



The roots of industrial engineering – The Gilbreths: Cheaper by the dozen

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Frank Bunker Gilbreth (1868–1924) and Lillian Evelyn (née Moller) Gilbreth (1878–1972) could perhaps be regarded as the mother and father of modern industrial engineering. They were an innovative husband-and-wife team that revolutionised the way we do things today.

Frank was the youngest of three children. Lillian was the oldest of nine children. He came from a long line of New Englanders. She came from a family of German descent. He was born on the USA's East Coast. She was born on the West Coast. He was the owner of a very successful construction business. She was an educated woman with social standing and grace. He started his adult life as an assistant bricklayer with no formal education beyond high school. She started her adult life as a student of English literature. He was a young man who had to support his mother and aunt financially. She lived a privileged early life as a member of a wealthy family.

They met in Boston in 1903, when Lillian was on her way to tour Europe, and they were smitten with each other. They got married in 1904, had a very happy and successful marriage, equally sharing their family and professional commitments and responsibilities. Lillian gave birth to 13 children, 11 of whom survived into adulthood. One child died at birth and the second eldest, Mary Elizabeth, suffered from diphtheria and died in 1912 at the age of six. The other children were Ernestine, Frank Jr, Anne, Martha, William, Lillian, Frederick, Daniel, John, Robert and Jane.

The Gilbreths perhaps became the best-known and most successful husband-and-wife team in the world of engineering of the early 20th century. They made significant and innovative contributions to science



→ *Frank and Lillian Gilbreth.*

and engineering in disciplines such as motion study, scientific management, ergonomics, human factors, continuous improvement and psychology. They can claim credit for numerous patents and innovative designs aimed at finding and implementing “the one best way” of doing a job. This includes the definition of the so-called “18 fundamental motions” or therbligs, including search, find, select, grasp and position, many of which are still part of modern-day computer user interfaces. These motions are used to study motion economy in the workplace.

After World War I, Frank and Lillian contributed extensively to the improvement of surgical and rehabilitation procedures for returning soldiers.

One day, when a mailman observed the Gilbreth “brood”, he asked: “How d’ya ever feed ‘em?” Frank responded: “Oh, they come cheaper by the dozen.”



→ Frank B. Gilbreth, his wife and children in their family car, nicknamed "Foolish Carriage", in an undated photograph.

And so this phrase became a mantra for 20th-century mass production and automation.

Frank's story

Frank was born on 7 July 1868 to John and Martha (née Bunker) Gilbreth of Fairfield, Maine. After his father's sudden death from pneumonia in 1871 and for financial reasons, his mother was forced to move Frank and his sisters, Anne and Mary, to Boston where she opened a boarding house. After passing the Massachusetts Institute of Technology (MIT) entrance examination in the summer of 1885, Frank decided to forgo higher education and entered the construction trade as a bricklayer's assistant. Frank noted that the bricklayers with whom he trained all had different approaches to bricklaying and soon devised a method that eliminated unnecessary motion and greatly increased productivity.

Frank quickly worked his way up in the company and was soon able

to support his mother and aunt. In 1895, he started his own contracting firm, Frank Gilbreth and Company. The company became famous for its ability to finish projects early and under budget. In 1902, Frank's firm finished building the Augustus Lowell Laboratory for MIT in 11 weeks, a feat unheard of at the time. Frank's firm became highly successful, completing major construction projects all over the USA and abroad. Soon after marrying Lillian, he sold the business and started a consulting firm, Gilbreth Inc., with Lillian as a full and equal partner. This was possibly the first industrial engineering and management consulting firm in history. Frank was the first to propose that a surgical nurse should serve as a "caddy" (Gilbreth's term) to a surgeon by passing surgical instruments to him or her as

requested. Gilbreth also devised the standard techniques used by armies around the world to teach recruits to disassemble and reassemble their weapons quickly, even when blindfolded or in total darkness.

Frank developed many improvements in bricklaying. He invented a scaffold that permitted the quick adjustment of the working platform so that the worker would be at the most convenient level at all times. He equipped the scaffold with a shelf for bricks and mortar, so that the builder no longer had to bend down and pick up each brick. Frank also had other labourers stack the bricks with the best side and end of each brick always in the same position, so that the bricklayer no longer had to turn the brick around and over to look for the best side to face

Life is like a coin. You can spend it any way you wish, but you only spend it once.

– Lillian Gilbreth

We should be taught not to wait for inspiration to start a thing. Action always generates inspiration. Inspiration seldom generates action.
– Frank Gilbreth

outward. The bricks and mortar were placed on the scaffold in such a way that the bricklayer could pick up a brick with one hand and mortar with the other. As a result of these and other improvements, Frank reduced the number of motions made in laying a brick from eighteen to four and a half.

Frank was a member of the American Society for Mechanical Engineers, the Taylor Society and a lecturer at Purdue University. He suffered a heart attack and passed away while waiting for a train. He was 56 years old.

