# Films that Work

## Industrial Film and the Productivity of Media

*Edited by Vinzenz Hediger and Patrick Vonderau*

Amsterdam University Press

# Images of Efficiency

## The Films of Frank B. Gilbreth

*Scott Curtis*

From 1912 to his death in 1924, Frank B. Gilbreth – a disciple of Frederick W. Taylor and, with his wife, Lillian, one of the most prolific popularizers of scientific management – made hundreds of films designed to document, analyze, and correct worker movements in a "quest for the one best way" to do any given job.[1] Scientific management, of course, swept through the American workplace at the turn of the 20th century as Progressive ideals of reform and uplift joined forces with industrial trends toward increased specialization and rationalization of labor.[2] Reformers and industrialists alike could agree that "efficiency" and the elimination of "waste" (economic for the industrialist, social for the reformer) were vitally important to the moral and productive longevity of the nation.[3] This social and economic agenda attempted to assuage or solve bitter struggles between management and labor, especially as workers protested – by forming unions, among other tactics – the increased centralization of power in the hands of managers.[4] Taylor's management system appropriated the rhetoric of scientific objectivity and neutrality while regulating worker productivity. His method of regulation, which he dubbed "time study" (essentially measuring worker efficiency with a stopwatch), often drew protests from both workers and managers for its inaccuracy and reliance on the "subjective" skills of whoever happened to be holding the stopwatch.[5] Designed to be an improvement on Taylor's methods and thus to garner cooperation from worker and manager alike, Gilbreth's method of "motion study" via motion pictures and other visual technologies promised an even more thoroughly "scientific" and "objective" solution. Frank and Lillian Gilbreth succeeded in promoting motion study to industry as an essential tool for designing and measuring work. Together, time and motion studies are still used today as a means of finding the "methods of greatest economy and for measuring labor accomplishment."[6]

Exactly what kind of work did these images do? On the one hand, these images remind us of the work of Etienne-Jules Marey or others like him, who used filmic and photographic technology to measure human locomotion in order to understand the origins and limits of human fatigue.[7] But Gilbreth did not use his films in this way; his method of extracting data from the films, as we shall see, was positively crude compared to Marey's, or especially compared to the sophisticated photogrammetry of Wilhelm Braune and Otto Fischer of Ger-

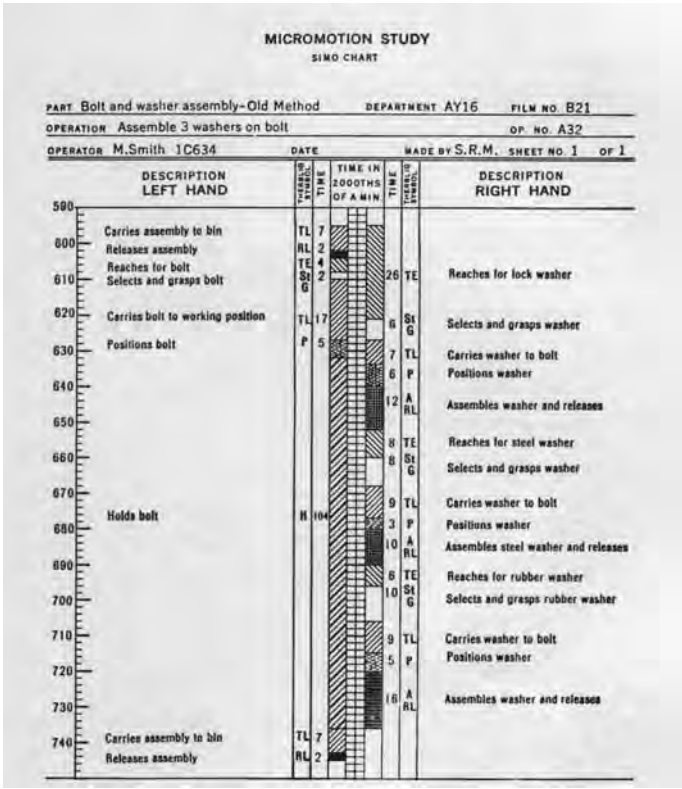
many in the 1880s.[8] On the other hand, some have argued that Gilbreth's films do not do much work at all. Brian Price, one of the leading experts on the Gilbreths and their legacy, maintains that their films were primarily promotional tools for selling the Gilbreth package: "That their strategies and 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."[9]

