Thomas Edison: Father of Innovation Management

For years I have been talking with participants in my innovation workshops around the world about the American inventor, Thomas Edison, and recommending that they study him - his ways of thinking and his methods. If they had gone to the source closest to hand nowadays, Wikipedia, they might have found a lengthy and unintelligible essay. My hope is that this piece might prove to be more useful.

by Roger Neill

While Edison's reputation as an inventor of genius, perhaps the greatest the world has known, is secure, widely acknowledged throughout the world, his pioneering role - as the father of project management - is less widely recognised or understood.

This situation was substantially of his own making, the result of his consistent management of his personal "brand" – a term from a later era, but one which he would have understood well. Edison the Great Inventor bestrode the media of his era, personally creating and managing his reputation as a genius and becoming as a consequence a major celebrity in his own lifetime. It appeared that he and he alone was the *fons et origo*. In reality he managed multiple parallel project teams from quite early in his extraordinary career – teams consisting of brilliant and diverse talents, working together to solve problems and find new solutions. "The greatest invention of the nineteenth century," the mathematician and philosopher Alfred North Whitehead wrote, "was the invention of the method of invention."

journeys of discovery – so much so that he often found difficulty in embracing other people's breakthrough concepts. For years he resisted the benefits of alternating current in the supply of electricity, of the flat disc as the medium for recording and playback, and of the wireless, the radio. This syndrome is quite commonplace among inventors, both geniuses and lesser mortals. The destination having been envisioned, Edison usually moved swiftly from imaginative leap to systematic exploration and problem-solving, captured perfectly in his best-known adage: "Genius is ninety-nine percent perspiration and one percent inspiration." It might be noted that, without that one percent, the remainder of the work is usually redundant.

My own sense is that even his most triumphant and visionary successes have been dramatically undervalued. With his colleagues, he was not just the inventor in 1877 of the phonograph: in reality he imagined and found a way to make real both the recording of sound and its playback. That opened the way for the

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However, it must be said that Edison was invariably the visionary, the one who imagined and initiated each of the great whole recording industry, for much that happens in sound on radio and television, for sound on film, and for the multitude of other specialised applications that fill our lives today.

He was not just the inventor in the 1879 of the electric light bulb: he envisioned and created the whole system needed for domestic, commercial and street lighting, including generators, fuses, sockets and all the rest of the paraphernalia needed. He believed that electricity would sweep away gas as the power source for lighting, and he made it become a reality.

Other major projects were aimed at making unsatisfactory innovations function properly. It is well known that Alexander Graham Bell invented the telephone, but less well understood that, in order to make Bell's machine work at all, you had to shout, and even then the sound produced at the other end of the line was both faint and crackly. Edison set about solving this problem, and in the process, by separating voice-out from voice-in successfully, invented not only a fully operational telephone system, but also the first microphone.

In all of his great inventions, Edison's teams worked tirelessly not only to solve the technical and design problems, then to industrialise and commercialise the process, but also continuously to improve the product - sometimes incrementally, sometimes radically. Edison secured 1,093 patents during his lifetime, still a record.

Edison the Child

Thomas Alva Edison was born on February 11th, 1847 at Milan in rural Ohio. Of Dutch stock, his father Samuel Edison had been a

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tailor, a carpenter and a tavern-keeper in Canada by the time of his marriage to the well-educated Nancy Elliott in 1828. Thomas was the seventh child born to Sam and Nancy.

mechanical communication, the telegraph. Messages were transmitted by Morse code – dots and dashes – by means of electrical impulses along a wire. Although he was already partially deaf, Edison could hear

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Not surprisingly he was an inquisitive child, asking questions continuously and constantly conducting experiments. On one occasion he sat for hours on goose eggs to see if they would hatch. When he burned down the barn as a six year-old, experimenting with fire, he was thrashed in the village square by his father, the neighbours called out to view the spectacle. By the age of ten he had a chemical laboratory in the cellar and operated a primitive home-made telegraph.

School for Edison was a disaster. Starting at eight he only survived there for three months, walking out when the teacher told him he was "addled". From that time on, his mother taught him at home. At ten he was reading Shakespeare, Dickens, Gibbon's *Decline and Fall of the Roman Empire* and the *Dictionary of Sciences*. Throughout his life he was to become a voracious reader.