Lillian's story

Lillian was born on 24 May 1878 to William and Ann Moller of Oakland, California. Her father was a store owner and the large family enjoyed a privileged lifestyle. Her mother was often ill and Lillian had to care for her three younger brothers and five younger sisters. She excelled in school and was mainly interested in music and poetry. Despite this, her parents did not expect her to go to college. They thought it was more appropriate for a girl of her social standing to marry a rich man and become a homemaker like her mother. She enrolled at the University of California at Berkeley against her parents' wishes and majored in English, Foreign Languages and Philosophy, planning to become a teacher. She continued her graduate studies at Columbia University and Berkeley and received a doctoral degree in Psychology from Brown University in 1915. This was a remarkable achievement, considering her responsibilities as a wife, mother and full-time consultant. After marrying Frank, she became a full partner in his consulting company.

She may be one of the first female industrial engineers to hold a doctoral degree.

In 1900, after graduating with honours from Berkeley, she was asked to present the commencement speech at the graduation ceremony. She was the first woman in Berkeley's history to receive that honour. This was only the first of many "firsts". She became the first female member of the Society of Industrial Engineers in 1921 and received the first Gilbreth Medal for distinguished contributions to management from the Society of Industrial Engineers. In 1966, she was the first woman to receive the Hoover Medal for distinguished public service by an engineer. She also became the first female professor at the University of Purdue's Engineering School and became a full professor in 1935. She taught at Purdue until her retirement in 1948 at the age of 70. She also received 22 honorary degrees from universities like Princeton, Brown and Michigan.

As a consultant to Macy's, Lillian was so successful in improving productivity that she was asked to train the company's executives in the implementation of her management techniques. While working with General Electric, Lillian set out the principles of good kitchen design, including the "best" height for kitchen appliances. These principles are still adhered to today. She invented the foot-pedal dustbin and the shelves inside a refrigerator. These shelves included one for holding eggs, which is still found in most modern refrigerators. She was also the first person to integrate psychology into concepts of industrial management. Lillian stressed her belief that every housewife and mother should be a homemaker, but above all, an

effective and efficient manager. She was a member of the Society of Mechanical Engineers from 1924, and in 1944, she and Frank received the Gantt Gold Medal from the Society of Mechanical Engineers and the American Management Society. The medal was awarded to Frank posthumously. Lillian served as an advisor to former US presidents Hoover, Roosevelt, Eisenhower, Kennedy and Johnson on matters of civil defence, war production and the rehabilitation of the physically handicapped.

She and Frank have a permanent exhibit in the Smithsonian National Museum of American History, and her portrait hangs in the National Portrait Gallery. She died peacefully at the age of 94.

A formidable team

Although the Gilbreths' work is often associated with that of Frederick Winslow Taylor, there was a substantial philosophical difference between the Gilbreths and Taylor. Taylorism was primarily concerned with reducing the time it took to perform processes. The Gilbreths sought to make processes more efficient by reducing the motions involved. They saw their approach as being more concerned with workers' welfare than Taylorism was. The typical worker often saw Taylorism as management's attempt to increase profit at the worker's expense. Their emphasis on the "one best way" and the therbligs predates the development of continuous quality improvement.

The Gilbreths' lifelong quest consists of finding "the one best way" to make the task faster, but also easier. They aimed to achieve higher productivity without negatively affecting working conditions and to make more profit while making the job easier for the worker. It was a philosophy that pervaded home and school, hospital and community; in fact, life itself. It was something that could be achieved only by cooperation between engineers, educators, physiologists, psychologists, psychiatrists,



→ Frank and Lillian Gilbreth with eleven of their thirteen children (one died at birth, and the other died at the age of six).

economists, sociologists, statisticians and managers. Most importantly, the individual's comfort, happiness, service and dignity are at the core of everything.

Frank and Lillian wrote several books together, such as *A primer of scientific management* (1912). None of these books, however, named Lillian as co-author, because the publishers thought that the books' credibility would suffer if it was known that a woman had co-authored them.

The book *Cheaper by the dozen*, written by two of the Gilbreth's children, Frank Jr and Ernestine Gilbreth Carey, offers some light-hearted anecdotes about life in the Gilbreth household.

For example, if irregular jobs had to be done, such as painting the back porch or removing a stump from the front lawn, each child who wanted extra pocket money had to submit a sealed bid stating their willingness

to do the job, together with the completion time and cost. The lowest bidder got the contract. Frank would oversee and control the project's execution using the same principles he applied with such success to his construction projects.

In an effort to export his philosophy to the planning and improvement of his family's activities in the house's only bathroom, Frank used activity charts, process charts, work charts and other industrial engineering tools to schedule and control bathroom activities. He also controlled the sequence in which these activities should be performed, the time allowed and even the specific motions to be used.

With this purpose in mind, he took motion pictures of his children performing these everyday bathroom activities and analysed them to specify the most efficient way of completing the task. He was possibly one of the first people to use this

technique for activity planning. Furthermore, every child who was old enough was required to initial the charts in the morning after they had completed the prescribed activities, such as brushing their teeth, taking a bath, combing their hair and making their beds. If anyone did not do it, Frank would blow a whistle. All the children immediately had to assemble for a family conference. At this meeting, the culprit was identified and suitably chastised. 📌

Adapted primarily from Cheaper by the dozen by Frank B. Gilbreth Jr and Ernestine Gilbreth Carey, Pioneers in improvement and our modern standard of living, IW/SI News 18 (September 1968), Business and economic history second series 18 (1989): available at <http://web.mit.edu>, and many other easily available websites, such as <http://gilbrethnetwork.tripod.com>, <http://vectorstudy.com>, <https://www.asme.org>, www2.webster.edu and www.feministvoices.com.