Both of these positions are true, in their own way, but both overstate their case. The Gilbreth films belong fully neither to the tradition of Marey nor of P. T. Barnum. There is a little bit of both Marey and Barnum in Gilbreth; we need to look closely at the Gilbreth films and their application in order to sort out the kinds of work they accomplished. I suggest that we analyze the way Gilbreth used his images in much the same way that he analyzed the motions of workers. For example, after Gilbreth had filmed, say, a worker assembling something, he would submit this film to repeated viewings, indicating on a data sheet the kinds and duration of each movement made by the worker's left hand. Then he would do the same for the right hand. This he called "micromotion study." (Mere "motion study," by contrast, involves documentation and measurement of the task without detailed, frame-by-frame extraction of data.) He would then translate this data into what he called a "simultaneous motion chart" (or SIMO chart), which would graphically compare the kind and amount of work of each hand.

The right hand, for example, might be doing more work than the left. From this, Gilbreth would figure out a way to distribute the work equitably and symmetrically, hence efficiently, thus decreasing worker fatigue and increasing productivity.

We can do the same for the Gilbreth films themselves. What kind of work do they do? I submit that they do two kinds: productive and promotional. Only by carefully charting out the uses to which a Gilbreth film is put can we understand the relationship between these two kinds of work, the "right hand" and the "left hand." It may turn out that the distribution of work is asymmetrical, but it is important to note that whatever the distribution, Gilbreth is deriving significant productivity from his films by giving them multiple, simultaneous tasks. Indeed, in this sense, Gilbreth's visual technologies are incredibly efficient images. They provide, at once, documentation of processes that the analyst can study and improve on, as well as images of efficiency for workers to study and to assimilate. Because the films both document and promote, they are exemplary industrial films; they demonstrate a process while promoting that process as "the one best way," much like all sponsored films. Here, however, the process they document (the worker assembling something) is not the primary product. Instead, the product is the process of filming, or the image of efficiency that the

*Figure 1 Motion-study experts still use Gilbreth's simultaneous motion (SIMO) charting system to display graphically the work of each hand for a given task*




*Ralph M. Barnes,* Motion and Time Study *(New York 1980)*

documentation represents. In other words, Gilbreth was not promoting any specific process that he filmed so much as the films themselves as a process. The act of filming itself becomes the product.

However, that product is careful not to disturb class relations. In fact, those relations are built into the process, even into our generic distinctions between scientific and educational film. For if we inspect his method closely, we also find that the films reveal interesting "right-hand, left-hand" dualities within documentary practice, especially regarding the relationship between science ("objectivity") and spectacle ("subjectivity"). And this relationship between science and spectacle arguably rehearses or reinforces the relationship between "manager" and "worker." That is, the line between them is inscribed not only in how

workers are filmed, but how the films are viewed and how they are used to persuade viewers. I would therefore argue that the difference between "science" and "spectacle" aligns neatly with class divisions. This essay, then, will perform something of a "micromotion study" of the Gilbreth films and photographs in order to chart out exactly the kind of work they did; this will then provide the data necessary to assess their legacy and their significance to an understanding of industrial film theory and practice.

## Efficient images

It is perhaps misleading to call Frank Gilbreth a "disciple" of Taylor. Certainly, by the time they actually met in 1907 Gilbreth was an ardent admirer of Taylor and his system; Gilbreth had already established himself as a successful contractor who had won wide acclaim for his innovative and efficient approaches to bricklaying. Taylor, for his part, was well-known for his "scientific" approach to management and considered himself a patriarch and protector of the system bearing his name. But for some reason Taylor did not adopt Gilbreth into his inner circle of experts, whom he trained and considered the only rightful heirs to scientific management.[10] The Taylorites were cautious towards Gilbreth, but willing to use his skills for self-promotion to their ends: with Taylor's blessing and encouragement, Gilbreth often made public presentations on behalf of scientific management. Gilbreth's wife, Lillian, was a full partner in her husband's endeavors; her degree in psychology proved invaluable for public discussions of the benefits of scientific management for workers. But when Frank and Lillian decided to quit construction and start consulting, the Taylorites saw them as competitors rather than collaborators, and a rift developed that by 1914 was unbridgeable. Gilbreth's use of film and photography must thus be seen as first an improvement on Taylor's methods, but ultimately as a means of differentiating the Gilbreths from Taylor. Specifically, while Taylor employed a stop watch in order to speed up worker productivity, Gilbreth used photographs and films to find alternative work methods; whereas Taylor concentrated on *speed*, Gilbreth concentrated on *efficiency*.

