

The Origin and Evolution of Activity Analysis

Cynthia Creighton

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Practitioners of occupational therapy in the early 1900s selected therapeutic activities with an intuitive understanding of their characteristics and operations. The term activity analysis and the methodology for breaking down and examining tasks scientifically, however, were borrowed from industry during World War I. Methods originally used in time and motion study of jobs were applied to vocational retraining and therapeutic crafts; later, they were applied to a broader range of activities. The most systematic early use of activity analysis was in occupational therapy for physical dysfunction, particularly in military hospitals. Development of the concept was gradual until the 1970s, when the delineation of theoretical frames of reference for practice led to important changes. Today, activity analysis is viewed as a multifaceted process that involves both generic and specific components.

Cynthia Creighton, MA, OTR, is Research Associate, Rehabilitation Institute of Michigan, 261 Mack Boulevard, Detroit, Michigan 48201.

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A wounded soldier works on a weaving project, which requires flexion and extension of the fingers. (Photo courtesy of Moody Medical Library, The University of Texas Medical Branch, Galveston, Texas)

In 1911, industrialization had resulted in unprecedented economic growth for the United States. The average employee worked a 9-hr to 12-hr shift, 6 days per week, for a wage of approximately \$2 a day. The automobile assembly line had not yet been invented.

Two books that would revolutionize industry were published that year: *The Principles of Scientific Management* (Taylor, 1911) and *Motion Study* (Gilbreth, 1911). Taylor, past president of the American Society of Mechanical Engineers, proposed in his text that management in business and industry be approached as a true science with clearly defined rules and principles. An important element of Taylor's new system of management was the study and standardization of jobs to increase productivity. Soon, efficiency experts were observing and timing workers in shops and factories nationwide. As a laborer shoveled ore or cut metal, the consultant identified the fundamental operations, the most efficient tools, and the optimum speed for the task.

Gilbreth (1911), 10 years younger than Taylor and also an engineer, was the first to use the term *analysis* when discussing the systematic study of jobs. He believed that the worker's movements should be the focus of such studies. Gilbreth outlined the steps in analyzing a task as follows: "1. Reduce. . . practice to writing. 2. Enumerate motions used. 3. Enumerate variables which affect each motion" (p. 5). Three categories of variables were considered in a motion study: characteristics of the worker (e.g., physical build, experience, temperament), characteristics of the surroundings (e.g., lighting, tools), and characteristics of the motion (e.g., direction, length, speed). Gilbreth documented these in chart form and in photographs. The purpose of analyzing a job was to identify and teach the "definite best" (most productive and least fatiguing) method of performance (p. 93).

Gilbreth (1911) also discussed adapting activity to make it more efficient:

A careful study of the anatomy of the worker will enable one to adapt his work, surroundings, equipment and tools to him. This will decrease the number of motions he must make, and make the necessary motions shorter and less fatiguing. (p. 10)

In his own bricklaying business, he made adaptations such as reversing the position of materials for left-handed workers and placing stock on a scaffold so the bricklayer no longer had to stoop when picking it up. In 1913, he began founding small museums of devices designed to simplify work and prevent fatigue (Gilbreth & Gilbreth, 1920).

Gilbreth and his wife, Lillian,¹ became well known both at home and abroad as consultants to the business

¹Lillian Gilbreth also applied motion study methodology to organizing the Gilbreths's home and raising 12 children while earning her doctorate at Brown University. The American public came to know the family through the books *Cheaper by the Dozen* and *Belles on Their Toes*, written by two of the children.

community (Yost, 1949). In 1914 and 1915, Gilbreth visited hospitals in Europe to analyze surgeons' work. World War I had begun, and he met disabled veterans and learned about the groundbreaking research of Jules Amar.

Amar (1918) was a French physiologist appointed by his government to investigate scientific management and apply its principles to the training and reemploying of wounded soldiers. At that time, France led the world in the study of human physiology and the development of instruments to measure physiological functions; Amar began analyzing jobs in terms of their physiological requirements. He described the planes of motion in which work was performed and measured movements with simple goniometers. To document strength requirements, Amar attached spring dynamometers to tools such as a file, a plane, and a spade. He measured energy expenditure during work, using oxygen consumption, pulse rate and blood pressure, and urine and blood by-products as indicators. The results of the analyses were applied in a three-part program to reeducate soldiers (many of them with amputations). At the beginning of the convalescent period, exercise and crafts were used to strengthen stump muscles and build endurance. The patient was then fitted with a prosthesis or splint and taught to use it in vocational tasks.

