Work

IN THE HOME

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Preface

Our major aim in preparing this book is to examine the diversity of human resources used to accomplish work and to provide information about these resources that is relevant to the family's management of its work. We have drawn on research and thinking in many fields, including industrial psychology, psychology, industrial engineering, anatomy, physiology, physical education, and anthropometry; those composite fields such as human engineering and ergonomics; and, of course, home management. The literature in all of these fields contributed invaluable information for delineating the personal costs of work. This interdisciplinary approach represents the growth of "household engineering" and "work simplification" to a stage of development consonant with an increased level of knowledge and changes in the physical demands of work.

The result is a broad concept of the human costs of work, encompassing not only the physical and temporal components but also the affective and cognitive components. Knowledge of the worker's inputs, the nature of the work, the workplace, and the relationships among these are prerequisites to competence in solving the work problems of home management. This broad background is essential to the development of sound methods of work economy.

Work in the Home may be used in its entirety as the basis for a course concerned with the management of the human costs of work. Various sections could serve as the text for selected topics in courses on home management, housing, and equipment.

We have assumed that the reader will have some background in the social and natural sciences. An interdisciplinary approach demands a breadth of knowledge not yet achieved by most beginning students. For this reason, our book will generally be more useful as a textbook for upper-division students who are interested in human development and environment. In some instances, the book will serve as a point of departure for study at the graduate level.

We have also visualized our book as a reference for those not formally enrolled in college courses but whose interest is in improving the level of living of families. There is much in the book that will enrich the background and serve as a source of data for professionals in educational fields and in business and industry, such as manufacturers of equipment and supplies used in homes, architects, industrial designers, and the many dedicated persons in social work and rehabilitation of the physically handicapped and the underprivileged.

Our emphasis on identifying the costs of using the human resource to accomplish homemaking work was planned to fill a gap in the home management and human resource literature. Much has been written about nonhuman resources but no other book has been devoted exclusively to an examination of the personal costs of homemaking work and the means of controlling them through the design of work content, work methods, and workplaces. It is our hope that our book will help provide a broader basis for the choice of resource in raising the level of living of families. Less effort in accomplishing work frees the homemaker or other family member to engage in employment work or to provide a richer life for herself and her family. A knowledgeable allocation of resources to achieve goals is based on the consideration of human as well as nonhuman resources.

The content of our book also holds potential for those who are interested in the conservation of the human resource in business and industry. Since our focus is on work and the problem of minimizing the costs of work to the individual, the implications need not be limited to workers in a given situation. Most of our data pertain to women at work in their homes and to the design of workplaces related to women. Consequently it will be necessary to project some data to others at work in homes, to women at work in business and industry, and to other workers in other situations.

We trust that our efforts will stimulate further development of this field of study. Too often the printed word is considered final rather than an intermediate completion point. We encourage each of you to raise questions and initiate further research.

Many persons have helped us during the preparation of this book. We gratefully acknowledge their interest, advice, questions, and technical assistance.

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Work

IN THE HOME

Introduction

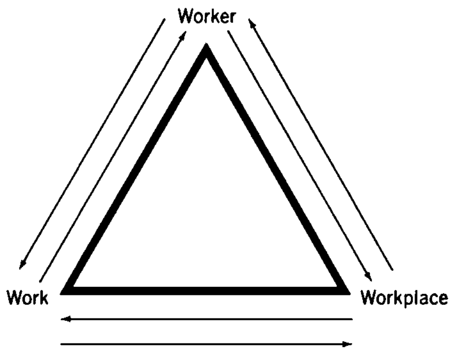
The house is the physical setting for family living. Housekeeping has its own worth and dignity as the means by which this setting is maintained and the family's needs for food, clothing, and shelter are met. Work management principles comprise an aspect of home management which offer the possibility of maintaining the physical setting and of meeting physical needs, leaving family resources for the desired personal, developmental, and recreational needs of family members.

The work of housekeeping is for the benefit of the entire family and the resources required for it are those of the entire family. A resource contributed by one family member to accomplish work is a part of the total resources available for all purposes. It is in the interest of families to minimize the use of whatever resources for work accomplishment are scarce or are valued for purposes other than work.

Changes in social conditions, patterns of living, and health emphasize the need to know how to minimize the human costs of household work. More and more, women are joining the labor force with the result that they have less time to allocate to household work, and other family members contribute more help. Not only homemakers, then, but also husbands and children can benefit directly by applying knowledge about human costs of work to homemaking activities.

Measurement of the personal costs of work requires not only a broad concept of these costs, but the use of knowledge about two other dimensions—the work itself and the place of work. The concept of these three dimensions of work—the worker, the work, and the workplace—provides the framework for studies aimed at appraising the use of the human resource.

In a given study, each dimension may in turn receive major attention, but at the same time knowledge is generally gained about the remaining dimensions. They are interrelated; they cannot be completely isolated. Each affects the other to some extent (Steidl, 1963c:4).



When the focus is on the worker, knowledge is sought concerning the demands placed on the individual by the particular activity and by controlling the interplay with other activities. The number, variety, and duration of positions, feelings toward the activity and the conditions for doing it, amount of judgment, skill, organization, attention, and effort, are studied here.

The work itself is studied to make the following determinations: the amount and use of time and space; the spacing of the parts of the activity; the interplay with other activities; the materials, processes, and tools involved; the type of activity; the place of work; the person performing the activity; and the facilities used.

The workplace is studied to determine the conditions that expedite the activity, that exert the minimum of strain on the worker, and that require minimum effort. Thus, aspects such as the location in vertical and horizontal space, the spatial arrangement of parts, the amount of space for work and storage, and specific features are examined.

Knowledge of the effect of different procedures and working conditions on worker input makes possible intelligent choices in efforts to reduce the necessary work to a minimum. Knowledge of the description and measurement of worker input is requisite to controlling the human costs of work.

In developing our frame of reference—the worker, the work, and the workplace—and our concept of the human costs of work, we have brought together known facts, suggested explanations when evidence did not exist, and indicated areas and problems needing research. We trust that our readers will be stimulated and challenged to develop and improve the study of the personal costs of accomplishing work.

PART I

The Worker

CHAPTER 1

Concept of the Human Costs of Work

Choice of tasks and work methods must be based on a thorough understanding of all aspects of the costs of work; we cannot assume that it is always desirable to reduce the energy cost. Individuals vary in their need to conserve physical resources and in their standards for achievement. The aims of a study of the work of the home should be to provide information helpful in assessing the costs of homemaking work in terms of family resources and to show how the use of certain resources can be minimized. This kind of study should result in improved ability to assess all the costs of work without undue emphasis on the use of any one resource for all families.

COMPONENTS OF WORKER INPUT

Broadly conceived, the cost (in human resources) of worker input may be considered to have four components (Bratton, 1959a):

1. *The affective component.* Attitudes, feelings, and interests.
2. *The cognitive component.* Knowledge, thought processes, and skills.
3. *The temporal component.* The time of the worker and the timing of tasks.
4. *The physical component.* The use of the body in the work.

Expenditure of any of these inputs by any member of a family constitutes use of family resources and is a consideration in choice of tasks, work methods, and equipment.

Any one of these components may assume unusual importance to one family and be relatively unimportant to another or to a given family at one stage and not at another. The work specialist is in error if she assumes that only two of these, time and physical work, are her concern. The cognitive and affective components of worker input also influence the assessment of costs to the family, the outcome of work study, choice of supplies and materials, and the acceptance of design of equipment.

The affective component concerns the part that personal interests and attitudes play in making the work easy or difficult. This aspect offers little in the way of objective measure of costs but is nevertheless important and cannot be ignored. The personal factors that make work seem easy or hard, desirable or undesirable, must be considered if one is to effectively simplify work. The woman who likes to be "on the move" will not find a work method easier if it eliminates walking and requires her to remain for long in one spot.

The cognitive component is the component of thinking. The content of this component is usually presented as a resource in home management textbooks but is sometimes overlooked by the work specialist. The knowledge the worker has of how to do the work and of the result desired, and the skill she has to produce the result, contribute importantly to ease of work. For many homemakers, especially beginners, the greatest time and work saver is to learn the job. Sometimes the best help the work specialist can give is to suggest ways of speeding up the learning process.

Time is generally considered an aspect of the homemaker's work and regarded as one of the resources with which the family's goals are achieved. Units of time provide an easily understood measure of the cost of work, and time is one of the more often studied aspects of the homemaker's job. It is a mistake to assume that reduced-time cost has top priority for all homemakers. A function of the work specialist is to help homemakers assess the time cost of a given product or standard and to help those who wish to reduce the time cost to find ways of achieving the desired outcome.

The physical component of work is widely recognized. For a long time home management specialists have concerned themselves with studies of energy expenditure and have used these for assessing the physical costs of work. Other means of assessing the physical costs of work will be discussed later in this book. The concept of the physical dimension of work needs to be broadened to include a maximum number of the demands of work upon the body of the worker.

The four-component approach to worker input will help to assess the range of the human costs of work and thus enable one to rationally choose the use of resources for work. An educational program concerned with the work of the home should enable us to see possibilities for the use of alternate resources and to feel free to prefer the use of one over another. Balance in the use of resources may contribute more to family satisfaction in the home than minimizing the use of one resource. As increased use of one resource permits decreased use of another, the provision of a desired environment may be achieved with greater satisfaction to the family. An understanding of the work of the home and its total cost to the family may, at times, result in a reversal of the proverb, "Use the head to save the heels." Today's homemaker who finds the mental costs of homemaking too high may be better served if she knows how to use her heels to save her head.

Understanding the work of the home means recognition of all costs, not only to the worker but in value conflicts in family living.