Gilbreth first started using motion picture technology in 1912 for his installation of scientific management at the New England Butt Company in Providence, Rhode Island, "a small foundry and factory employing about three hundred men in the production of braiding machines for making shoe laces, women's dress trimmings and electrical wire insulation."[11] To achieve his stated goal of "out-Tayloring Taylor,"[12] Gilbreth employed a motion picture camera to record the motions, duration, and conditions surrounding a job. However, on

the factory floor the "conditions" of a job – especially the lighting conditions – were not easily filmed, so Gilbreth built a "Betterment Room" on the site, specifically constructed so that worker motions could be filmed. The worker and his or her working area or machine were brought from the factory floor and set up in the room; Gilbreth continued to use this approach for all his films. Two elements of the "mise-en-scène" of these films are noteworthy. First, we see that each worker and his or her station is placed against a white background with a four-inch grid pattern.

*Figure 2 A typical shot from one of Gilbreth's motion study films. Note the chronometer, the grid, and the camera angle*

*The Quest of the One Best Way (USA 1968)*

The grid is ostensibly designed for easy measurement of worker movements; when the film is examined slowly or under the magnifying glass, the analyst can determine the length of a movement against the grid.

I say "ostensibly," however, because close inspection of the films reveals that only the crudest estimates of distance could be made with this system – the angle of the camera is almost always completely inappropriate for this kind of detail work. That is, Gilbreth only rarely filmed his subjects from an appropriate angle and height if he was indeed interested in taking accurate measurements from the photogram. Instead, the grid more likely serves other purposes: the white background provides contrast and extra light, and the grid, while giving a rough estimate of distance, also gives the *impression* of "scientificity." Like Muybridge's grid background, which is useful as a guide if not a precision instrument, it provides a fig leaf of objectivity.

Yet Gilbreth repeatedly relies on proclamations of precision. The second notable element of the image is the chronometer – a clock, placed in view of the camera, with a second hand that moves 20 times a minute. Given a steady frame rate and an accurate chronometer, Gilbreth could reliably measure the duration of any given movement. Gilbreth boasted, "Our latest microchronometer re-

cords intervals of time down to any degree of accuracy required. We have made, and used, in our work of motion study investigations of hospital practice and surgery, one that records times to the millionth of an hour."[13] This, I believe, is bluster. In research films for which measurement is crucial it would be incongruous, to say the least, to find such extraordinarily precise measurements of time alongside such a disregard for accurate measurements of distance.[14] Moreover, given the methodological constraints of micromotion study, nothing could be gained by such small increments. Clearly, we cannot compare Gilbreth's motion pictures with bona fide research films; precision – or even measurement – was not the primary goal in Gilbreth's motion studies. True enough, not all research films measure, but my point here is that the grid and the chronometer in Gilbreth's films are more *promotional* than productive. The instruments do a different kind of work than that claimed by their accompanying rhetoric. But this is not to say that they are completely unproductive. So what information is the image under motion study expected to reveal? What work, other than promotional, is the film expected to perform?

The answers to these questions depend less on the content of the images than who is looking at them. That is, the work the films perform – productive and promotional – is divided between two kinds of viewers: managers and workers, broadly speaking. The films do one kind of work for experts with a trained eye and another kind of work for laymen with an untrained eye. This division of labor is not unusual; we find it precisely at the difference between research films and educational films. Scientists make research films in order to document phenomena or processes. Research films can, on the one hand, document aspects of the object that the researcher has already observed and confirmed; in this case, the film is not the primary object of observation, it is merely a confirmation or illustration of it. Or, on the other hand, the motion picture can be used to reveal new aspects of the object unavailable to normal observation (as in time-lapse cinematography, for example); in this case, the film itself is the primary object of observation, a substitute for the object – the film is the ground for exploration and discovery. In the first kind of research film, questions have already been asked and answered. In the second kind, the film prompts entirely new questions. Both versions of the research film, however, presume an expert eye.[15] Both versions are predicated on a particular mode of viewing, namely, the kind of close, undistracted observation that is associated with scientific method. We can see this as well in the actual form of a typical research film: unedited footage, nearly always without sound (even in the sound era), and without explanatory captions or narrative. If any explanations are given, they are usually in accompanying articles or lectures. By studiously avoiding the structures of identification and the techniques of emotional involvement entailed in most

documentary editing patterns, for example, the *form* of the films implies the objective, distanced, expert gaze of a scientific observer.

