Frank and Lillian Gilbreth and the Manufacture and Marketing of Motion Study, 1908-1924

Brian Price
The Evergreen State College

Even as large-scale enterprises increasingly integrated the manufacture and marketing of mass-produced goods in the late 19th and early 20th centuries, scientific managers elaborated and popularized their efficiency methods and strategies in an attempt to carve out a distinctive scientific-professional niche within the changing industrial world. No one worked more assiduously in this effort than Frank and Lillian Gilbreth, and no one was more conscious of the intimate relationship between the manufacture and the marketing of an innovative product.

Indeed, my central argument is that the Gilbreths' fame and reputation is due less to the inherent quality of their motion study techniques, or to their achievements in practical motion study and scientific management installation, than to their prolific efforts to publicize both themselves as humane scientists and their principles and techniques as conducive to greater efficiency and workplace harmony. In fact, in a period characterized by rapidly changing business dynamics and troubled labor-management relations, the Gilbreths found that their motion study methods, though sound in theory, at best produced only partial and temporary efficiencies in practice, and more often than not exacerbated tensions, not only between the workers and managers they were supposed to reconcile, but also among scientific managers themselves. Ultimately, the Gilbreths simply were less successful as manufacturers than as marketers of their motion study strategies. That their strategies and techniques survived and prospered is testimony less to their intrinsic worth as they practiced them than to the image of their worth which the Gilbreths carefully cultivated.

Prior to his celebrated meeting with Frederick W. Taylor in December 1907, Frank Gilbreth had acquired renown as an innovative building contractor. His reputation was based on speed work achieved by mechanical innovations (an adjustable bricklayer's scaffold and cement mixers), systematic management (coordinating activities on and among construction sites, generating labor efficiency), and advertising publicity employing glossy pamphlets replete with photographs, many of them chronological images displaying his buildings in progressive stages of completion [6, 7, 8, 10, 11].

Gilbreth did not approach Taylor as a naif, therefore, but rather as one who saw himself with as much to teach as to learn. Thus, even as he read Taylor's works and employed his acolytes to introduce time study for task and piece rate setting on his building sites, Gilbreth began putting into action new bricklaying methods, publishing them in his *Bricklaying System* with the announcement that, "The motion study in this book is but the beginning of an era in motion study, that will eventually affect all of our methods of teaching

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the trades ... and increase the efficiency and wages of the workman" [6, p. 140].

The motion study Gilbreth inaugurated was dependent initially on simple trial-and-error methods. Thus, in renovating bricklaying methods he used his adjustable scaffold to keep his workers level with the wall they built so as to eliminate the motion of stooping; he arranged mortar and bricks to eliminate reaching; and he simplified the labor process so that a bricklayer could repetitiously grab a brick and trowelful of mortar simultaneously, swivel, and simultaneously deposit mortar in the furthest tier of bricks and the brick in the next closest. Thus he claimed to reduce the bricklayers' motions from as many as 18 to as few as 4-1/2 [6, pp. 148-51].

Gilbreth's achievement gained him considerable public acclaim [2] but the acclaim was by no means universal. Brick masons in particular reacted to Gilbreth's usurpation of their prerogatives and struck his sites twice [4, 42]. To make matters worse, Gilbreth's motion-studied efficiencies failed to aid his company's financial stability. At the very moment that his integration of systematic management, time study for piece rate setting, and motion study for labor efficiency gave him the potential to gain control of all on-site work, the construction depression of the winter of 1911-12 threatened him with bankruptcy [52, p. 206]. Accordingly, because he felt that in motion study he had a significant tool with which to solidify his own reputation within the rising scientific management movement, Gilbreth chose this time to make his career move, exiting the construction industry and dedicating himself to his own version of Taylorism.

Gilbreth's career transition occurred at a propitious time. Louis Brandeis' promotion of scientific management efficiencies as an antidote to railroad rate increases in the 1910 Eastern Rates Case raised Taylorism's public profile, while the subsequent trade union antagonism to scientific management highlighted by the Watertown Arsenal strike in 1911, served to provide the scientific managers with opportunities to explain themselves before an aroused national audience [49]. Given Taylor's use of Gilbreth's bricklaying innovations as illustrations for his popular *Principles of Scientific Management* [46], and the American Federation of Labor's singling out of motion study for special disapprobation [34], Gilbreth had a special stake in defending scientific management and in maneuvering his motion study brainchild more firmly before Taylor's attention.