FATIGUE

If all the personal costs of work could be summed up in one word, that word would be fatigue. Whether or not she feels tired is the important fact to the worker. It would simplify the problem if we could just agree to say that fatigue consists of feelings of tiredness; if you feel tired, you are, if you don't feel tired, you aren't. But this would be costly in industry where accident and error could be related to fatigue that is not felt as fatigue. It is sometimes costly in the home where accident and error can also take their toll in a material way or in family relations with increased tension and irritability.

Fatigue is sometimes categorized as physiological and psychological. Such classification has its usefulness and has some basis in the facts of human behavior but can be misinterpreted if our understanding is superficial. In reality they may not be two discrete types of fatigue but a complex, because they are often interrelated and overlapping.

There are those who hold that with the passing of heavy physical work from the American home physical fatigue is no longer a problem, and that psychological fatigue must constitute the entire fatigue problem of homemakers. There are also those who, sometimes unknowingly, treat energy expenditure at any level as directly proportional to fatigue without regard for the natural capacity of the body for physical work.

The term psychological fatigue is also misinterpreted. For some people, it has the connotation of imagined or not real. They believe that an improved mental attitude is all that is needed for fatigue prevention. This point of view is characterized by the expression, "It's all in your mind," with implied blame for the person who does not of her own volition get it out of her mind. Such a point of view ignores the reality of the effects of aversion, frustration, and boredom and assumes that right-thinking homemakers will not have a fatigue problem. Misinterpretation of either the psychological or physiological sources of fatigue will leave the work specialist poorly equipped to deal with fatigue problems.

Fatiguing Experiences

As a background for considering the physiological and psychological aspects of fatigue, we can look at some common situations in which we experience fatigue, situations that are often associated with feelings of tiredness. These situations can be summarized in a nontechnical way:

1. A long period of mental or light physical work in a restricted or uncomfortable position.
2. A long period of work in a standing position.
3. A long period of making continuous postural adjustments, such as when riding in a car.
4. A period, possibly short, of heavy physical exertion.
5. Working at a disliked task.
6. Working at an unaccustomed task.
7. Working at a task that requires close attention or extreme alertness.
8. Working under pressure, for instance, when meeting a deadline.
9. Working without sufficient knowledge or information.
10. Emotional stress, whether working or not.

Most of these situations occur in homemaking tasks and are familiar to homemakers. What are the fatigue-producing elements in all of these? How do they relate to what is known of the physiological and psychological bases of fatigue? How do they relate to the normal activities of the homemaking job—to work problems?

It is not possible to sum up under the term fatigue a satisfactory answer to these questions. The answers can be formulated only after reaching a broad understanding of how the worker is involved in work performance. The basis for such understanding will be presented in the following chapters.

Fatigue Studies

Fatigue of industrial workers has long been of concern. In Great Britain, between the years 1919 and 1938, the Industrial Fatigue Research Board made over 80 reports on their studies of industrial efficiency and the preservation of health among workers. Attempts to devise a fatigue test were not successful; investigators resorted to indirect measures, the chief ones being level of output and rate of working. In his review of their pioneer work, Chambers (1961:47) states:

"This brief discussion of various types of fatigue indicates quite clearly that fatigue is not a simple state of the organism. Further, there seems to be no reason to regard industrial fatigue as a specific variety; rather it would appear that dynamic and static muscular fatigue, mental fatigue, boredom, and skill fatigue all ocur [*sic*] in varying degree amongst workers in industry. Insofar as these have deleterious effects on efficiency and health it is important to attempt prevention or alleviation. Obviously there can be no panacea; for example, rest pauses may be effective in reducing fatigue in certain repetitive tasks but may be ineffectual in other types of work."

Fraser (1958:263), also of Great Britain, reviewed experimental work in the study of fatigue. One of his conclusions was:

". . . it is misleading to consider fatigue as a single and simple phenomenon which builds up in the same way under different conditions and in different individuals. Several types of fatigue can already be distinguished occurring under different conditions, in different types of activity, and requiring different methods of study and measurement. Individual differences in susceptibility to fatigue are also clearly evident."

Psychologists in the United States have also studied fatigue. Bartley (1965:23–24) believes there are three sorts of fatigue:

"The first has to do with the effects of exertion. This is to say we need to know what happens in the body as a result of expending energy. Most of the energy transformation takes place in muscle, hence a great deal of attention is to be paid to what goes on in muscle.

"The second class of phenomenon that concerns us is the organization of processes within the body. Organization is something that occurs at various levels. Much of it is neuromuscular and is involved in performing acts of skill or meeting demands in which activity is of a restricted or predetermined form. To understand how fatigue develops in such situations is to understand matters relating to the *organization* of internal activity rather than to *energy expenditure.*

"The third concern has to do with the relation of the organism as a person to the environment."

Bartley indicates a number of typically fatigue-producing situations including paced performance; prolonged activity; action in the face of remoteness of goals; frustrating situations; inadequacy; and interaction with the environment—too exacting for a specific body mechanism.

The complexity of fatigue concepts is emphasized by Ryan and Smith (1954:287):

"The term fatigue has been used in many different senses, and in fact it is not a term referring to a single unitary phenomenon. Instead it is a blanket term for many different effects of work—all of those effects which are harmful or deleterious, and which are a function of the duration and amount of effort, but which are recoverable through rest. Thus only the beneficial effects of exercise and learning, and the drastic effects resulting in permanent damage are excluded from the concept."

Ryan and Smith suggest four different kinds of effects of work which have been termed "fatigue":

"1. Feelings of weariness, tiredness, exhaustion, unwillingness to continue work, aches and pains attributed to work.

"2. Deterioration in ability to perform the work itself. (Loss of capacity for the work.)

"3. Deterioration in ability to perform other tasks and activities. (Transfer of fatigue.)

"4. A large number of physiological changes—in blood chemistry and structure, excretory products, glandular secretions, etc." (p. 287).

These authors identify two areas in particular which need more attention: (1) the feelings of tiredness experienced by the worker, and (2) the physiological correlates of tiredness. "Fundamental research into the nature of tiredness—how many different kinds there are, and how they are related to the kind and conditions of work, is one of the most important tasks for scientists in this field" (p. 298).

INDICATORS OF WORKER INPUT

The study of fatigue has been pursued with a variety of measures—psychological, physiological, physical—some objective, some subjective. None has proved satisfactory. The interrelationships among the factors are not clear. Measurement of a single dimension of a factor is generally inadequate since more than one dimension of a given factor as well as more than one factor probably enter into the cost. Identification of all factors involved and the dimensions of each continues to be a difficult problem.

The significance of each amount of change occurring with each indicator or measure is another problem of work measurement. Units of measurement vary with the factor—seconds for time, inches for distance, and cubic centimeters of oxygen for energy expenditure. A small change may be meaningful with one indicator of input but not with another. The importance of the changes may also vary with the individual because of the interplay among factors involved.

Measures vary in the information they yield. They provide the means for analyzing different aspects of a problem. The choice of an appropriate measure requires knowledge of what elements of input each measure is estimating or assumed to be indicating. The variety of measures used to study fatigue is indicative of the sources that are thought to be potential contributors to the costs of work.

In this chapter, we examine briefly some of the indicators of worker input; more thorough examination is reserved for the particular chapter concerned with that type of input. Our purpose here is to suggest the scope of the problem of studying what a person puts into his work.

Attempts to evaluate the costs of work include subjective reports and objective evidence. Both types present problems; both have advantages.

We can all report any adverse feelings that we associate with working —aches, tiredness, effort, and so on. We can also rate how extensive that feeling is, i.e., how tired we are. The problem with these subjective reports of fatigue is that not all of the fatigue may be related to the work, not all of the changes may be evident immediately to the individual—some are cumulative changes, and the basis for the evaluations is not absolute and may vary from time to time with a given individual as well as among individuals. On the plus side, the subjective evaluation may well be a general, gross expression of most of the undesirable effects of the activity; it may also point to particular aspects causing the fatigue.

Of the objective indicators of worker input, some are physiological while others are external to the individual. Oxygen consumption or energy expenditure is probably the best known of the physiological measures, but it is not particularly well suited to studying the cost of work for the modern American homemaker. Energy expenditure measures total body activity—the rate of oxidation in the body as a whole—but not fatigue.

Other physiological changes (such as chemical indicators of glandular function) may prove effective, but further work remains to be done before they are useful for our purposes (Ryan and Smith, 1954). The reduction of eosinophil count in the blood has been claimed to relate closely to reduced capacity for work and may have some promise as an objective measure of the cost of work (Redfearn, 1960).

Changes in the functioning of the central nervous system (physiological in character and caused by fatigue) may be evidenced in types of behavior which are studied by the psychologist. Finger tremor is an example of disruptive changes in the central nervous system resulting from fatigue; finger tremor can be measured in both frequency and amplitude to provide an objective measure of the effects of work. A study by Mize et al. (1956) for the design of baking centers made use of this technique.

The flicker-fusion test has been proposed as a means of indicating changes in the functioning of the central nervous system resulting from a variety of tasks, rather than visual tasks alone. When a flickering light is presented and the rate of flicker is gradually increased, there comes a point when the flicker is no longer noticed and the light appears steady. Changes in the rate at which flicker fusion occurs for an individual are thought to be associated with fatigue. Flutter fusion is the auditory counterpart of flicker fusion and is thought to indicate similar changes in the nervous system with greater sensitivity. Further work remains to be done to understand how these phenomena function and to establish their merit for indicating the effects of work. The fusion rate may be a function of the person's effort.