Educational films, on the other hand, presume an untrained eye. Often, the raw footage of the research film is edited, explained, and packaged for a lay audience. Sometimes material is photographed specifically for the film in an easy-to-understand form and then edited into a story structure or similar rhetorical approach. Here we can make a useful distinction based on modes of viewing: if the research film presumes "observation," the educational film presumes "spectatorship." The first presumes "contemplation," while the second presumes "distraction." The distinction depends not only on the difference between the attentive gaze of the scientist and the distracted gaze of the layperson, but also on the presumed *direction of knowledge* in relation to spectator and screen. In the research film, the knowledge of the scientist flows toward the image, thereby framing the phenomenon depicted. In the educational film, the knowledge represented on screen flows toward the spectator.

Let me put it another way. Scientific observation connotes an attentive, measuring gaze, but the most important aspect of scientific observation is the context the scientist brings to it; the researcher assimilates observed data into an existing framework of knowledge. What the scientific observer already knows frames what he or she observes, thus incorporating or juxtaposing new data with old and thereby generating new insights. "Observation" therefore implies the *production* of knowledge. On the other hand, the lay spectator learns from the educational film, but does not bring new knowledge to it. (Structurally speaking, the position of "spectator" precludes that possibility because he or she cannot enter the conversation among experts who produce knowledge.) "Spectatorship" therefore implies the *consumption* of knowledge. The division of labor between these two kinds of "useful" film therefore echo in their presumed mode of viewing a hierarchy (even a class system) between experts and laymen – or between managers and workers.

For the present discussion, however, the distinction between research and educational films is less important than their presumptive modes of viewing. Even so, the boundary between observation (with its connotations of expertise, objectivity, and productivity) and spectatorship (inexperience, subjectivity, consumption) is by no means crystal clear. Any given viewer may occupy either position at any given time, even alternating positions in the course of a single film. But the presumed modes of viewing – the viewer to whom the films address themselves – allows us to see clearly the different kinds of work the Gilbreth films are expected to perform. Specifically, I find four kinds of work: On the one hand (say, the "right" hand), there is the work of *standardization* and *problem-solving*. On the other ("left") hand, we can see the work of *visualization* and *promotion*.

What kind of productive work did the films do for Gilbreth and his band of experts? First, they *standardized* the object of investigation. Taylor's method of time study required the expert to time the worker, as many times as needed, as he or she performed the task. Each performance was different, of course, not only in terms of the worker, but also in terms of the expert's "performance" of the timing itself. Instead, Gilbreth filmed the worker's best performance and that record served as the standard and object of study. Gilbreth thereby eliminated the variables of human interaction while simultaneously standardizing the worker (this one performance becoming the exemplar of all who perform the task) and the work (both the task under observation and the observation itself). Moreover, because film decomposes and recombines movement into standardized, individual units (the film frames, the shot), it was the perfect tool for Gilbreth's similar analysis and synthesis of the worker's body.[16] As Elspeth Brown notes,

> The filming of repetitive industrial labor encapsulates the logic of the industrializing process.... The ways in which Gilbreth saw the working body had already been structured by an industrialized consciousness predicated on decomposition, interchangeability, standardization, and kineticism. Film presented itself in 1912 as a logical methodological culmination of Gilbreth's already fully industrialized visuality.[17]

Second, the films performed *problem-solving* tasks. With the film in hand, Gilbreth reviewed the film, looking for ways to improve the efficiency of the worker's performance. In this respect, the films functioned as research films in that close observation by an expert eye could reveal information not normally available.[18] Micromotion study – the minute recording of worker movements via photographic and cinematographic technology – is also an important part of the problem-solving process, according to Gilbreth. "From the data on the film and the observations of the observer, can be formulated an improved method."[19] But we should be cautious about assigning micromotion study too large a role in the problem-solving process. It is important to note that neither Gilbreth nor future motion-study experts regularly used this form of analysis. Because it requires a considerable amount of detail work from highly paid experts, it is a very expensive process; one expert even notes that "a micromotion study is often the last resort." [20] Then there is the fact that, in Gilbreth's case at least, it was apparently not very necessary. Brian Price argues persuasively that the improvements that Gilbreth made at his factory installations were not the result of motion study, but due instead to efficient work design and the application of basic principles of scientific management.[21]