On Taylor's behalf, Gilbreth participated in public debates with trade unionists on scientific management [15, 43], while Lillian Gilbreth compiled *The Primer of Scientific Management* [14] to address a popular audience by answering the most common questions about Taylorism. She went on in *Psychology of Management* to argue that scientific management, contrary to union claims, was the only management method consonant with the psychological health and development of workers [32]. In the meantime Frank Gilbreth organized the Society for the Promotion of Scientific Management, giving the beleaguered Taylorites a forum for mutual support, self-defense, and the promotion of their principles [37].

Through such activities the Gilbreths not only performed a service for Taylor but also identified Frank Gilbreth as a leading exponent of the new

managerial science. However, after having gained Taylor's approval, when he undertook his own installation career at the same time as making substantial improvements in motion study technique, Gilbreth reinvigorated Taylor's suspicions and created the conditions for his mentor's alienation.

Gilbreth began his installation career at the New England Butt Company of Providence, Rhode Island, armed with a new motion study technique he called micro-motion study. Micro-motion study involved filming a worker's operations against a cross-sectioned background while a chronometer within the motion picture camera's field of vision counted time. By examining the film through a magnifying glass, Gilbreth could determine the times of the worker's motions to the one-thousandth of a second while measuring the length of those motions against the background. He could then compare methods, alter work conditions, and synthesize the best elements of motion into a method which would become standard for that job.

Gilbreth saw micro-motion study as a potent antidote to labor hostility as well as a major advance over stop-watch time study. The unions charged that time study, despite its scientific pretensions, was merely a tool of management designed to speed up the pace of production. Gilbreth countered that micro-motion study, by replacing the subjective time-study man and his stop watch with the objective eye of the camera and chronometer, provided meaningful scientific accuracy in observing and timing work operations. He further claimed that the more efficient work methods derived from micro-motion film analysis meant increasing production by eliminating unnecessary and inefficient motions and substituting more productive ones, driving up output by greater worker effectiveness, rather than by faster speed [1, 36].

Even as the Butt Company installation progressed, Gilbreth went to work at publicizing micro-motion study as an advance over time study and as an advantage to workers. Claiming that his new technique revolutionized braider machinery assembly processes and increased output per assembler from 11-12 to 60 machines per day [18], Gilbreth arranged to unveil his discovery at the American Society of Mechanical Engineers meeting in December 1912 before an audience including Taylor and most of his disciples. There, R.T. Kent called micro-motion study "as revolutionary in the art of time study as was the invention of the power loom in the art of weaving" [36, p. 1188].

Gilbreth's revelation did not please Taylor. Indeed, in his own presentation Taylor responded by redefining time study by incorporating Gilbreth's motion study ideas, though not endorsing his specific techniques [45]. What Taylor did not know and what Gilbreth did not admit was that the most important facets of braider assembly redesign at the Butt Company were determined by straightforward observation before Gilbreth's micro-motion laboratory had been completed, that the greatly increased output per assembler had been achieved by assigning time-consuming elements of the process to other workers, and, finally, that because he could not arrange powerful enough artificial lighting to overcome the factory gloom, Gilbreth was almost totally reliant on stop-watch time study for piece rate setting [51, July 1912-Jan. 1913]. In short, at the time that Gilbreth announced its virtues, micro-motion study had not yet lived up to a single one of them. Gilbreth

nevertheless achieved a public relations coup. Although he could only fall further afoul of the trade unionists, who already saw motion study as a tool for creating automatons [34, 35], Gilbreth pressed home his image as an innovator, popularizing his new technique by using it to time the fastball speeds of pitchers at baseball games and engaging an academic audience by inaugurating a series of Summer Schools of Scientific Management for college professors in Providence beginning in 1913 [9, 13, 16, 40].

Gilbreth continued innovating. While studying the motions of handkerchief folders for the Herrmann-Aukam Company of South River, New Jersey, Gilbreth invented additional motion study techniques which he dubbed cyclegraphs, chronocyclegraphs, and stereochronocylegraphs, all designed for the analysis of minute, fast worker motions. The basic cyclegraph method involved mounting a miniature electric light on a ring that could be slipped onto a worker's finger, showing up on the back of the hand. The movement of the light created a bright line on a single time-exposed photograph. A line full of twists and turns bespoke inefficient movement. The worker's tools, equipment, and motions could then be altered until the shortest, smoothest line was developed. Gilbreth improved on the cyclegraph motion map by interrupting the flow of current so as to obtain, in the resulting sequence of flashes, a record of the time and direction of the motions under observation. The resulting image was a chronocyclegraph. A stereochronocyclegraph created a three-dimensional image of motion by using time-exposed photographs from two slightly off-set cameras, the positives from which could be viewed through a stereoopticon or stereoscope. With his customary eye for publicity, Gilbreth arranged for Fred Colvin of the *American Machinist* to break the news of his latest advances to the engineering world [3].