Objective criteria external to the individual have also been used to indicate the effects of working. In studies in home management and industry, the kind and amount of movement have provided objective information about worker input, useful in comparing work methods, layouts, and design of equipment. Quality of movement as determined by principles of body mechanics is logically combined with subjective reports of discomfort and strain. Criteria used in industrial studies include rate of work, output, errors and scrap material, and unauthorized rest pauses. These have been relatively unsuccessful in determining input because they may be affected also by the motivation of the worker, his concept of the amount he wants to produce, the manner in which he paces himself when the work is not machine paced, and group pressure to produce a particular amount or to keep production below a certain level.

Transfer of fatigue from work to other activity has provided another way of studying worker input. Welford, Brown, and Gabb (1950) studied commercial air crews on overseas flights and made several comparisons: performance for one crew in learning a new and complex task after a flight and retesting after rest; and performance of another crew in learning the task before a flight and again after the flight. Performance was poor on first test and retest for those returning from a long and difficult flight and better for those who first learned the task when rested. They concluded that a marked effect of fatigue may be found when an individual is in a new situation and must learn new and complex tasks. Ryan and Smith point out that the designing of tests for such studies presents certain problems, but study of transfer of fatigue may be a promising procedure.

Evidences of the deterioration of performance from fatigue in highly skilled work have been cited by Bartlett (1943, 1953), Broadbent (1953), and Welford (1953). The timing of the units of activity goes wrong and the rhythm of the activity is lost or broken. The worker becomes unaware of information in his surroundings that is important to the activity. One consequence is that the right actions are more often made at the wrong time; another is that he becomes more aware of physical discomfort and becomes irritable.

Another direction for the study of input centers around measurement of *effort*. Ryan and Smith 1954:287) have stressed the great importance of studying effort as a measure of the cost of work. Effort is "a characteristic of the working activity itself. It is also more fundamental in the sense that fatigue itself derives from effort, being the cumulative effect of the prolonged expenditure of effort."

"Effort refers primarily to the experience of the individual, a feeling of working hard or easily" (Ryan and Smith, p. 280). Although we can rate our effort, this is a rough evaluation and present methods may not be sufficiently accurate. They explain further:

> "The feelings of effort must be related to some change in the way the organism is functioning and must be reflected in some physiological mechanism . . . measurable in physical or chemical terms.
>
> ". . . the most essential aspects of effort are probably to be found in the central nervous system . . .
>
> "Three main indicators of effort have been used . . . (1) muscular tension, (2) electrical resistance of the skin, and (3) changes in circulation such as pulse rate, blood pressure, and pulse product" (p. 281).

Muscle tension as an indicator of effort can be measured by recording the amount of force exerted on the tool or a surface during the work. An example of this may be found in a study of ironing by Knowles (1946) in which the amount of force exerted on the ironing board was recorded. Muscle tension may also be measured by electromyography, which is a means of recording the electric potentials in acting muscles whether or not they are the ones directly used in the work.

Electrical activity in the skin has provided another indicator of effort —galvanic skin response (GSR). Electrical resistance of the skin is lowered as effort increases. However, emotion also lowers the galvanic skin response. This fact is used in lie-detector tests.

Changes in circulation, such as pulse rate, blood pressure, and pulse product, also provide physiological indices of effort as well as the general activity level of the individual. Until recent advances in electronic equipment, however, measurement of these changes during work has been disturbing to the worker and could not be continuous. Frequent readings throughout the work period are necessary to provide information for evaluating input. One difficulty with pulse rate and blood pressure is that they are also indicators of emotion.

The concept of activation (or mobilization or arousal) may be useful in explaining effort and ultimately the relation between effort and fatigue (Scott, 1960). A certain level of activation is necessary for productive output. Activation is viewed as a continuum extending from deep sleep at the low end to frantic emotion, excitement, and extreme effort at the high end (Duffy, 1941, 1949, 1951; Malmo, 1957; and Schlosberg, 1954). Intermediate between these extremes are wakefulness and light and moderate activity. Performance may suffer from either under- or overarousal; both are accompanied by disorganization of response.

Physiological responses may serve to quantify the level of activation. The fact that the same physiological responses used to measure effort are used to measure level of activation—muscle tension, galvanic skin response, heart rate—is viewed as more than coincidental by Scott. He proposes that level of activation may be equivalent to reported intensity of effort. He reasons that if effort is reflected in heightened activation and fatigue is reflected in lowered activation, effort and fatigue differ markedly in their activation component. The distinction between effort and fatigue may be reduced to a quantitative one.

In the long history of attempts to study human fatigue, many changes in the functioning of the body have been identified with it. Too often the changes which can be objectively determined and are assumed to be the result of work performance have not correlated well either with the worker's own feelings of tiredness or with the output of work. Although the concept of fatigue has remained elusive, in the following chapters we will present what is known about the effects of work on the worker. Such information may serve as the practical and rational bases for evaluating work content, work method, or workplace design and arrangement in the home. A student interested in the management of the work of the home will continue to be challenged to learn new developments in the various aspects of fatigue study.

CHAPTER 2

The Affective Component

The affective component concerns the worker's personal feelings about the activity—his attitudes and interests, his preferences and dislikes. These aspects may contribute to the homemaker's feelings of working hard or easily. Feelings of working easily may contribute to greater satisfaction with the work. Feelings of working hard may be directly related to the unhappy feeling that we are doing more than necessary to accomplish the work.

Most of us find it more difficult to do those activities that we dislike compared to those we like—it takes more out of us emotionally for we do not enjoy the time spent and it is not satisfying. When an employed person becomes dissatisfied with his job, he may be able to change to another that more nearly matches his interests. This is not often the case with wives—they have made their choice of an occupation that will continue throughout their married life; even when they are gainfully employed, they generally continue to manage domestic activities and carry on other aspects of the occupation of homemaker.

How do homemakers feel about homemaking work? Do they tend to like or dislike it? Are there many tasks that they dislike? How can negative qualities be minimized?

Dissatisfaction with work may have many deleterious consequences. Feelings of tiredness and fatigue may become chronic. The accomplishment of work-oriented goals may be hampered. The dissatisfaction may permeate other aspects of our lives and into the lives of others.

What factors contribute to satisfaction with our job and to preferences for tasks? Is there a relation between the goal character of work and satisfaction with work?

JOB SATISFACTION

Our concern with job satisfaction is necessarily focused on satisfaction with homemaking work and the relationship to accomplishment of homemaking activities. Satisfaction with the role of wife and homemaker is the province of specialists in family relationships and those concerned with mental health rather than work specialists. We must be aware, of course, of the close relationship between satisfaction with household work and with role of homemaker. It is sometimes difficult to separate them for household work is an ever-present part of that role; everyday tasks have to be planned and performed, supervised, or delegated to keep the home going. Also, we must be aware of the close relationship between the homemaker's satisfaction and the well-being and development of other family members in the home.

"Just a Housewife"

Much has been written about the dissatisfaction of the American woman with her role of housewife. Much of the discontent seems to stem from the better educated woman's desire to use more of her abilities. More and more, women are receiving a college education. The value judgment in our society now is "a girl has the same opportunity and can do the same as a man" (Korner, 1956:544). Women have proved that they are mentally capable of doing more than housework, and it is culturally acceptable to seek education and employment. However, Korner continues, "Our present age does not emphasize the value 'housewife' either in education or in school. To the contrary, there is a thorough indoctrination that being a housewife is a fate and not a call. Becoming a housewife requires considerable value adjustments from any woman."

Not only is there a lag between value change and cultural change, but there is also the conflict between the individual's conception of responsibilities of homemaker, wife, and mother and the desire for personal fulfillment. As Myrdal and Klein (1956:xi) note in their introduction, "The emphasis has now shifted from the discussion of: 'What *can* women do?' to one of: 'What *should* women do?' Implicit in this question is an interest both in women's individual well-being and in the welfare of society."

Myrdal and Klein estimate that an average housewife can be considered to be employed full time in the home for only one-fourth to one-third of her normal adult life. The number of children averages fewer than formerly thus reducing the time span for caring for children. Technological advances have lightened the physical input for doing housework, and the decreased workload provides the basis for part of the controversy.

When women say, "I'm *just* a housewife," we might wonder if they really do place a low value on their work and thus do little to enhance their satisfaction with it. It appears that they do not recognize the contribution they make to their husbands, children, and to society through the effective management of the home. Myrdal and Klein (1956:12) point out that: "The mental health and happiness of coming generations depend, to an extent which we have to-day only begun to understand, on the love and security which maternal care provides during early childhood. In this sense women bear a special responsibility for the future quality of our people."

The importance of women's contribution to their family and the conflict women have in defining their role have been noted also by Margaret Mead, a world renowned anthropologist. Dr. Mead (1963:24) deplores certain omissions in the 1963 report by the President's Commission on the Status of Women:

". . . None of the specific recommendations of the report are directed to the emotional conflicts and problems created for a married woman and her family if the woman takes a job. Nothing is said about women who would rather center their lives in the home. There is no real discussion of the values involved in a choice between working outside the home for money and inside the home for love. There is no emphasis on the mother's role as an educator of her children (except a lip-service speech about passing on tradition), and the concept of a woman as a *wife* to her husband is missing entirely from the report. In fact, the report assumes that once the children are grown, women can stay away from home for months at a time, if a career should require it, and no one will suffer.

"The report also omits one of the most significant facts about women in the United States today—that working women, working at lower-level jobs than men, give over a tremendous amount of their time to repetitive drudgery related to things rather than to people. The report takes no cognizance of the sacrifice most women make every time the needs of the individual—their traditional concern—have to be subordinated to a time clock, an assembly line or a deadline.

"There is no real recognition of the principal historical difference between women's and men's roles—no recognition of the fact that while men generally have devoted themselves to organizing and exploiting the outside world of nature and society, women have devoted most of their time and attention to the care and well-being of individuals, primarily to their families."