This is not to discount the continuing significance of motion studies for the field of work measurement. I do not want to characterize motion studies as an empty gesture; a simultaneous motion chart does the important work of vividly

displaying problems in work design. But this is exactly my point. Motion studies are only secondarily a problem-solving technique. It is primarily a process that translates a film's data into graphic terms. It is a means for rendering one kind of image (detailed, moving) into another (simplified, still) in order to visualize more clearly the essential elements of the task. Once these elements are identified, alternative solutions can be proposed. But more importantly, this rendering process provides a graphic image of *what efficiency and inefficiency look like*. Motion and micromotion studies can undoubtedly solve problems. But there is evidence to indicate that, for Gilbreth, the educational aspects of this technique were more significant than its problem-solving capacity. Motion studies have not been used primarily for measurement or for work design; they were used first and foremost to visualize an image of efficiency.

## Images of efficiency

Visualization was absolutely crucial to the Gilbreth program, but it also replicated the manager-worker hierarchy. According to the Gilbreths, to visualize is to plan, to imagine a future solution based on observation of present details. But not everyone is equipped to observe and to visualize; only the trained eye could be expected to do both. In fact, the ability to observe and to visualize is precisely what distinguishes a manager from a worker or, more broadly, an expert from a layman. In *The Psychology of Management* (1914), Lillian Gilbreth describes visualization in exactly these terms:

> The best planner is he who – other things being equal – is the most ingenious, the most experienced and the best observer. It is an art to observe; it requires persistent attention. The longer and the more the observer observes, the more details, and variables affecting details, he observes. The untrained observer could not expect to compete with one of special natural talent who has also been trained. It is not every man who is fitted by nature to observe closely, hence to plan. To observe is a condition precedent to visualizing. Practice in visualizing makes for increasing the faculty of constructive imagination. He with the best constructive imagination is the master planner.[22]

What role, then, do the films and photographs play for the expert? Certainly, they are an aid to visualization: Gilbreth's images helped the specialist in planning the most efficient work design by serving as a document of the problem from which to visualize the solution. Yet the importance of images as an aid to visualization is different for the expert and the worker. In fact, there is the im-

plication that the expert is not tied to these technologies in the same way that the worker is:

> It is not always recognized that some preliminary motion study and time study can be done without the aid of any accurate devices. It is even less often recognized that such work, when most successful, is usually done by one thoroughly conversant with, and skilled in, the use of the most accurate devices.... With this training and equipment, a motion- and time-study expert can obtain preliminary results without devices, that, to the untrained or uninformed, seem little short of astounding.[23]

The expert can visualize on his own, without the aid of images. This is not the case, however, for the worker, who needs an image in order to visualize.

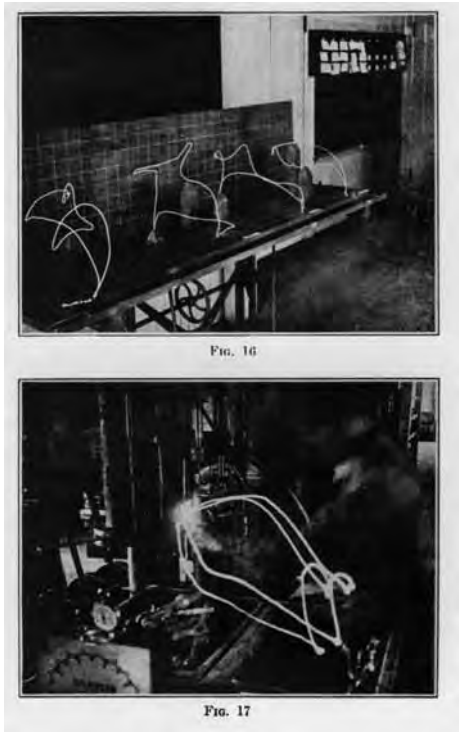
> The average engineer, who becomes, through his training and the necessity of his work, a good visualiser, even though he is not one by nature, often fails to realize the small capacity for visualisation possessed by the average person. A long experience in teaching in the industries made this fact impressive and led to the invention of the cyclegraph, and, later, the chronocyclegraph method of recording, in order to aid the non-visualising worker to grasp motion economy easily.[24]

Experts (*cum* managers) can see the solution in their heads; they can visualize. Workers cannot, so they must rely on visual aids. Only the lack of a little imagination holds the worker back, apparently.