Though Gilbreth became identified as Taylor's most scientific and innovative follower, he managed through his practical installation work only to increase Taylor's distrust. At a time when trade union militancy against scientific management was at a peak, Gilbreth had to employ carrot and stick diplomacy at the Butt Company to avert a strike by workers influenced by the IWW and AFL, an occurrence which gravely undermined Taylor's faith in Gilbreth's abilities [51, August 1912].

Matters between the two came to a head due to Gilbreth's handling of his contract with Herrmann-Aukam Company in 1913-14. Gilbreth took the job to exercise his chronocyclegraph techniques on the detailed motions required in handkerchief folding and packaging. But he soon diverted his attention to building his reputation abroad when he gained a contract to install scientific management at the giant Auergesellschaft electric light and gas mantle manufacturing company in Berlin. In Gilbreth's absence the Herrmann-Aukam owners broached Taylor with complaints about the pace and quality of Gilbreth's work. Taylor recommended that his orthodox disciple, H.K. Hathaway, finish Gilbreth's job, a signal of disapprobation so severe that Gilbreth took it as a declaration of war [47, March 11, 1914].

Gilbreth's response was immediate and thoroughgoing, heralding an abrupt shift in his image-management tactics. From Germany he wrote Lillian Gilbreth, "*We must have our own organization and we must have our own writings so made that the worker thinks we are the good exception*" [22, May 9,

1914]. Becoming the good exception, however, required considerable maneuvering. Severing his relations with Taylor meant cutting himself off from all mainstream scientific managers and generating a quite distinctive profile as an independent efficiency expert. That scientific management was then under concerted federal government scrutiny due to the AFL-backed International Association of Machinists efforts to have Taylorism banned in government arsenals and navy yards clarified Gilbreth's task (48).

To deal with potential negative publicity stemming from Taylor and his disciples, Gilbreth immediately decided to keep all information about his present and future installation work secret, sacrificing potential publicity for security against claims of incompetency [31, June 19, 1916]. Second, he began rewriting his autobiography. Having to this point emphasized his debt to Taylor's ideas for his own development of motion study, Gilbreth now sought to create a convincing version which would show that he invented motion study independent of and prior to his contact with Taylor [21, May 6, 1915].

Damage control was simpler for Gilbreth than creating a new, positive public profile. That Taylor died in 1915 did not diminish the energy the Gilbreths applied to the task. If anything it focussed them more clearly, for with Taylor out of the way the battle was on for who could most fittingly step into the leadership of the efficiency movement. Fortunately, by the time Frank Gilbreth returned from Germany, Lillian Gilbreth had completed two book-length manuscripts with which to launch his new image. To become the good exception among scientific managers, Lillian Gilbreth recommended emphasizing both Gilbreth's concern with the "human factor" and his scientific outlook. This meant arguing, contrary to the trade unionists, government commissions, and Robert Hoxie, that motion study particularly, and scientific management generally, increased industrial output in ways which improved and did not detract from the worker's mental and physical strength and individuality. Accordingly, Lillian Gilbreth's first manuscript, published as a series of articles in *Iron Age* in 1915-16 under both of their names, addressed the problem of the troublesome "human element." Her primary contention was that motion study was less a series of mechanical devices for improving output than a systematic program for the development and betterment of the worker. Motion study intended to train workers rather than to destroy skill. Motion study was, in essence, to be learned and internalized by the workers who, applying its principles, could become skilled motion study experts in their tasks and valuable aids to management, not mere narrow specialists in a craft or humdrum machine tenders. That is, she intended that as motion study standardized work processes, practices based on the motion study way of seeing would become the foundation of new worker skills for which they would be individually rewarded by piece rate wages and promotion [24, 29, 30].