Dr. Mead's points concerning the type of work women often do for paid employment are well taken and contribute to our analysis of the total problem of some homemakers' dissatisfaction. The very nature of a married woman's movement in and out of the labor force necessitates her being employed in the less skilled jobs where only a comparatively short training period is required.

These issues connected with "What *should* women do?" are noted here because we believe they have a direct relation to the cost to the homemaker in performing household work—whether she is in the paid labor force, is active in community activities, or is a full-time homemaker. A woman's lack of clarity about what she wants to do or a conflict among goals makes it difficult for her to assign priorities among her endeavors. The complexity of the situation is increased if dissatisfaction arises from a part of the activities such as housework. For these reasons the minimizing of effort and dissatisfaction from doing homemaking work is desirable.

Mental Health

The importance of housework in the lives of homemakers and the effect on their well-being has not been the object of much study; in fact, the effects of work on the mental health of men and women in the paid labor force has received insufficient attention:

"Work has an influence on many sides of our life. If we are unhappy in our work, this unhappiness has its effect on our home life. If we are happy with what we do and the people with whom we work, then this satisfaction contributes to more satisfying and richer living outside the work situation.

"Despite the importance of work, very little effort has been made to study and understand just how someone's work influences his well-being." (Levinson, Price, Munden, Mandl, and Solley, 1962:184).

Satisfaction in work, of course, is not the only contributor to mental health. Whitehorn (1954:607) concludes: "The building of mental health and the imparting of mental health are not matters to be worked at in isolation but form a part of the context of living. . . . must therefore be viewed as aspects of a culture, rather than as results of a specific technique."

Kornhauser (1962:46), in a study of skilled and semiskilled factory workers, determined that mental health was dependent on factors associated with the job, but concluded that: "If we are to understand why mental health is poorer in less skilled, more routine factory jobs, we must look at the entire pattern of work and life conditions . . . not at single variables." It is within this context of work as a contributor to mental health that we consider some data on the mental health of homemakers.

Data from two major investigations will help us understand more of what is known about the importance of work in mental health and mental illness. The two studies are alike in that individuals were interviewed, but the orientation differs. The first study sought to determine what American people thought of their mental health (Gurin, Veroff, and Feld, 1960a). The second study (Langner and Michael, 1963) focused on the relationship between mental disorder and the sociocultural environment in an urban community.

Gurin, Veroff, and Feld selected a sample representative of the total population for their survey. The researchers (1960a:xi) assumed that:

". . . mental health springs not from avoiding all stress—always staying out of trouble—but from a capacity to accept normal amounts of stress, with some ability to rebound or to handle trouble. When he feels unable to do so through his own resources, the individual may or may not seek help from others—and he may or may not get it."

Since the survey asked persons for their own estimate of their mental well-being—happiness, absence of worries, feelings of self-satisfaction—we can identify areas of perceived need and plan appropriate, organized ways of meeting the needs.

Of the 2,460 persons interviewed in the nationwide survey, men and women did not differ in their evaluation of present happiness or in anticipation of future happiness (Gurin et al., 1960a, b). Over one-half (1,383) were women, and 70 percent were married at the time of the interview. Sources of both happiness and unhappiness were most often in the category "economic and material" (29 and 27 percent). Children were mentioned as a source of happiness as frequently as economic and material reasons. Jobs were mentioned as a source of happiness slightly more often than as a source of unhappiness (14 and 11 percent of the respondents, respectively). Apparently this percentage does not include the homemakers with respect to their occupation of housewife.

Perceived sources of weaknesses and strengths—sources of shortcomings and strong points—give us additional insight. Women mentioned "housewife" as a strong point, but that particular response was either not mentioned or not listed as a separate category for sources of shortcomings. In discussing role characteristics, Gurin et al. (1960a:76) note:

"As one would expect, men mentioned their occupational role performance as a source of strong points for them, whereas women refer to their housekeeping role performance as a strong point. If we compare the frequency with which men mention occupational strong points with the frequency with which women mention housekeeping strong points, there are no significant differences between them."

Further understanding of the satisfaction of homemakers with and adjustment to their roles of wife, mother, and housekeeper can be obtained from the data concerning the sources of inadequacy in marriage. Gurin et al. measured adjustment in three life roles (marriage, parenthood, job) in three ways: gratification, problems, and adequacy. Sources of inadequacy with respect to role functioning in marriage—provider, housekeeper, and parent—are of special interest to us. Over 800 of the 2,460 respondents said they never felt inadequate. Almost 1,000 said they felt some degree of inadequacy; in each of two groupings of inadequacy ("a lot of times, often" and "once in a while, once or twice") about 20 percent gave "poor housekeeper" as a source of inadequacy. This suggests the need for continuing to educate women in managing household work, for this is roughly 10 percent of the married women interviewed. Subsequent analyses indicated that feelings of inadequacy in housekeeping were especially evident among the young and the young, college educated women.

Kiell and Friedmann (1957:91) suggest some reasons why college educated young women have feelings of inadequacy in the role of housekeeper:

"Her liberal arts degree has made her more knowledgeable in a variety of field but with not enough to make her feel secure. So it is with her married life. As a housewife she is required to carry on a number of diverse tasks and play a variety of roles. But with neither the training nor the incentive, she does not feel secure nor does she have a sense of fulfillment from a job expertly done."

Home management specialists are in a unique position to help young educated homemakers acquire information basic to the more successful accomplishment of tasks. The need for directing more action programs toward this group is indicated.

Even though a comparison of job satisfaction of homemakers and adequacy at work is not possible from the Gurin et al. (1960a) study, those data on employed men merit our attention. Feelings of job satisfaction, reports of work problems, and feelings of adequacy on the job were obtained from the employed men in the survey. About 75 percent of the 925 employed men were very satisfied or satisfied with the job. Work problems—work blocks, inability to get along on the job, problems with vocational choice—were reported by a larger proportion of the dissatisfied than satisfied men. About one-third of the sample of employed men were also asked questions concerning adequacy on the job; a positive relationship was found between satisfaction and feelings of adequacy on the job. However, a low relationship was found between the adequacy and problems measures. Feelings of inadequacy at work were in terms of skill or how good a job a person felt he was doing. The researchers interpret the low relationship between the adequacy and problems measures as

". . . indicating that people apparently do not translate feelings of lower adequacy and competence into what they define as a work problem. This contrasts with the findings in the marriage and parenthood areas, where feelings of inadequacy were clearly related to the experience of problems. . . . The lack of relationship between these measures in the job area may reflect . . . that adequacy in the job has a much clearer objective referent than in the marital and parental roles and may therefore be less related to the general introspection or self-questioning that is represented in recognizing problems in a role" (pp. 147–148).

We might speculate whether or not homemakers would view "adequacy on the job" (that job being housewife) in the same manner since one role in marriage is housekeeper. Would the objective or subjective referents dominate the evaluation?

Gurin et al. studied how people cope with their problems as well as how people feel they have adjusted to life. It appears that an important aspect of coping with problems concerns whether an individual seeks help. There is a greater chance of dealing with problems if we wrestle with them actively rather than accept them with apathy. Apparently awareness of help is a critical factor. These facts suggest that we should publicize sources of information and programs offering homemakers help with ways to manage their household work.

The data from Gurin et al. suggest that housework is a contributor to the poor mental health of some homemakers, but the data do not explain how important a contributor the work is. Let us turn to the second major investigation.

In the Midtown Manhattan Study, Langner and Michael (1963) sought information with respect to how many persons were psychiatrically impaired, the degree of impairment, who they were, and how they got that way. Two Mental Health Ratings were determined for each subject by two psychiatrists working independently with the data. Stressful factors in the environment were then studied. "Work worries" was one of 14 stress factors isolated for Mental Health Ratings.

Two worries, about work and about overwork, were combined in the work worries factor.* About one-half of 690 males and one-half of 256 never-married females, but three-tenths of 714 ever-married females worried about work often or sometimes. Little difference was found among the three groups in the proportion worrying about overwork, but 20 to 28 percent worried often or sometimes about overwork.

The importance of worrying about work or overwork in mental health risk may be surmised from the researchers' conclusions. In general, the risk involved in any one factor was small. Of the 14 stress factors, 10 were combined in a score; one of the 10 was work worries. The most important fact is that the number rather than the pattern of negative factors predicts the mental health risk. The risk of impairment seems to be linear to the number of stresses and suggests no "breaking point" beyond which total impairment might be expected. Individuals differ in their reaction to stress and in their strength to deal with a particular force at a particular time. If work worries can be removed as one of the stress factors, the number of negative factors is thus decreased and the mental health risk lowered. The management and work specialist has a potential contribution to make in preventing mental illness of homemakers by helping to reduce worry about housework.

Our contribution could take several directions. Comfort, reassurance, or advice on how to proceed may be sought by homemakers who feel inadequate in their housekeeping, who say they are poor housekeepers, or who worry about it. Some reassurance can be given to those homemakers who carry a heavy workload, such as those with young children, in knowing that others in the same situation have problems similar to theirs. They can also gain help from knowing how others have coped with similar problems. In other instances, it may be necessary to emphasize the need to change ourselves. If a homemaker does not set a goal of doing the housework, poor housekeeping can result, and she may need help to realize that she must change herself to accept the task of doing the work and/or of raising her standard for accomplishment. Techniques for carrying out tasks and development of skills may need to be learned. The design and organization of workplaces may constitute a major problem. In each case the management specialist will need to identify the sources of the problems.

* The researchers point out that the items "applied equally to both men and women and to people in various marital states. Housewives, for instance, could and did report that they worried about their work and about overwork" (p. 303). Active recognition of the importance of housework to the homemaker is unusual.