Cyclegraphs are the best example of Gilbreth's use of images to aid visualization.

These were still photographs of workers as they performed their task with a small incandescent bulb on their fingers. The shutter would remain open for the duration of the task, so that the resulting photograph would show the path the worker's movements had taken as bright, white lines. By interrupting the light at regular intervals, these continuous bright lines would become discontinuous dashes of light that indicated the duration, as well as the direction of the movement; Gilbreth called these photographs "chronocyclegraphs." (Gilbreth also experimented with stereoscopic versions, which he of course dubbed "stereochronocyclegraphs.") Mimicking Marey's use of similar devices to capture the variables of human locomotion, the cyclegraphs were, according to Gilbreth, crucial for demonstrating the "paths of least waste."[25] Gilbreth even crafted wire models of these paths of light in order to provide a "tactile" display of the one best way. (These models were originally developed to help the blind, bringing to mind Kittler's dictum that "media begin with a physiological deficiency."[26]) Whether these photographs and models actually worked as training aids is another question entirely. Price shows that Gilbreth's systems unraveled – the improvements in worker efficiency lost – as soon as he left the factory.[27] Even if their effectiveness as educational tools is in doubt, they provided a com-

*Figure 3 To create his "cyclegraphs", Gilbreth attached small lights to the worker's hand, photographed the path the hands took during task, then created three-dimensional wire models for instruction*




*F.B. and L.M. Gilbreth,* Applied Motion Study *(New York 1917)*

pelling image of efficiency – compelling enough that Gilbreth continued to get work. What does efficiency look like? It has smooth lines, simplified design, and standardized geometries. We can even see this aesthetic in the simultaneous motion charts: Efficiency is here clearly symmetrical and consists of geometrical units, like bricks, recalling Gilbreth's first career. (As Sharon Corwin has argued, this set of choices eventually found its way into American art, especially the work of such Precisionists as Charles Sheeler.[28]) The aesthetic of cleanliness and order – the very picture of efficiency – pervades Gilbreth's images; this is arguably their most effective instructional technique.

This presentation of efficiency may also be the true function of these images. For if Gilbreth's films and photographs did not function primarily to measure, to provide solutions, or to instruct, what were they really meant to do? Who were they really for? Neither experts nor workers, but *owners*. Gilbreth often

boasted to his wife about the rhetorical power of his images, their ability to "chloroform" potential clients into procuring his services.[29] And, as Richard Lindstrom has demonstrated, Gilbreth used the seductive lure of "being in the movies" to coax cooperation from otherwise recalcitrant workers and managers.[30] Gilbreth's films and photographs were like a calling card, a snappy, eye-catching technique that was instantly attached to his name.[31] For example, after developing the cyclegraph, Gilbreth envisioned applications in a variety of fields, especially sports, the publicity from which he hoped would gain him a larger audience. He teamed up with Walter Camp, the famous Yale football coach, to make a series of motion studies of athletes. His first in the series – cyclegraphs of a number of champion golfers – received national coverage in *Golf Illustrated* and *Vanity Fair* in 1916. The images illustrated the path of the golfers' swing and the articles held out the promise of greater golfing "efficiency."[32] It is not clear, however, what information a golfer could glean from the article – or the technique – in order to improve his or her swing. Of course, this is exactly the issue: Gilbreth's images are not about information; they are about the process itself. Gilbreth appears to be selling solutions (and there may be some in the back somewhere), but he is really selling a process of visualizing an *imagined* solution, a utopian efficiency. He is mostly selling the technique and wonder of the camera. In this respect, Gilbreth's legacy is aligned less with Marey than with Muybridge, or especially with Harold Edgerton, the MIT engineer whose high-speed photographs received much attention and acclaim, but revealed very little scientifically.

This emphasis on promoting the process while giving the impression of objectivity and utility seems to also be the defining feature of the industrial or sponsored film. Industrial films usually follow a documentary format while serving as an advertisement or promotional spot for a product, process, or company. As Vinzenz Hediger and Patrick Vonderau argue, the industrial film contributes to the establishment and maintenance of organizations in three ways: it provides a "record" of industry events and practice, induces employees and others to share goals through its "rhetoric," and adheres to the principles of "rationalization" that aim at improving performance.[33] We can see clearly how Gilbreth's films fit into this scheme, and how they seamlessly do all three things at once. Indeed, Gilbreth's films are incredibly efficient in that they serve multiple functions simultaneously: they standardize the object of study, provide the ground for solutions to problems in work design, visualize the solutions for workers, and promote the solutions to managers and owners. But they ultimately promote more than a workplace solution – they promote themselves as images of efficiency and as the proprietary process of Frank B. Gilbreth.