Edison the Teenage Worker-Inventor

At twelve Edison took his first job, as a newsboy on the railway, hawking newspapers, magazines, books, postcards, cigars, fruit and confectionery snacks on board. There was no salary or wage – he lived purely on the proceeds of his sales. Robert Louis Stevenson, recalling his great journey by train across America in 1879, wrote of the newsboys who "imitated the manners of the more vulgar drummers or travelling salesmen who were their steadiest customers." Edison worked from seven in the morning until nine in the evening, in between journeys re-stocking and then studying at the local library. He created and successfully launched the *Grand Trunk Herald*, which he wrote, edited and printed on board in the baggage car, using a second-hand printing press.

During this period Edison became fascinated by the latest means of

these. He invented his own system, which he installed initially at home, then connected to the house of a friend, then six houses were linked together.

His great facility at telegraphy came about quite serendipitously. One day in 1862, when Edison was fifteen, he saw the two year-old son of a stationmaster playing on the rail track, a loose freight car rolling towards him, unable to stop. Edison dashed on to the track, grabbing the child and pushing him to safety. In gratitude, the stationmaster offered to teach Edison telegraphy, and in three months of intensive tuition he became a brilliant operator. He went on to take a series of jobs in different cities as a telegrapher, living in rented rooms and spending his wages on equipment for his experiments.

In Cincinnati, rooming with two actors and a fellow telegrapher, Ezra Gilliland, he conceived the idea of sending two messages at the same time, in opposite directions along the same wire, a technical impossibility at the time. This was a problem he did eventually solve, later moving on to enable four messages to be sent at once, two in each direction. Around this period he also devised electrical rat traps and cockroach exterminators. Perhaps he lived uncomfortably close by these creatures in his cheap accommodation.

Edison the Young Entrepreneur

At twenty-one, frustrated by the work that constantly got in the way of his true vocation, he took a job at the Western Union office in Boston, in his spare time reading constantly at the public library and haunting the bookshops. He bought Faraday's complete works on electricity, reading it at night. "I've got so much to do and life is so short," he said to a friend.

In Boston he found backers - for his "duplex" telegraph and for another of his ideas, an electric vote-recorder (his first patent) - so he resigned from Western Union and became a full-time inventor and entrepreneur. Both products failed, but his next innovation, a machine giving minute-by-minute stock prices (a "stock ticker") was a success.

The following year, Edison moved to New York. Shabby, dirty and penniless on arrival, he talked a tea-taster into giving him a packet of tea, which he exchanged in a nearby café for coffee and apple dumplings. Without a bed, he walked the streets that night, the next morning finding a friend who lent him a dollar, which he lived on for several days.

He visited the Gold Indicator Company in New York, an organisation set up to market his stock ticker. The still-homeless Edison was allowed to sleep in the battery room and pursue his experiments. When the company's machine broke down, amid some panic, Edison quickly fixed the fault and was promoted to Chief Engineer, going on significantly to improve the effectiveness of the company's equipment.

He then set up his first company with two colleagues, a businessman and a publicist, to develop and market stock tickers. With this, Edison became a manufacturer, with workshops in Newark, New Jersey. He expected his staff to work as hard as he did, on one occasion locking them in for sixty hours until together they had tracked down and repaired a fault.

On Christmas Day 1871, he married one of his workers, sixteen year-old Mary Stillwell. They were to have three children, the first two being the telegraphically nicknamed Dot and Dash. But Edison was mostly an absent husband and father, working day and night and only taking short naps. He kept invoices and bills on two hooks in his office, saying "the humbuggery of bookkeeping, which I never understood."

By this time he was caught in power plays between Western Union and the entrepreneur, Jay Gould, Edison pulled this way and that by the competitors. Edison moved on to develop pioneering copying devices - the electric pen and the mimeograph - then went back to the telegraph he had worked on so assiduously as a teenager, this time wishing he could develop it from "duplex" to "quadriplex", so that four messages could be transmitted simultaneously. He solved the problems successfully, supported by Western Union, but when they failed to pay his bills, he took

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the invention to Gould, only to be cheated by him. So he returned to Western Union, who made a fortune out of the invention. All this led to lengthy legal disputes regarding ownership of the patents and the whole experience persuaded Edison that he should stop being a manufacturer and go back to being a full-time inventor.

Edison the Project Manager

The twenty nine year-old Edison now (in 1876) built new workshops in the woods at Menlo Park, New Jersey, only twenty-five miles from New York City. Here he was to recruit and lead whole teams of outstanding engineers and scientists who worked on many projects in parallel. Some regard this as his greatest innovation. Certainly it has had profound and sustained consequences all over the world.