Satisfaction with Homemaking Work

Let us now return to the more specific aspects of satisfaction with homemaking work. What information do we have that indicates not only how satisfied or dissatisfied homemakers are with household work but the reasons for their evaluation? Occasionally, the questions have been included as a part of a study in which homemakers were the respondents. When Nolan and Tuttle (1959) asked 237 full-time homemakers to evaluate the advantages of full-time homemaking, a few (5 percent) expressed dissatisfaction with housekeeping saying that they found it repetitious and monotonous; over one-half, however, said there was no disadvantage in particular, but dislike of a specific task was indicated as a disadvantage by over one-third. Advantages of full-time homemaking included: enjoy doing specific task; enjoy caring for family; being own boss; and like everything. The mean scores of attitudes for the 237 full-time homemakers as well as 59 employed wives toward "ability to cope" and "satisfaction with own situation" indicated that those in both groups were satisfied with their situation.

Some associations between socioeconomic status and attitudes toward homemaking were suggested in a comparison of the home management of "lower middle" and "upper middle" homemakers by Van Bortel and Gross (1954). Those in the latter group had a less favorable attitude toward household work and a tendency to express dissatisfaction with the role of homemaker.

Kelsey (1965) tapped a somewhat different dimension than overall satisfaction when she obtained a rating from 50 homemakers on how satisfied they were with the way they were managing their household work. Nearly one-tenth of the women were somewhat dissatisfied or dissatisfied, almost one-half were satisfied, and the remainder (over two-fifths) were somewhat satisfied with the way they were managing household work. Apparently most of the homemakers in this group had achieved sufficient facility in managing to satisfy themselves, on the average or across tasks. In rating individual tasks, however, they gave more expressions of dissatisfaction with the way they were managing the household activities; this was particularly evident for the tasks of ironing, mending, regular care of house, and sewing.

Information concerning job satisfaction has also been obtained indirectly in response to which tasks are liked or disliked. In four studies (Dickins, 1961; Walker, 1955; Warren, 1940; Wyskiel, 1960), almost 1,450 homemakers were asked to identify liked and disliked tasks; between 1 and 10 percent stated that they disliked *all* homemaking tasks.

About one-half of the women were gainfully employed homemakers, but evidence is not sufficient to conclude that a relationship did or did not exist between dislike of all homemaking tasks and employment. In Georgia (Holmes, 1962), 80 percent of the 186 employed homemakers were working to earn money; out of 17 percent giving a noneconomic reason for working, 15 percent said they liked work outside the home better than housekeeping. One cannot conclude that they disliked housekeeping—only that they did not like it as well as their paid work.

In Holland, over 600 homemakers were asked to indicate on a three-point rating scale their appreciation for housekeeping in general. One or 2 percent did not like housekeeping, about 75 percent liked it, and about 25 percent used the intermediate position between liking and disliking (Pieters-De Roon, 1961). The sizable proportion using the intermediate position compares with a conclusion reached by Herzberg, Mausner, Peterson, and Capwell (1957) in their review of industrial studies of job attitudes, i.e., that in those studies in which respondents were given the opportunity, they tempered their statement of satisfaction. Herzberg et al. also concluded that a minimum of 13 percent of workers in the more than 50 studies expressed a generalized negative attitude to their jobs.

Support for the Herzberg et al. estimate is found in the Gurin et al. (1960a) survey: close to 25 percent of the 925 employed men felt neutral, ambivalent, or dissatisfied with their job. The men in the two latter groups account for about 18 percent of the total, slightly higher than the minimum estimate by Herzberg et al.

Sources of job satisfaction and dissatisfaction have been studied frequently in industry. Some readers may be interested in Vroom's (1964) critical review and analysis of determinants of job satisfaction. Herzberg, Mausner, and Snyderman (1959) have theorized that factors affecting job satisfaction do not operate on a continuum; that is, satisfaction of certain factors, *satisfiers*, may increase satisfaction with the job but their absence would not make him dissatisfied—would merely pull him toward a neutral point. *Dissatisfiers* would operate in the same manner; their presence would contribute to an unhappy employee but their absence would not turn him into a happy employee. Herzberg et al. further suggest that the satisfiers concern the content of the job, the dissatisfiers the context. Studies supporting and refuting this idea can be found, many in the *Journal of Applied Psychology*. Maloch (1962) applied the theory to her data for most- and least-liked household tasks. Her data were not conclusive, perhaps because they concerned tasks rather than the total job.

Even though these few studies that included information about satisfaction with household work are not as definitive as we might want, the general picture is that there are some homemakers, perhaps 10 percent, who are not satisfied with their job of housewife. This is not to say that the other homemakers like all of their job. Homemakers can and do identify disliked tasks.

LIKED AND DISLIKED TASKS

Even though a general, overall rating of satisfaction may be given the total job of homemaking, most homemakers readily identify some tasks as liked and others as not liked. Almost traditionally, certain homemaking tasks are identified by homemakers as liked (meal preparation, child care), others as disliked (dishwashing, ironing, cleaning), and the remainder (washing, shopping for groceries) in that shady, intermediate zone of not most or least liked. An overview of a number of studies concerning preferences for tasks is given in Table 2-1.

Number of Liked and Disliked Tasks

Household work comprises many tasks. To obtain a rough indication of the magnitude of satisfactions and demands of household work, one might well ask, How many tasks does a homemaker like, how many dislike? Given the opportunity, is more than one task reported? One might assume that the greater the number of liked tasks, the more satisfying the total job of homemaking and the more positive the attitude toward homemaking responsibilities.

More liked than disliked tasks were found in two investigations. Walker (1955) reported 99 women out of 250 as giving a second response and 37 a third response for homemaking activities liked but fewer for homemaking activities disliked: 44 and 7, respectively; the estimated mean number of tasks is 1.5 for liked tasks and 1.2 for disliked tasks. Homemakers in Wyskiel's (1960) study averaged just as many disliked as liked tasks—1.3. In many ways, these means are surprisingly low; perhaps this provides support for Maloch's idea (1963b) that an entire task may not be liked or disliked but rather a specific part of it. The low means could also be interpreted as signifying that homemakers like moderately well the majority of their tasks.

Kelsey's (1965) data also provide some information on this question, for she asked 50 homemakers to rate how much they liked or disliked each of 10 task areas in general. (Walker and Wyskiel analyzed data from open questions.) Kelsey provided four rating positions; with the

Table 2-1. Attitudes toward Household Tasks from Selected Studies in the United States

Source	Liked tasks	Percent	Disliked tasks	Percent	Sample number
Dickins (1961:18)	Cooking, canning, meal preparation (white, urban)	38			135
Hunter (1960:2; 1961:425)	Food preparation	52	Cleaning	41	511
			Ironing	32	
Wiegand and Gross[a] (1958:9)	Looking after children	56	Ironing	43	98
	Food preparation	16	Dishwashing	30	
Hillman (1956:61)	Planning and meal preparation	53	Cleaning	43	259
			Ironing	30	
Hillman (1954:35)	Planning and meal preparation	53	Cleaning	55	135
	Care of children	28	Washing	18	
Van Bortel and Gross[a] (1954:38, 39)	Cooking	52	Ironing	27	
			Care of house	25	52
Walker (1955:103, 105)[b]	Cooking and baking	48[c]	Cleaning	33	250
Muse (1946:45–58)	Meal preparation	14[d]	Cleaning	47	183
	Washing	14	Dishwashing	17	
Warren (1938:393, 395, 398)	Cooking and meal preparation	27	Cleaning and keeping house in order	21	502
			Nothing or not reported	48	
Total					2125

[a] Ranking of specified tasks was used.
[b] From 1952 data collected by Wiegand (1953).
[c] First response (does not include all who mentioned liking or disliking an activity).
[d] Difficult to ascertain percentages, but these figures represent the first given liked task and the first given disliked task.
Source: Maloch, Francille (1962:5).

two negative positions combined, 30 percent of the homemakers disliked none of the household activities; 26 percent disliked 1 of the activities; 18 percent, 2; 14 percent, 3; and 12 percent, 4, 5, and 6 activities. Given the opportunity, some of these homemakers did rate a substantial number of activities disliked, but a larger portion rated none or few as disliked.

It is fortunate that more tasks are not disliked. Otherwise, too much of the homemaker's capacity for work would be dissipated through conflict related to disliked tasks and not left available to be invested in other homemaking responsibilities and personal gratification.

Reasons for Task Preferences

Knowledge of which factors are associated with liking and disliking tasks provides more information toward understanding worker input than merely knowledge of which tasks are generally preferred. More recently, the question "Why?" has been asked more consistently. In an informal, nationwide study in 1960, home management specialists of the Agricultural Extension Service talked with 511 homemakers and Hunter (1961:427) reported:

"Many homemakers said they enjoyed certain situations and kinds of work because of: family appreciation for their efforts; a sense of creativity in doing certain jobs; skill acquired at an early age—do job well; physical conveniences, comfort, and beauty; pride in accomplishment; meeting the standards of themselves, their husbands, and/or their children; and seeing certain jobs as a challenge. Women who did not express these satisfactions were unhappy with various homemaking problems."

Wyskiel (1960) was also successful in determining reasons for preference. Over one-half of the reasons for liking homemaking tasks were classified in a single category—fun, creative, challenging; other categories were: satisfying results; pleases husband; and relaxing. Reasons for disliking homemaking tasks were more varied: boring, monotonous, repetitious; results not satisfying; physically strenuous; time-consuming; and other. Hillman (1954, 1956) reported similar reasons for disliking tasks: the many steps necessary to do the job; its monotony; the regularity of the job; the need for standing to do it; inadequate storage; lack of proper equipment; and amount of time consumed.