## Notes

My thanks to John Carnwath for valuable research assistance.

1. This phrase, the motto of the Gilbreth family, is strewn throughout their work, but see especially Lillian Moller Gilbreth, *The Quest of the One Best Way: A Sketch of the Life of Frank Bunker Gilbreth* (Easton, PA: Hive Publishing Co., 1973 [1954]).
2. On Taylor and scientific management, see Monte A. Calvert, *The Mechanical Engineer in America, 1830-1910: Professional Cultures in Conflict* (Baltimore: Johns Hopkins Press, 1967); Daniel Nelson, *Frederick W. Taylor and the Rise of Scientific Management* (Madison: University of Wisconsin Press, 1980); Daniel Nelson (ed.), *A Mental Revolution: Scientific Management since Taylor* (Columbus: Ohio State University Press, 1992); and Robert Kanigel, *The One Best Way: Frederick Winslow Taylor and the Enigma of Efficiency* (New York: Viking, 1997).
3. On efficiency as a cultural phenomenon, see Samuel P. Hays, *Conservation and the Gospel of Efficiency: The Progressive Conservation Movement, 1890-1920* (Cambridge, MA: Harvard University Press, 1959); Samuel Haber, *Efficiency and Uplift: Scientific Management in the Progressive Era, 1890-1920* (Chicago and London: University of Chicago Press, 1964); Cecelia Tichi, *Shifting Gears: Technology, Literature, Culture in Modernist America* (Chapel Hill: University of North Carolina Press, 1987); and Ed Andrew, *Closing the Iron Cage: The Scientific Management of Work and Leisure* (Montreal and New York: Black Rose Books, 1999).
4. For more on scientific management and its history with labor unions, see Milton J. Nadworny, *Scientific Management and the Unions, 1900-1932: A Historical Analysis* (Cambridge, MA: Harvard University Press, 1955); and Lizabeth Cohen, *Making a New Deal: Industrial Workers in Chicago, 1919-1939* (Cambridge and New York: Cambridge University Press, 1990).
5. For his own explication, see Frederick Winslow Taylor, *Scientific Management; Comprising Shop Management, the Principles of Scientific Management [and] Testimony before the Special House Committee* (Westport, CN: Greenwood Press, 1972). For more on Taylor and his legacy, see the volumes by Daniel Nelson above.
6. Ralph Mosser Barnes, *Motion and Time Study,* 2nd ed. (New York and London: J. Wiley & Sons, 1937), vii.
7. On the science of work in Europe, see Anson Rabinbach, *The Human Motor: Energy, Fatigue, and the Origins of Modernity* (New York: Basic Books, 1990). On Marey, see Marta Braun, *Picturing Time: The Work of Etienne-Jules Marey (1830-1904)* (Chicago: University of Chicago Press, 1992), esp. Chapter 8. For more on Gilbreth's relation to Marey's legacy, see Ramón Reichert, "Der Arbeitstudienfilm: Eine verborgene Geschichte des Stummfilms," *Medien & Zeit: Kommunikation in Vergangenheit und Gegenwart*, 5 (2002): pp. 46-57; Philipp Sarasin, "Die Rationalisierung des Körpers: Über 'Scientific Management' und 'biologische Rationalisierung,' " in *Geschichtswissenschaft und Diskursanalyse* (Frankurt am Main: Suhrkamp, 2003); and Florian Hoof, " 'The One Best Way': Bildgebende Verfahren der Ökonomie und die Innovation der Managementtheorie nach 1860," *Montage AV: Zeitschrift für Theorie und Geschichte audiovisueller Kommunikation* 15, 1 (2006), pp. 123-38.
8. Wilhelm Braune and Otto Fischer, *The Human Gait*, trans. Paul Maquet and Ronald Furlong (Berlin and New York: Springer, 1987).

