between generally unrelated items. This program, called "Enquire," was the conceptual groundwork for what became the Web.

After some further commercial work in graphics and communications software, Berners-Lee returned to CERN as a Fellow in 1984. Five years later, having gained experience in real-time data acquisition systems, he proposed that a global hypertext database be constructed in which every package of data would have a distinct "Universal Document Identifier" [UDI], which any network user could use to retrieve that data. Berners-Lee dubbed his project "the World Wide Web."

The Internet had been designed in 1973, and was up and running by 1983. As developed by Vinton Cerf and others, the Internet is basically an international network of computers that delivers "packets" of information from one "address" to another -- the most familiar example being e-mail. Berners-Lee's vision was to create a comprehensive collection of information in word, sound and image, each discretely identified by UDIs and interconnected by hypertext links, and to use the Internet to provide universal access to that collection of information.

Berners-Lee made his vision a reality within two years of his proposal. At CERN, working on a NeXT machine, he composed the first server, "httpd," and hypertext browser/editor, "WorldWideWeb," in late 1990. In the summer of 1991, Berners-Lee made the Web available on the Internet. By giving the specifications for HyperText Markup Language (HTML: the code in which Web sites are written), HyperText Transfer Protocol (HTTP: the code by which sites are moved into and out of the Web), and UDIs (now a.k.a. URLs), Berners-Lee made it fairly easy for anyone with Internet access to contribute, as well as collect, information.

Over the years, openness of information has remained Berners-Lee's guiding principle. That is why he never took steps to gain intellectual property or other commercial rights over the Web, as the international computing community came to realize its immense potential. In 1994, after academia and industry had begun to use the Web --- thanks mainly to the first easy-to-use browser, Marc Andreessen's and Eric Bina's Mosaic --- Berners-Lee formed the World Wide Web Consortium [W3C], based at the Laboratory for Computer Science at MIT (where he had just joined the faculty).

Today, Tim Berners-Lee continues his work of promoting the Web as an open, accessible, interactive and universal community. He has recently written a book about his past, present and future visions of his creation, "Weaving the Web."

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