An association between fatigue and attitude has been noted by Van Bortel and Gross (1954) and Maloch (1962). Wyskiel (1960) tentatively concluded that there might be a relationship between disliking a task and finding it tiring, for about one-half of the tasks reported as tiring were reported by the same homemakers as disliked. However, two of the earlier studies suggest that the relationship is not generalized to all disliked tasks but linked to specific tasks and other factors. Wilson (1929:45), in studying the use of time of over 500 homemakers, stated: "It is interesting to note the connection between fatigue and dislike for specific tasks. . . . Dishes are irksome but not tiring, while laundry work is more tiring than tiresome. Cleaning is both, and sewing, neither. Cooking is more irksome than fatiguing."

In the second study, a time study of 183 farm homemakers, Muse (1946) found an association between tiredness and dislike especially for washing: "Only a very few of the housewives expressed dislike for washing for any reason other than because it was tiring" (p. 53). In contrast to the concentration of answers of "tiring" for washing are additional ones for ironing, house cleaning, and dishwashing. "The reason most often given for disliking ironing was that it was tiring. Other reasons were the attendant heat and steam and the fact that it was such a time-consuming job and had to be done with considerable frequency and regularity" (pp. 54–55). House cleaning, or some phase of it, ". . . was the most tiring for 40, the most disliked by 25, and both the most tiring and most disliked for 21 women. The reasons commonly given for disliking cleaning were that it was tiring, it was time-consuming, and it had to be done too frequently" (p. 58). Dishwashing was the most disliked task by 32 women and most tiring for 11. "The most common reasons for disliking it were the frequency of the job, its monotony, and the fact that it consumed so much time" (p. 50).

More recently, in Maloch's study (1962), "tiring" was given as most important in disliking the least liked task by almost one-third of the homemakers although tiring was not accepted as a *characteristic* of least liked tasks, i.e., not enough homemakers agreed that their least liked task was tiring. Data from these studies indicate that certainly we should not be surprised to find that disliked tasks are tiring, but we should not preclude other reasons for dislike. Technological advances may be an important factor in fewer reports of tiredness.

What are other reasons, besides "tiring," for disliking household tasks? And just as important, what are reasons for liking tasks? Maloch's (1962, 1963a, b) investigation had its major focus on these questions to determine characteristics of most and least liked tasks.

Using a cross-task approach, Maloch identified certain qualities of tasks as characterizing most and least liked tasks of a selected group of urban homemakers with young children. Characteristics and qualities of tasks were sought through the use of open-end questions, specific questions, and 24 graphic rating scales. Each scale comprised a bipolar phrase with five intervals or rating positions between the poles, such as:

Creative _____: _____: _____: _____: _____: Not creative.

Each homemaker rated her feeling about each pair of terms for her most and least liked tasks as well as about two tasks the researchers designated.

The graphic rating scales were classified within the framework suggested by Ryan (1958:79–80):

"Activities as imagined or anticipated have the following directly experienced properties which are of special importance in determining the setting or acceptance of tasks and actual behavior: (a) means-end relations . . . (b) intrinsic interest, desirability, or pleasantness of the activity . . . (c) fittingness to a social or physical situation. . . ."

The *characteristics* of the most liked and least liked tasks (Maloch, 1963b:9) within the framework suggested by Ryan were:

"Most Liked Task	Least Liked Task
Means-end relations	*Means-end relations*
	Short-term results
Intrinsic interest	*Intrinsic interest*
Like supplies and materials	Dislike time spent
Almost always completed as planned	Not creative
Like time spent	Monotonous
Pride in results	Uses little mental skill
Satisfying	
Can set own pace	
Social or physical situation	*Social or physical situation*
Adequate equipment	Another adult not generally present"
Results are appreciated by family	

The characteristics were determined from the homemakers' ratings on the graphic rating scales and represent high agreement among homemakers. The concentration of characteristics within "Intrinsic Interest" emphasizes this dimension of the affective component.

Maloch also studied the 24 graphic rating scales to determine *groupings* of the scales. Three methods of factor analysis were used: principal components analysis, centroid factor analysis, and cluster analysis.* Groupings of the scales, or qualities, were similar by the three methods. Of the 24 scales, 5 were classified as evaluative, 19 as nonevaluative. All of the bipolar phrases were evaluated by the homemaker when she rated them, but 5 seemed more personally evaluative than the others

* Factor analysis is a statistical method for interpreting correlations of scores "to determine whether the variations represented can be accounted for adequately by a number of basic categories smaller than that with which the investigation was started. Thus data obtained with a large number of *a priori* measures may be explained in terms of a smaller number of reference variables" (p. 1). A factor describes the area within which consistency can be found. The researcher interprets the content of a factor and generalizes from the data. Benjamin Fruchter (1954) *Introduction to Factor Analysis.* D. Van Nostrand, Princeton, New Jersey.

and had relatively high correlations for the least liked task. The basic problem was to find more discrete groupings of the qualities; one technique was to divide the qualities into two groups. The 5 evaluative scales were: pride in results—no pride in results; satisfying—not satisfying; creative—not creative; interest—monotony; and, like time spent—dislike time spent.

For both the most and least liked tasks, the nonevaluative qualities yielded groupings or factors which were labeled: *control over task, skill, demands of task,* and *social or physical situation,* or a combination of these. The groupings were generally not separate but were related to one another, for a quality in one group was frequently related to a quality in other groupings. The numerous interrelationships indicated the difficulty of delineating these qualities of tasks.

Further research is needed to build on this initial work. Not only do other groups of homemakers need to be studied, but those factors determining the characteristics need to be identified rather specifically. What makes a task monotonous? Which aspects of a task require the use of little mental skill? In what ways does the homemaker set her own pace? It is through better understanding of the determinants of preference for work that work can be designed for increased satisfaction.

Monotony and Boredom

In various studies, homemakers have described tasks as monotonous and boring. The same tasks are not always so described. Is the same phenomenon present? Is this a matter that what is accepted and preferred by one person may not be by another? The complaint of monotony and boredom in industrial situations has been of concern. Research and opinion in this field can be related to the work of the home.

Monotony and boredom have long been associated with repetitive work in industry. Some confusion may have resulted because the terms are frequently used together. They can be distinguished, although they may well occur together in repetitive operations. A situation or operation is boring if the content is not interesting and monotonous if it is repeated again and again. Thus, a play, a movie, a conversation may be boring but not necessarily monotonous. Baldamus (1961) would reserve the term boredom for professional occupations and use tedium for the corresponding sentiment in repetitive work. One might speculate whether homemakers are referring to a lack of interest in the content of tasks, to the sameness of the work from day to day or week to week, or to the repetition of operations within tasks. A few household tasks do comprise a limited number of groups of operations or subtasks which are repeated; although such cycles of work are probably of longer duration than in many industrial jobs, the basic problem of repetitiousness may be similar.

Ryan and Smith (1954) point out that the characteristic of repetition has been assumed to be a primary determiner of boredom and has been overstressed. Actually, repetitive work has positive aspects for some persons and they seek this kind of work; it appeals to them because little attention is required, they can daydream or think of other things, and a rhythm can be set up. We have heard some homemakers say that they use such time for planning and thinking about various matters.

Some of the research of the Industrial Health Research Board in Great Britain (Wyatt, Langdon, and Stock, 1938) suggests that boredom in repetitive work is associated with the specific content of the job rather than a susceptibility to boredom. In contrast, evidence from a study of sewing operations in a factory (Cain, 1942; Smith, 1951) indicated that monotony susceptibility on the job was related to dislike of regular habits outside of working hours, and that those who adjusted well to the repetitious work tended to prefer a regular routine of household work and other outside activities.

More recently, Turner and Miclette (1962) illustrated circumstances under which repetition of a job was *not* an important source of dissatisfaction or low morale. Assembly operators whose job cycle was 1 minute or less were studied. The researchers concluded that two conditions for satisfaction with repetitive work must be present:

"In the first place, the product being worked on and the work process must contain some important perceived attractions. Secondly, for these attractions to operate in a positive way, important 'distractions' must be minimized. By distractions we mean circumstances that are perceived as disruptions or barriers to achieving the satisfactions associated with the attractiveness inherent in the nature of the product and process" (p. 215).

Results of other studies of work in industry could be discussed here, but rather essential differences separate work in industry and in the home and the ensuing satisfactions and dissatisfactions. The following comparisons will illustrate some of the differences.

Variety or repetitiousness. In the home, the number of task areas and number of specific tasks or subtasks is large, especially when compared to industrial jobs that comprise a single cycle lasting only 1 minute or less. In the Walker and Guest (1952) study of work on the assembly line, some jobs required a single operation. Operation was defined as: "a series of motions by the worker which are generally concerned with the use of the same tool, and generally applied to the same part of a product" (p. 38). Few tasks in the home now have only one operation. The solution in industry to lack of variety is either job rotation or job enlargement; the latter is hardly necessary in the home, even though homemakers may complain about a lack of variety. Their complaint probably pertains to variety in a much grosser sense than number of operations.

Machine pacing. This refers to control of rate of work by a machine. Machine pacing was a major cause of dissatisfaction of workers on the assembly line in the Walker and Guest study. In the home, comparatively little work is machine paced; rather, it may be process paced for short periods of time, but it is most often controlled by the homemaker. The homemaker frequently has a choice in rate of work and scheduling of rest pauses; the worker on an assembly line does not for the most part.

Accomplishment. The unit size of task in industry is often only a fragment of the total needed for the product. Workers find it difficult to see what they have achieved for their task is too small and demands little of them. With housework the homemaker can see what she has accomplished when she completes tasks for she is generally responsible for the total product. However, the product may not last long, and she may feel some lack of accomplishment in that the work is so soon undone.