9. Brian Price, "Frank and Lillian Gilbreth and the Manufacture and Marketing of Motion Study, 1908-1924," *Business and Economic History,* 18 (1989), p. 88.
10. The best presentation of the often troubled relationship between Taylor and Gilbreth is Milton J. Nadworny, "Frederick Taylor and Frank Gilbreth: Competition in Scientific Management," *Business History Review* 31, 1 (1957), pp. 23-34.
11. Brian Charles Price, "One Best Way: Frank and Lillian Gilbreth's Transformation of Scientific Management, 1885-1940" (Dissertation, Purdue University, 1987), p. 153.
12. Ibid., p. 154.
13. Frank Bunker Gilbreth and Lillian Moller Gilbreth, *Applied Motion Study: A Collection of Papers on the Efficient Method to Industrial Preparedness* (Easton, PA: Publishing Co., 1973 [1917]), p. 66.
14. Unless, of course, distance isn't an issue, as in the time-lapse films of Jean Comandon, for example.
15. Gotthard Wolf makes a similar distinction, calling the first kind a "Dokumentationsfilm" (documentary film) and the second a "Forschungsfilm" (research film). But since I am focusing here on a distinction based on mode of observation, I will group them both in the same camp. Gotthard Wolf, *Der Wissenschaftliche Dokumentationsfilm und die Encyclopedia Cinematographica* (Munich: Johann Ambrosius Barth, 1967).
16. Gilbreth notes that the combination of motions "can never be considered standardized till each separate motion is a standard." Frank Bunker Gilbreth, *Motion Study: A Method for Increasing the Efficiency of the Workman* (New York: D. Van Nostrand Co., 1911), p. 70.
17. Elspeth H. Brown, *The Corporate Eye: Photography and the Rationalization of American Commercial Culture, 1884-1929* (Baltimore: Johns Hopkins University Press, 2005), p. 84.
18. The expertise required at this stage is underlined by Gilbreth's habit of reviewing negatives rather than making positive prints. See Gilbreth, *Applied Motion Study,* p. 81.
19. Ibid., p. 46.
20. Ralph Mosser Barnes, *Motion and Time Study: Design and Measurement of Work,* 7th ed. (New York: Wiley, 1980), p. 111.
21. As Price explains, "Gilbreth estimated that by February 1913 word of his invention had been broadcast in at least two million individual copies of periodicals alone. Of course, Gilbreth did not publicize the facts that the development of the basic packet and bench braider assembly method at the Butt Company preceded the installation of micro-motion study equipment; that because of the limitations of his artificial lights he was still dependent on stop watch time study for task setting; and that when he attributed the assemblers' increased output to improved, micro-motion studied methods, he subdivided and redistributed the jobs of filing, fitting, and inspecting, and did not discount the possible impetus to higher output of either increased supervision or financial incentives on the performance of the workers. Micro-motion study, as presented, was on the map." Price, "One Best Way," 1987, pp. 206-207.
22. Lillian Moller Gilbreth, *The Psychology of Management: The Function of the Mind in Determining, Teaching and Installing Methods of Least Waste* (Easton, PA: Hive Publishing Company, 1973 [1914]), pp. 76-77.

23. Gilbreth, *Applied Motion Study,* pp. 60-61.
24. Ibid., p. 83.
25. Ibid., figure 16.
26. Frank Bunker Gilbreth and Lillian Evelyn Gilbreth, *Motion Study for the Handicapped* (London: G. Routledge & Sons Ltd., 1920); Friedrich A. Kittler, *Discourse Networks 1800/1900*, trans. Michael Metteer with Chris Cullens (Palo Alto, CA: Stanford University Press, 1990), p. 231.
27. Price, "Frank and Lillian Gilbreth," 1989, pp. 94-95.
28. Sharon Corwin, "Picturing Efficiency: Precisionism, Scientific Management, and the Effacement of Labor," *Representations* 84 (2003), pp. 139-65.
29. Richard Lindstrom, "'They All Believe They Are Undiscovered Mary Pickfords': Workers, Photography, and Scientific Management," *Technology and Culture* 41,4 (2000), pp. 725-51, here 736.
30. Ibid.
31. Brown quotes a letter from Frank to Lillian about the impact of the cyclegraphs: "I have made a decided hit.... The cyclegraphs will make anybody sit up and take notice." Quoted in Brown, *Corporate Eye*, p. 101.
32. See Brown, *Corporate Eye*, pp. 102-106.
33. See Vinzenz Hediger and Patrick Vonderau, "Record, Rhetoric, Rationalization: Industrial Organization and Film," in this volume.