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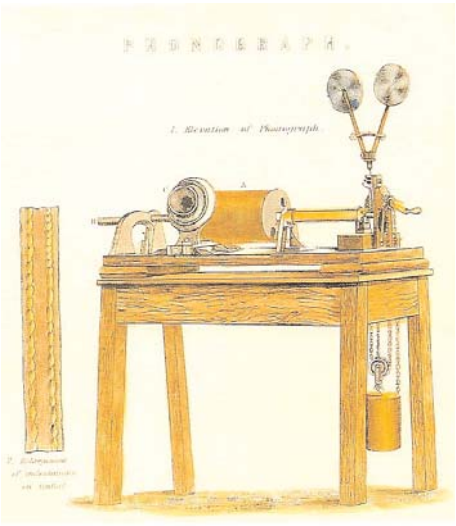
Moreover it was to become the most fecund period of his life. Some inventions were of a specialised nature, of long-term importance to the future of science and technology. Among them, the "tasimeter" measured heat very precisely – a gas jet at a hundred feet, the sun's corona in an eclipse; the "odorscope" measured smells undetectable to the human nose; the megaphone enabled speech to travel over several miles.



Edison's tin-foil phonograph of 1878

However two specific areas occupied the most time and energy – the telephone and the phonograph. The latter was a completely new concept, the former an invention that needed significant improvement in order to become practically useful.

As has already been noted, the Scottish-born Bell invented the telephone, filing the patent in February 1876. The major drawback of Bell's instrument was that outgoing and incoming sounds, transmitter and receiver, went through the same device. The speaker had to shout and the listener heard this only faintly, through a fog of hiss and crackle. Edison was commissioned by Western Union to find an answer. It became clear to him that sending and receiving should be separated, and that the signal had to be boosted, but that was only the beginning. He needed to invent a new kind of transmitter, incorporating a form of variable resistance which corresponded to the sounds of the voice.

He and his telephone team worked by trial and error, assessing some two thousand different chemical compounds before arriving at an ideal solution, carbon. This was positioned as a button between two metal plates. At one stroke, Edison had not only enabled the telephone to function effectively, but also invented the first primitive microphone. Because Bell owned the patent on the receiver, his and Edison's inventions had to be used together, and after a period of mutual piracy, Western Union sold their rights to Bell's company for $3.5 million, Edison taking a significant cut.

While working on the telephone, Edison started work on the phonograph. The fundamental idea came to him in a flash. While doing some work on a message repeater for use in Morse code telegraphy, experimentally recording the dots and dashes of Morse code on to paper wound round a grooved cylinder, and then "playing back" the indentations, Edison noticed that the pointed stylus he was using on the paper cylinder "gave off a humming noise from the indentations – a musical, rhythmic sound resembling that of human talk heard indistinctly." Edison wondered whether human speech could be similarly recorded and reproduced.

So he connected the telephone transmitter and the cylinder machine together and "shouted the words 'Halloo! Halloo!' into the mouth-piece, ran the paper back over the steel point and heard a faint 'Halloo! Halloo!' in return." Thus was sound recording born.

A machine was built and a demonstration set up for the lab staff. Edison recited "Mary had a little lamb…" into the mouthpiece to a frankly incredulous audience – until his voice clearly came back reciting the nursery rhyme. "There is no doubt that I shall be able to store up and reproduce at any future time the human voice perfectly," wrote Edison.

The patent application named a number of anticipated usages: the new machine would "be largely devoted to music, either vocal or instrumental – and may possibly take the place of the teacher. It will sing the child to sleep, tell us what o'clock it is, summon us to dinner, warn the lover when it is time to vacate the front porch…and even receive the last messages of the dying. It will enable the children to have dolls that really speak, laugh, cry and sing… It will preserve the voices of our great men and enable future generations to listen to speeches by a Lincoln or a Gladstone. Lastly, the phonograph will perfect the telephone and revolutionize present systems of telegraphy."

This is an extraordinary list, clearly the product of some sort of early "brainstorm". Some of the applications took wing as soon as the phonograph became commercially available, while others took time to become a reality. I particularly like Edison's prediction, some half a century in advance, of the "ansaphone" and its successors.

The first phonographs turned out to be something of a fad. They played for less than a minute and produced faint and fuzzy sound. Edison decided to move on and in 1878, on a vacation with a group of scientist friends in the Rocky Mountains, he was struck by a thought of his friend, Professor George Barker, that he might look at the possibility of producing light electrically.