Occupational Therapy and Motion Study

When Gilbreth returned from his travels, he and his wife presented papers to several professional groups about the application of motion study to "re-education of the crippled soldier" (Gilbreth & Gilbreth, 1920). The theme of the papers was as follows:

In considering any type of activity to which it is proposed to introduce the cripple, we first analyze this activity from the motion study standpoint, in order to find exactly what motions are required to perform the activity, and in what way these motions may be adapted to the available, or remaining, capable members of the cripple's working anatomy, or eliminated by altering the device or machine itself. (pp. 45-46)

One in this series of papers was presented in March 1917 at the founding conference of the National Society for the Promotion of Occupational Therapy (NSPOT) at Consolation House in Clifton Springs, New York (NSPOT, 1918). Titled "The Conservation of the World's Teeth," it recommended that disabled veterans be retrained as dental assistants (Gilbreth & Gilbreth, 1920). During the meeting, Frank Gilbreth and Jules Amar were elected honorary members of the Society (NSPOT, 1918).

The Gilbreths clearly believed that engineers were best qualified to analyze and adapt jobs for people with disabilities (Gilbreth & Gilbreth, 1920). Still, in their presentations after the Consolation House conference, they began acknowledging the contributions of George Barton and William Rush Dunton, Jr. (first and second presidents of the National Society). Barton and Dunton, in turn,

began incorporating motion study into their work and their writings. A paper about Barton's practice with convalescents at Consolation House stated that he

considers what motions are possible or impossible, desirable or undesirable; then he finds some occupation which involves those possible and desired motions. . . . Failing to find such an occupation in his own knowledge, the "Director" turns to his "materia medica"—a huge fifteen-hundred page catalog of tools and machines—from which, by a visualization of each tool, how it is used, and what motions are necessary for its use, he "compounds" his "prescription." (Newton, 1919, pp. 4-5)

Dunton (1919) discussed the work of both Amar and the Gilbreths in his second occupational therapy textbook and provided a bibliography of the Gilbreths's publications on motion study.

When the United States entered World War I, activity analysis was included in the new occupational therapy programs and in training courses that were developed to serve returning American soldiers. In early 1918, Elizabeth Upham wrote a curriculum plan for a proposed government course to train teachers of occupational therapy.² The plan, presented to the U.S. Senate and the Federal Board for Vocational Education, stated that students should study "1. Analysis of industrial, commercial, and agricultural occupations in terms of therapeutic values. 2. Modification of processes, special devices and tools for special needs and fatigue prevention" (Dunton, 1918, p. 89). Upham's required reading list included selections from Amar's research.³ Later that year, Upham became director of the first university-based occupational therapy school, at Milwaukee Downer College, Milwaukee (Reed & Sanderson, 1980).

The first systematic application of activity analysis in an occupational therapy clinic may also have been in 1918, at Walter Reed General Hospital in Washington, DC. Bird Baldwin (1919a), director of the new occupational therapy department, described the selection of therapeutic activities for patients as follows:

First, the work must be one which involves as an essential part the movements required by the prescription, or in which these movements recur from time to time as the work is performed by the normal individual. In order to discover the activities in which certain specific movements were thus involved, a survey was made of all the shop and ward activities, and insofar as it was possible by observation and practice, each activity was analyzed into its constituent movements. (p. 449)

Baldwin's activity analyses were detailed but addressed primarily joint position and action. For example, his analysis of engraving described the position of each body part: Fingers flexed at all joints, thumb extended at the interphalangeal and metacarpophalangeal joints to guide the tool, shoulders rigid and slightly abducted. Other

²The term *occupational therapist* was not yet in use. Practitioners in the new discipline were called *teachers of occupation* or *reconstruction aides*.

³An English translation of Amar's most recent text had been published in 1918, making his ideas more accessible to American students.

important requirements, such as muscle strength and vision, were not delineated, although they were clearly considered when patients' programs were planned (Baldwin, 1919b). Activities were also adapted by changing the tools or methods used when this was indicated to improve the patient's physical function or compensate for deficits.

Between the Wars

In the 1920s, after the NSPOT had become the American Occupational Therapy Association (AOTA), a standing committee of the organization began publishing a series of papers designed to help therapists establish new departments in curative workshops and state psychiatric hospitals (AOTA, 1924). Dunton and Association president Thomas Kidner were among the influential members of the committee. Their reports included guidelines for analyzing crafts⁴ in terms of joint motion and muscle strength (AOTA, 1928). Crafts requiring active motion with strength were listed for each body joint, and actions of the two sides of the body were differentiated. No attempt was made to quantify the requirements (e.g., in degrees of range or grades of strength). These craft analyses remained a standard reference for occupational therapists working with physically disabled patients for many years.