Lillian Gilbreth argued in *Fatigue Study* that the aim of motion study experts was to determine accurately the fatigue resulting from any job, then to eliminate that which was unnecessary by designing convenient workbenches, furnishing chairs, providing regular rest-recovery periods, and so on. In short, as the obverse of the motion study coin, fatigue study enhanced efficiency so as to reveal its benefits to workers in a tangible way. Fatigue study also had

strategic and psychological value. By performing a fatigue survey on first entering a factory, by providing swift antidotes to obvious fatigue-producing activities like standing and stretching, and by replacing traditional skills with motion study skills, Lillian Gilbreth believed that the scientific manager and motion study engineer bettered the chance of acceptance by workers [27]. Such vision, backed by an appropriate declaration of intentions, enhanced by an immediate fatigue survey, and reinforced by such basic industrial betterment techniques as open meetings to discuss installation progress was meant to give reality to industrial welfare leader H.F.J. Porter's imprecation that, "Men can easily be led and they will then be imbued with a better spirit than when they are being driven" [41, p. 311].

Lillian Gilbreth's writings enabled her husband to play a double gambit. To workers and industrial relations and betterment experts, Gilbreth could play the fatigue study card, contending that motion study humanized work conditions and facilitated industrial peace. To owners, managers, and efficiency experts, Gilbreth could tip the motion study card, arguing that he could boost output by applied motion study science.

To aid in the latter Gilbreth had a final motion study innovation. By 1915 he had discovered the basic alphabet of all work motions, naming them therbligs. All work motions, he contended, could be reduced to a mere sixteen varieties: search, find, select, grasp, position, transport loaded, assemble, use, disassemble, inspect, preposition (for next operation), release load, transport empty, wait (unavoidable delay), wait (avoidable delay), and rest (for overcoming fatigue). Assemble, use, and disassemble could be resolved into the other therblig units, providing an extremely detailed analytical breakdown of any operation. By analyzing micro-motion film or chronocyclegraphs, the therbligs could be identified and plotted on simultaneous motion (simo) charts. The simo chart listed horizontally the parts of the body -- arms, legs, trunks, and head -- with subdivisions (for example, arm could be dissected into upper and lower arm, wrist, thumb, fingers, and palm). The vertical axis displayed elapsed time. By assigning each therblig a color and symbol, Gilbreth could chart each body part's fundamental motion against time, producing a clear visualization of the relationships between the therbligs employed in any job. Simo charts enabled Gilbreth to discern whether, for instance, one arm was actively working while the other was merely passive during the motion cycle. If so, he could redesign the operation with an eye to actively employing both arms simultaneously while shortening the times for movements made by placing tools and parts closer to the worker's grasp. Therbligs were a stunning advance, providing Gilbreth with a superb analytical tool and bolstering his confidence in the validity of his pursuit of a science of motions. Gilbreth made his discovery public in a paper for a local New York ASME meeting in the winter of 1915-16, entitled "Motion Study for the Crippled Soldier," locating perhaps his most fundamental motion study invention within a paper whose ostensible subject, the treatment of handicapped war veterans, undermined the likelihood of critique [28, pp. 138-39].

Equally important for their public demeanor, the Gilbreths returned then to an attack on time study and a promotion of motion study as a science.

They made clear in *Applied Motion Study* that they, not Taylor's orthodox disciples, inherited his concern with the science in scientific management [20]. To cap off their reprofiling blitz, the Gilbreths came up with a snappy slogan which unified their concern with the human element and their concern with the scientific analysis of work processes. They were, they intoned, on *"the quest of the one best way to do work"* [25, pp. 96-97].

The Gilbreths held this profile without marked change despite significant alterations in the worker-management environment. After World War I the AFL and the Taylor Society (as the SPSM was renamed) reached a rapprochement engineered largely by industrial relations experts like Robert G. Valentine, who argued that the autocratic behavior of scientific managers should be mellowed by taking industrial welfare and industrial relations policies into account, mitigating the Taylorites reliance on what appeared to workers as counterproductive driving methods to increase production [50]. The aftermath of war saw greater cooperation between former enemies and an apparent alignment of the Gilbreths' scientific management competition in their wake. But the Gilbreths did not reduce their energies in carving out their own path. Frank Gilbreth organized a Committee for the Elimination of Unnecessary Fatigue within the Society of Industrial Engineers, holding regular fatigue luncheons at their quarterly meetings as a means of pushing motion study in its "human element" format to a ready audience of engineers and managers. He also worked with the National Safety Council, the American Posture League, and the Eyesight Conservation Committee [26, 44].