The existing electrical system, the arc light originally developed by Sir Humphrey Davy in 1808, was "too bright and too big", wrote

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Edison and assistant experimenting with electric light

Edison. “What we wished for was little lights, and a distribution of them in people’s houses in a manner similar to gas.”
It is clear that from the start Edison envisioned the complete system, from the generation of the electricity, through its distribution, to the lamps themselves, together with necessary fuse systems. So many parts of this system needed either to be invented from scratch, or to have adaptations made to existing inventions.

In developing the lamp, the key problem was that the early filaments tested were both too expensive and burned out too quickly. Edison shifted quickly from “imaginative leap” to “trial and error”. Eventually he settled on carbon as the basis, a substance he understood well from earlier work, but he needed to find a suitable substrate on which to bond the carbon to a thread, over time testing more than 7,500 materials. For a while, cotton thread seemed the best candidate, the filament lasting for 45 hours, then cardboard. “Finally, I carbonized a strip of bamboo from a Japanese fan, and saw that I was on the right track,” wrote Edison. Now they had to establish which strain of bamboo would be best suited for the purpose. It was in the end in Japan that they found exactly what they were looking for. It gave 900 hours of continuous light.

In parallel, Edison built a glass-blowing plant at Menlo Park, installed the most advanced vacuum equipment, calculated the size and cost of copper mains, worked on an improved dynamo, driven by steam and producing a steady 110 volts, created a system for sending power from the generators, through feeder wires, to distribution points, and from there to individual buildings and streets.

Edison was asked around this time how he arrived at his ideas: “Often, perhaps while walking on Broadway with an acquaintance, and talking about quite other matters, amid the din and roar of the street, the thought would suddenly flash in his mind that such a desired thing might be accomplished in a certain way. He would hasten home, set to work on the idea, and not give up until he had either succeeded or found the thing impractical.”

First, Edison successfully provided the lighting system for a newly-built ship, the SS Columbia. Then he had eight miles of underground mains laid at Menlo Park, lighting the houses in the village - and lamp posts for streets that did not yet exist.

Now he turned his attention to the southern end of Manhattan, moving his headquarters there and obtaining agreement from New York City to set up a complete system, including the laying of eighteen miles of underground mains. “I saw every box poured and every connection made on the whole job,” he said. “There was nobody else who could superintend it. I used to sleep nights on piles of pipes at the station.” On September 4th, 1882, the lights were switched on. Edison was thirty five.

Edison the Celebrity

Today we sometimes seem to believe that the cult of celebrity is a modern phenomenon. It clearly is not. The print media in the late nineteenth and early twentieth centuries were well developed, diverse and powerful in their ability to create public heroes.

Like, for example, the Australian diva, Dame Nellie Melba, the great Polish pianist, Paderewski, and the Scottish writer, Robert Louis Stevenson, Thomas Edison became world famous, a legend in his own lifetime. Each of them recognised the importance of projecting clearly and consistently their own personal “brand”, taking responsibility for the management of that process themselves.

So strong was public interest in him by 1876 – visitors made pilgrimages in droves to see his workshops in Newark even before he had done his work on the phonograph or electric lighting – that he decided to move lock, stock and barrel to a new campus at Menlo Park. How did he achieve such a position? And how did he sustain and grow it?

The following year, 1877, the local press began to report on Edison’s work on the telephone. Even at this early stage, Edison presented himself as forthright, even cantankerous, to journalists. This stance can create enemies, but from the news reporter’s standpoint it always makes for more interesting copy. Edison stoked up media hostility between himself and Bell, referring to the “inexplicable peculiarity” of the Scottish inventor’s telephone, allied apparently to the “witches of Salem”. His flair for publicity was outstanding – courting journalists and constantly handing them sensational stories about future breakthroughs.

Edison consistently courted the scientific press, the phonograph particularly stimulating high levels of interest and coverage. He was invited to demonstrate it at a meeting of the National Academy of Sciences in Washington DC, his every

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comment reported by the *Washington Post*. The hall was so packed that the doors were taken off their hinges in order to enable the maximum numbers to hear his demonstration of his amazing new machine.

On a trip west in 1878 with other leading scientists to observe an eclipse, Edison took along his recently-developed "tasimeter" in order very publicly to measure the heat of the sun's corona. In the party was Edison's most consistent journalist-supporter, Marshall Fox of the *New York Herald*. The experiment was also written up by another member of the group, the editor of the most influential scientific magazine, *Nature*.