Physical situation. The industrial worker may not have a great amount of control over the physical situation, but, if it bothers him too much, he probably changes to another job. He often knows what the physical aspects of the working situation are before he gets into them, such as the noise, dirt, and heat. The homemaker may have more opportunity to change the physical situation for her work, but not all tasks can be done in a pleasant situation. With cleaning jobs, it is the nature of the task to be dirty; with ironing in hot weather, the task is hot and humid (again inherent in the task) but air conditioning could alleviate the latter problem.

Appreciation. Work in industry may be rather impersonal; much may depend on the supervisor. In the home, expressions of appreciation may depend on the personalities of the family members, but at least those who consume the product are likely to be at hand not many miles away.

Advancement. In industry, promotions and pay raises are possible. The homemaker is not promoted, demoted, or fired, but she may get complaints! Advancement is logically studied as a factor in job satisfaction in industry, but it is not relevant in studies of satisfaction with housework.

Monetary return. The paycheck is positive, material evidence of results of work. The homemaker rarely receives a paycheck for homemaking work and must gain satisfaction from seeing the goods and services she provides and from expressions of appreciation from the family.

Responsibility and authority. In industry, the extent of responsibility and authority varies with the position and type of work, and some evidence suggests increased satisfaction with increased responsibility and authority. Many homemakers have considerable freedom to organize their work, determine the methods, and vary the product. The responsibility is extensive. Some are not equal to it.

Social aspects of job. In industry, identification with a group generally needs to be established; those doing similar work often comprise a group as well as those working together as a team. In some studies, satisfaction has been related to the cohesiveness of the group and identification with a company. The homemaker, of course, is a member of a group—the family—and there is no question about membership in it. One might wonder if cohesiveness of the family enters into satisfactions of the homemaker with housework.

Choice of job. Compared to a homemaker, a person in industry has freedom to choose a job, the place of work, and job content and conditions. Placement tests may help determine suitability for a particular job. A woman makes her choice when she marries. Details of many aspects of the job are unknown; they must be met as they come. The homemaker does have some freedom to shape and determine some parts of the job. This again emphasizes the importance of knowing how to tailor a job to our liking as well as being able to get the workplace and working conditions comfortable.

Other aspects of job satisfaction could be contrasted to the homemaker's work, such as the use of the external criteria of absenteeism and turnover as measures of satisfaction. However, these aspects seem to have less relevance for our study of household work.

Although many differences are found between industrial work and that in the home, reference to the literature on job satisfaction in industry is desirable. The relevance of industrial job satisfaction studies to study of the work of the home lies more in the analysis of work and workers' opinions than in the specific results of the studies. Insight into the nature of work and the personal costs of work is gained even though the working conditions and type of work are more frequently different than similar. In fact, the differences between the industrial situation and that in the home often provide the contrasts that help identify important aspects. Some analogies between housework and industrial work and the effects on the worker can be made, of course. Methodology can often be adapted for use in subsequent studies of housework. The advanced student can profit from knowing the literature on job satisfaction studies in industry and relating it to housework. This is not to say that we can be only receivers of information. We who study the work of the home can contribute methodology, ideas, and theory of help to those who study work outside the home.

GOAL CHARACTER OF WORK

Accomplishment of household work is primarily a means goal of homemakers. Accomplishment is necessary if the family and home are "kept going." Since the total job of household work comprises many smaller jobs, tasks, or subtasks, goals must be set for accomplishing each as the occasion arises. Such tasks, then, actually become means activities toward achieving major, long range goals of homemaking. For the many homemakers who not only plan but also perform the work themselves, the parts of the total job must be accepted as tasks and the goal be set to initiate action and carry it to completion, or the work will not get done.

Certain forces may be present which encourage the homemaker to accept the various tasks. A minimal quantity of work is necessary to keep the family going, and the members expect the homemaker to do this minimum; a certain minimal quality is also expected. In a broader context, neighbors and relatives also impose standards for quantity and quality. Social pressures of these types are one type of coercion. Social prestige is another. The homemaker herself selects standards which will be personally satisfying. In so doing, she may perceive household tasks as obligations. The fulfillment of such obligations may become an end goal for the homemaker.

Certain forces also act to discourage the acceptance of a task. One consequence of choosing to act is that time and attention are committed to that task. More enjoyable activities may be foregone. The more substantial the commitment in time, attention, thinking, physical exertion, or the like, the greater may be the reluctance to initiate action. When a person is absorbed in an activity, he is not free to plan or think about another. At certain times, this may be quite limiting to the homemaker.

Reluctance to start a task may be expressed in different ways, but avoidance tactics are among the more interesting. In fact, they may even afford a certain amount of amusement to those who recognize that this is happening and who can laugh at themselves. How many times have we in professional work delayed starting a major task on first arriving at the office or laboratory (when time permitted) by performing rituals such as sharpening a pencil or reorganizing papers, or doing small tasks such as making a telephone call or reading a short article—all legitimate activities but not having as great an import as the major task? Of course, such preliminary activities may serve as a warm-up, eliminate interruptions and distractions, and/or give satisfaction from having completed something. Homemakers may also do certain small tasks before initiating action on the larger ones. The daily care of the house or tidying the kitchen may function as small tasks as well as serve the purpose of getting the house presentable in case unexpected guests appear. In industry, it has been observed * that some workers did short, less liked tasks first—those presenting difficulties or not permitting rhythm—so that they could settle down to longer and more favored tasks. Their procedure may also have had some of the element of postponing the acceptance of the larger task.

Work may become interesting and achieve its own goal character, although originally the activity was only a means to some end or an obligation (Ryan and Smith, 1954). The advantages of developing the intrinsic goal character of household tasks may be twofold: a lower initial level of effort is required in performing the activities, and greater efficiency and ease are possible in maintaining performance. Research is needed to substantiate these ideas of facilitating the initiation and continuation of activity.†

Ryan and Smith (1954) hypothesize that habit (a regular pattern of daily activity) tends to attain goal character and that developing skill tends to enhance the goal character of that activity. They also suggest three conditions as important in the development of temporary goal character in means activities and activities performed as obligations: "(a) division of the total performance into a series of sub-units. (Goal character is especially strong during these sub-units.) (b) a regular or rhythmic temporal pattern in the performance. (c) the requirement of close attention or absorption" (p. 382).

Condition (a) is a practical suggestion for us to consider, for it is an approach a homemaker can easily use to facilitate her work. In cleaning

* Personal communication, Dr. Patricia Cain Smith.

† Effort ratings were obtained in two studies of household work, but neither study was conclusive. Gaudin (1960) attempted to determine the relationship between preference for the task of machine washing of clothes, tiredness, and effort. In a laboratory study (Steidl, 1957), effort ratings for preparing and cleaning up a dinner ranged from 65 to 100 percent on a percentage scale. The 100 percent rating was related to loss of sleep rather than changes in the experimental conditions. In these studies, effort ratings were designed to determine input and the relationship to goal character of task was not made. This remains to be done.

the house, subunits might be by process or by product, i.e., all hand dusting, all vacuuming with the upholstery tool, all rugs or all carpets, or first one room, then another. In ironing, subunits might be a proportion of total number of items, proportion of the basket of ironing, or all items of each type.

Another advantage of dividing the total task into subunits is that with the completion of each successive unit, the gain toward completing the total set becomes proportionately larger. If we have 6 beds to change, and each bed is considered as a subunit, the first bed represents one-sixth of the total number or set, but the fifth bed represents one-half of those remaining.

Less tangible than the identification of subunits of a task but just as desirable is Ryan and Smith's second condition, (b) a regular or rhythmic temporal pattern. Tasks in which actions are repeated lend themselves to a rhythmical sequence of motions; examples include folding diapers, scouring the tub or sink, peeling carrots and potatoes, chopping foods, and ironing flatwork. A regular tempo and pattern of work is also facilitated by having good quality materials or supplies for the task and direct access to stored items; the rationale is that no part of the action is delayed or prolonged unnecessarily—the worker can proceed from one phase to the next. Greater continuity of action is achieved. The design and arrangement of workplaces also influence the logical progression of parts of activity from one section of the workplace to another.

Traction

Closely related to the three conditions identified by Ryan and Smith as important in the development of goal character in activities is the phenomenon of "traction." Baldamus (1951b:42), in analyzing industrial work, has described a temporary interest and satisfaction in work; he calls this traction: "Traction is, in a sense, the opposite of distraction. It is a feeling of being pulled along by the inertia inherent in a particular activity. The experience is pleasant, because it is associated with a feeling of reduced effort. . . . traction in various forms is the most characteristic experience in industrial occupations."

Traction is closely related to certain aspects of the task and one or more kinds of traction may be present: *object, batch, process, machine,* and *line* traction. The last named does not seem to be relevant to housework, for it "refers to modern methods of flow production whereby the same object passes through a series of operations carried out by different workers, with or without the help of a conveyor belt" (Baldamus, 1951a: 48).

Object, batch, and process traction are found in household tasks. Object traction is the pull toward completion of an object; batch traction is similar. The desire to finish ironing a garment before stopping or to iron all of the batch of dampened clothes are examples. Object and batch traction seem closely related to dividing the total performance into series of subunits, a condition suggested by Ryan and Smith (1954) as important in the development of temporary goal character.

Process traction, Baldamus (1951a:48) explains, ". . . is experienced in operations where the tempo and the nature of the movements are determined by the chemical or physical nature of the production process: melting, casting, glass-blowing, pottery-throwing, plating, soldering, welding, painting, chocolate-dipping, forging and many others." Examples of process traction are common in meal preparation: frosting a cake, mashing potatoes, making gravy, and so on. Some cleaning operations may also be examples: mopping the floor, waxing the floor, polishing furniture, and washing woodwork, to suggest a few.