At the same time, he arranged for a showdown between motion study and time study by preparing a lengthy indictment of stop-watch time study for presentation to the Taylor Society. Though the subsequent debate was as rancorous as it was inconclusive, and did nothing whatsoever to sway the stop-watch advocates to adopt Gilbreth's methods, it did at least afford the Gilbreths some personal satisfaction at seeing their enemies squirm [19].

The future of motion study was by no means assured. To be sure, motion study, fatigue study, and the One Best Way were terms with a certain currency in engineering and management circles. But Gilbreth's continuing difficulties with actual factory installations led him to retain the veil of secrecy over his work, not surprisingly since eruptions of worker, manager, and owner dissatisfaction with his techniques were common.

At the Auergesellschaft Company, for instance, workers associated with the powerful leftist Social Democratic Party at first watched Gilbreth's activities suspiciously as he renovated the company office system, then successfully demanded of the directors that Gilbreth be prevented from extending his work to the shop floor. Only after the drafting of many workers into the armed forces with the outbreak of war was Gilbreth able to make any progress in their domain [22, April 23, 1914]. In 1919 messenger boys at the Pierce-Arrow automobile company threatened to strike unless Gilbreth fulfilled his promises of promotion, which he took care of by disbanding the messenger system entirely [38, p. 32]. In 1924 workers at the American Radiator Company in Buffalo downed tools, refusing to be studied by Gilbreth's assistants, a condition which management resolved by revoking Gilbreth's contract and removing him from the plant [5, Jan.-Feb., 1924].

If anything, Gilbreth found foremen, superintendents, and managers more recalcitrant than workers. As he altered their routines, usurped their prerogatives, and undermined their security with his systematic changes, they all too often reacted, as at Auergesellschaft in 1914-1915, Cluett-Peabody shirt company in 1916, U.S. Rubber Company in 1917, Pierce-Arrow in 1919, and American Radiator Company in 1923-24, by stalling, failing to respond to his directives, and questioning the quality of his work [22, April 15, 1914; 12; 17, July 26, 1917; 5, Nov.-Dec., 1923].

Nor were owners always obliging, as Gilbreth's experiences at Herrmann-Aukam and American Radiator showed. In 1921 the owners of the Erie Forge Steel Company, financially straitened by the post-war depression, litigated against Gilbreth to get his expensive contract revoked, locking him out of the plant, and eventually settling with him out of court [23, July 12-17, 1921].

To darken the picture further, of the seventeen contracts Gilbreth gained between 1918 and 1924, he completed only five requiring limited work and three more involving only written recommendations. Of his six most important contracts requiring extensive factory renovation, five were cancelled prior to their completion. Gilbreth was working on three contracts when his heart gave out in June 1924.

At the time of his death Gilbreth had completely failed to prove the viability of motion study in industrial practice. Further, his continual attacks on stop-watch time study had done nothing to win members of the Taylor Society to his motion study banner. Given that he had not successfully organized his own cadre of followers, the practical future of motion study, despite the soundness of its principles and techniques in theory and in literary reputation, remained in considerable doubt.

Only Lillian Gilbreth's sterling efforts enabled her husband's brainchild to survive the 1920s. First, in a brief paper announcing that stop-watch time study, like motion study, had its place in scientific management, she capitulated to the obvious and declared a truce. Moreover, by running her own motion study schools and nurturing her husband's only installation assistant, Joe Piacitelli, she slowly laid the basis for motion study's continuation in practice. But it was not until the early 1930's, when developments in camera and lighting technology made motion study less expensive and cumbersome, that Allan Mogensen and others led the regeneration of a declining art [33; 52, pp. 320-21; 39].

The extent of the Gilbreths' efforts and travails illustrate the problems of gaining recognition and authority in a fluid business environment characterized by friction among competing parties. The manufacturing and marketing of a new product within a new management movement within a changing, contested industrial terrain posed special difficulties and necessitated bold tactics, especially as the Gilbreths were, essentially, small business people striving to retain financial independence in a milieu increasingly dedicated to economies of scale. The Gilbreth's shifting tactics, their continual realignment of motion study technology and techniques in relation to their sense of the state of labor-management relations, and their striving to build an identity unique among scientific managers manifest the ways in which they shaped

their product and themselves along political, rather than strictly scientific-technological lines. Accordingly, their experiences argue well for the integration of micro-political analysis into scientific-technological history.

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