Two years later, having been approached by a young freelancer on the *New York Times*, Edison set up and financed a new magazine, *Science*. It was, of course, a big supporter of Edison, his interests and his ideas. Notwithstanding a short break in 1882, *Science* remains one of the world's most prestigious journals covering original scientific research.

"Edison shifted quickly from 'imaginative leap' to 'trial and error'."

A major marketing opportunity was presented by the great expositions of the period, and Edison took full advantage of his celebrity to have his inventions dominate them. At the International Electrical Exhibition in Paris in1881, Edison's entire output was displayed, and a French journalist was hired to place regular laudatory articles in leading French publications. One outcome was the commission to provide lighting for the Great Foyer of the Paris Opéra, followed by the installation of Edison chandeliers at La Scala, Milan.

Perhaps the greatest of these exhibitions was the Exposition Universelle of 1889, again in Paris. As so often before, Edison dominated the massive Palais des Machines, taking a huge display space and including a forty foot high incandescent lamp mounted on a twenty foot pedestal and continuous demonstrations of the newfangled phonograph. It has to be said that everything at the expo was overshadowed by the amazing newly-erected Eiffel Tower, the clear star of the show and much admired by Edison. "I like the French," he said. "They have big conceptions. The English should take a leaf out of their books. What Englishman would have conceived this idea?" All told there were over 32 million visitors.

Edison's Failures

It would be wrong to give the impression that everything Edison touched was a success. His problem was that the dogged determination that served him so well when he was winning prevented him from abandoning projects that turned out to be losers.

One of the most debilitating of these was in iron ore milling from the mid-1880s. Edison believed that he could find a way using magnetism to extract iron from the waste from worked-out Appalachian mines. He succeeded after many years, but the process could not compete on price with freshly mined ore from new quarries. Yet, out of this fiasco, Edison created something important and new: the Portland cement kiln and the process surrounding it, enabling America to be self sufficient. Up to that time the material was all imported from Britain.

Later he spent several years, past his eightieth birthday, trying to develop an alternative to imported rubber. Having patiently tested and cross-bred dozens of native American trees, he declared victory – but the price was still too high, and in the meantime synthetic rubber had been developed in Germany.

His battle for direct current (DC) versus George Westinghouse's espousal of alternating current (AC) turned out to be his most comprehensive defeat, although DC has its supporters even now.

Other "failures" were inventions whose time had not yet come. In 1880 he pioneered the electric train, and over a long period he worked on his storage battery, considered by Edison "the most valuable of all his creations…it will revolutionise transportation." Its application to the automobile over a century later may yet prove him right.

Sound and motion pictures

Having moved on from the phonograph for nearly ten years, regarding it as more of a novelty item than a major product line, Edison returned to the fray when, in 1886, his major rival, Alexander Graham Bell, launched his "graphophone" - an improved product with a wax-coated cylinder. Edison responded with a solid wax cylinder and his team created an electroplated "master" record. This was a major breakthrough enabling for the first time large numbers of copies of each recording to be made. In the financial arrangements following this invention, Edison was cheated out of the business by his long-term friend and business associate, Ezra Gilliland. However that company failed and Edison was able to buy his patents back cheaply. And when Victor and Columbia became successful with Emile Berliner's newly invented disc records, Edison eventually followed suit, putting out recordings by both popular and classical artists.

Simultaneously, in 1887 or 1888 Edison became interested in the idea of developing motion pictures, conceiving them (prematurely) with sound. When the inventor of the Kodak camera, George Eastman, produced continuous strips of celluloid film, Edison realised that he could create a machine, a pioneering movie camera which he called a "kinetograph". Initially his goal was "to produce pictures representing objects in motion through an extended period of time." "Persistence of vision" was the goal, and this was achieved – using 46 images per second, creating the illusion of continuous flow, a "happy combination of photography and electricity," according to Edison. Motion pictures were made, dozens of them, in the "Black Maria", a specially constructed studio at West Orange, New Jersey – the first film studio in America.

At the last

In 1929 his closest friend and admirer, Henry Ford, organised a special celebration of the fiftieth anniversary of Edison's electric light. At the opening, towards the end of President Hoover's speech, Edison collapsed. He never fully recovered his health and died on October 18th 1931, aged eighty four.

"Farewell, Thomas Edison," the Paramount newsreel declaimed. "The nation places you among the immortals of America – and of all time."

For further reading, I recommend *Edison: Inventing the Century* by Neil Baldwin, Hyperion, New York, 1995.