In psychiatric occupational therapy, activity analysis took the form of classification of crafts according to their characteristics or applications. Louis Haas, another member of AOTA's standing committee, developed an early system of classification that was widely accepted (Haas, 1922). He analyzed and rated activities in terms of the types of tools and materials used, the noise involved, the potential for modifying methods, the appeal to various ages and sexes, and the simplicity or complexity of processes. As was typical in psychiatry, he was most interested in the characteristics of activities that would address patients' emotional and social needs (e.g., channel aggression, promote self-esteem).

World War II stimulated renewed interest in motion study, now sometimes called *work simplification*. Frank Gilbreth had died, but Lillian Gilbreth published a paper in an occupational therapy journal recommending that engineers and rehabilitation professionals work closely together to help handicapped soldiers (Gilbreth, 1943). The army's War Department (1944) printed a technical manual on occupational therapy that contained the most detailed activity analyses to date. In addition to the traditional breakdown of joint motions, this manual listed activities for strengthening individual upper-extremity and lower-extremity muscles. Charts rating the intensity of

motion at each joint during the performance of various tasks were also included.

Activity Analysis Comes of Age

In 1947, Sidney Licht, a physician who had been chief of physical medicine in an army hospital during the war, wrote a paper calling for more precise analysis of activities used in occupational therapy for physical dysfunction. He suggested the name *kinetic analysis* for the study of specific motions required in an occupation. Licht stated that a kinetic analysis should be based on actual observation of an experienced worker using proper body mechanics. It should describe the starting position and cycle of motion for the activity. The type of muscle contraction and degrees of joint range should be specified, as should the size and shape of tools used. Although Licht's terminology was not generally adopted, the elements of such an analysis are addressed today.

Through the 1960s, occupational therapists continued to analyze activities either in terms of physical requirements or in terms of emotional and social properties. In the 1970s and 1980s, however, a new way of thinking about the theory base of the profession led to major changes in activity analysis. Theorists began to delineate frames of reference within which occupational therapy intervention occurred (e.g., developmental, biomechanical, behavioral). Because each frame of reference included a unique perspective on the selection and uses of activity, each required a different type of activity analysis. Llorens's (1973) analysis of activities for treatment of cognitive-perceptual-motor dysfunction focused on the sensory systems stimulated and the motor responses produced. Trombly and Scott (1977) differentiated biomechanical analysis (emphasizing range of motion and strength) from neurodevelopmental analysis (emphasizing postures and patterns of movement). Cubie (1985) discussed volitional, habituation, and performance analysis within the Model of Human Occupation. The cognitive requirements of tasks were Allen's focus (1985).

Conclusion

Today, activity analysis is viewed as a multifaceted process (Cynkin & Robinson, 1990; Hopkins & Smith, 1988; Lamport, Coffey, & Hersch, 1989; Mosey, 1986). A comprehensive analysis first places the activity within a cultural and environmental context. Then both its generic properties (e.g., steps, tools used, cost, safety considerations) and its characteristics related to a specific frame of reference are described. The activity is discussed as it is normally performed and as modified for remedial or compensatory applications with patients.

Okoye (1988) provided an example of activity analysis as it is currently applied in occupational therapy. She discussed the importance of the computer as a medium

⁴During this period, the term *crafts* was used more broadly than it is today. Early craft analyses included work-related and recreational activities such as tennis, typing, gardening, and bookbinding.

for skill development, education, and prevocational training in our computer age. She presents a form for analyzing a computer-based treatment activity in which the therapist lists the hardware and software needed and answers a series of questions about the characteristics of the activity. The form delineates the neuromotor requirements for accessing the computer (posture, alignment, coordination) and the basic cognitive and sensory integrative functions necessary (visual discrimination, attention, problem solving), because the persons most likely to have difficulty are those with severe physical or multiple handicaps. For each requirement identified, the therapist lists alternative positioning, equipment, or methods for access (e.g., breakaway keyboard, audio reinforcement, software with slower speed options).

Although the original link with industrial engineering and other fields doing time and motion studies in the pursuit of productivity has been severed, occupational therapists continue to use activity analysis essentially as the founders did: to improve the functioning and quality of the lives of persons with disabilities. ▲

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