Machine traction—the feeling of being drawn along by operations on machines which are constantly running—appears to be less frequent in the home than object, batch, or process traction. The few household machines with which machine traction may occur include a rotary ironer, motor-driven clothes wringer, floor polisher, and possibly the food mixers, grinders, and blenders. To us, however, the vacuum cleaner does not seem to produce machine traction, possibly because revolving parts are not visible. Rather, the pull is to complete a particular area or to do all operations requiring a given attachment to the machine. The latter suggests process traction or possibly tool traction—which may not be present in much industrial work. We would define *tool* traction as the pull to complete all work requiring a particular tool. Tool traction may occur partly because the get-ready phase of some tasks involves getting specific tools out of storage, and the homemaker wants to take advantage of this input. Tool traction probably pulls the individual along in connection with process traction or object traction. Examples might include parts of such tasks like washing windows, washing woodwork, hand dusting or polishing, or vacuuming the upholstered furniture.

Baldamus (1951a) has also classified the various kinds of traction as strain-reducing factors. He believes that the specific conditions inherent in the type of work are more important in the worker's subjective experience and motivation than the general physical environment of a job such as heat, dust, and noise. If a worker dislikes the type of work, this will influence his effort unfavorably.

". . . work under modern conditions requires sustained and regular performance. It is this element of coercion which gives rise to the worker's experience of effort, particularly the effort to 'keep going' at the desired pace of work and to maintain regular attendance. This aspect may be referred to briefly as '*strain.*' Without coercion there would be no strain.

". . . Since strain is evidently an unpleasant experience, it follows that any specific condition which reduces strain will be conducive to a more favourable attitude towards work, while strain-increasing factors will be reflected in negative attitudes" (p. 46).

Baldamus called factors intensifying the feeling of strain "resistance." These factors are irritating obstacles and difficulties impeding a smooth flow of continuous performance.

"Resistance may be stimulated by irregularities in materials, in machinery, in implements and in manufacturing processes. Faulty organization and layout can also bring about resistance, as for instance when the flow of production is uneven and entails much enforced waiting. Hence the nature and the intensity of resistance are not entirely determined by the type of work, but are to some extent linked with the efficiency of production management" (p. 47).

Other strain-increasing factors besides resistance included direct supervision, monotony, and lack of variety.

Baldamus then empirically examined the relation between type of work and labor turnover. He concluded: "The evidence collected so far is at any rate sufficient to advance the statement that type of work is of far greater importance to the study of the human factor in industry than it was thought hitherto" (p. 55). The type of work or content of work has once again been emphasized as important in job satisfaction.

Baldamus' ideas concerning the importance of "level of strain" or the balance between strain-increasing and strain-reducing factors deserves consideration in future studies of homemaking work. Identification of strain-increasing factors in disliked tasks may point to changes that the homemaker or the manufacturer can effect so that the intrinsic appeal of the tasks is increased and effort decreased.

Duration of Task

We are all familiar with the situation where we feel we have performed an activity for a long enough time. The goal character of a task, liked or disliked, may be temporarily canceled out by satiation. Ryan and Smith (1954:386) hypothesize that: "Performing any task develops an internal resistance to continuation (satiation). . . . Satiation apparently builds up slowly and cumulatively, ultimately reducing the goal character of the activity to zero and leading to a change of activity."

Little information is available concerning the *optimal duration* for performing household tasks and the variation among tasks. Most experienced homemakers probably know about how long they are willing to continue work on tasks, liked as well as disliked. In getting ready to iron, they dampen only the quantity that they estimate they can do within a particular time period. Other factors may also impose a time limitation, but intrinsic appeal is probably an important one. Maloch (1962) found that a significantly shorter time was spent in doing least liked tasks than in doing most liked tasks. Homemakers with a favorable attitude toward cleaning performed more work and used more time in cleaning than those having an unfavorable attitude (Roberts, 1956). It is only reasonable that if the time is disliked and the task is not as satisfying as another activity might be, the task will not be prolonged beyond the minimum. Whether homemakers spend a shorter time on disliked activities because they have found shortcuts or whether quality and quantity standards have been reduced has not been determined. Ideally, a homemaker will be able to design her work so that those aspects she enjoys can be accentuated and those she does not enjoy can be streamlined.

If the quantity of work that must be done is such that we might become satiated before completing it, *perhaps* the technique of intentionally interrupting it with a change of activity might make it easier to resume and complete. This suggestion is based partly on an extension of the phenomenon known as the *Zeigarnik effect,* partly on the technique of setting up subunits of a task. The Zeigarnik effect is that an interrupted task is easier to recall than a completed task. Also, we are likely to resume performance on an interrupted task when the opportunity occurs. Zeigarnik explained that "tensions" are set up when a task is accepted, released when completed; somehow the tensions make it easier to recall an activity and resume it if interrupted (Zeigarnik, 1938). Whether an intentional interruption would operate in the same manner is highly problematical.

We might also speculate that an interruption *within* a cycle of work might facilitate resumption of a task. Baldamus (1961:58), in analyzing industrial operations with respect to tedium, noted that in those:

". . . which are intermittent, so that each cycle appears as a separate act, it appears that the discomfort of tedium is noticeably greater between two cycles than in the course of the cycle operation. More effort seems to be required to start a new cycle than to conclude one already in process. This suggests that tedium is primarily connected with the mental effort required to join two consecutive cycles. It would follow that the shorter the unit cycle, the greater (per day or hour) is the number of inter-cycle decisions required for a continuous performance, and hence, probably, the greater the tedium."

We would need to be selective in type of housework that is interrupted and at what stage, for some interruptions may impair the quality of the product, and others may actually increase the amount of work done. An intentional interruption may be most unreasonable when we recall that many homemakers complain about frequent interruptions from the children and telephone and plan to do a particular task at a particular time so that they will *not* be interrupted.

We can readily conclude that research is needed to determine factors influencing the optimal duration of household tasks and the need for devising techniques to delay the satiation incurred in performing disliked tasks. Such information will contribute to guides for designing some aspects of the use of time for personal satisfaction and accomplishment.

CHAPTER 3

The Cognitive Component

The cognitive component of the worker's input is a fundamental part of managing the home. The cognitive component describes the contribution of thinking—using knowledge, setting and defining goals, making plans, paying attention during work, making many judgments as the work progresses so that the activity can be controlled, and developing and using habits and skills.

As the homemaker performs the work of the home, she uses knowledge based on formal and informal study and on experience; she makes plans, judgments, decisions, and assumes responsibility for them. She pays attention to the task or tasks, mentally processing information as the work progresses. She uses skill, which is sometimes completely, sometimes partly a mental attribute. All of this constitutes the intellectual dimension of the worker's input, one of the determinants in ease of work and in job satisfaction. Inadequate knowledge, lack of skill, and excessive demands on attention can increase the mental cost of work to the point of fatigue.

The cognitive component, broadly speaking, serves two functions. One is to plan and coordinate the use of resources prior to action. Resources external to the homemaker, such as money, material goods, supplies, and the personal contributions of other family members are considered. The other personal contributions of the homemaker are also coordinated with her intellectual contribution.

The second broad function of the cognitive component is to bridge the gap between the goal or stated task and its accomplishment. Mental activities are needed to carry out or perform the activity and produce results. Much of the homemaker's work involves "open" tasks rather than "closed" tasks, to use Crossman's (1964) terminology; i.e., the external situation is not stable. The worker must constantly be taking new information into consideration. Even some of the more repetitive tasks, such as folding diapers and towels or chopping nuts, are not exactly closed tasks for some variations in the quality, shape, and organization of the materials require attention.

In performing these two broad functions, the homemaker might be thought of as a system that handles information; various inputs are required to determine the use of resources; interrelated elements exist within the system to produce output; the output is the resource use of the family (Maloch and Deacon, 1966). The cognitive component is concerned with the processes involved within the system for receiving and using the information, i.e., for handling the information. It is through understanding the processes involved in handling information that the management specialist can help achieve an organized approach to solving problems in work and workplace design.

Writers in the field of home management are in agreement that mental activity is required as one manages. A theoretical exposition of the mental activities involved in managing comprises a major portion of this chapter. It is our belief that understanding the possible mechanisms is a prerequisite to definitive research in planning and controlling tasks, just as it is a prerequisite to measuring the personal costs of the homemaker's intellectual input.

The reader will find that this chapter is a mixture of partially tested theories and premises plus our suggested applications to homemakers' work, with perhaps more theory than any other chapter in the book. The applications to household work are based on theoretical analysis rather than on results of formal studies. The transition from theory to applications to homemakers' work has been difficult and is less skillfully done than is desired. However, the selection of theory and suggested applications represent a start and may provide a base for further work. The reader is cautioned that proposed applications carry the limitation that they are based on untested theory, for many unanswered questions remain and further research may affect the validity of the suggested applications.

Relatively little is available to help us measure the personal costs of using the component of thinking. Efforts are necessarily concentrated on identifying what is happening when we think, what thinking operations must be performed, and what effects various situations, procedures, and activities have on our thinking.

In our attempt to bring together the variety of information that would contribute to our understanding of intellectual activities, we have included considerable explanation. This should help us in our attempts to identify what it is we are trying to measure. It is our belief that inadequate knowledge, lack of skill, and excessive demands on attention can increase the mental cost of work to the point of fatigue, even though precise measurement is a thing of the future.

KNOWLEDGE

The individual who possesses the requisite knowledge is thoroughly familiar with the many features of a situation or thing. The body of information that the homemaker knows is related to the broad scope of her job and, of course, to her intellectual ability and interest in household work.

The knowledge a homemaker uses must encompass not only the work aspects of her job, such as the procedures, materials, supplies, and tools that she uses, but also the family members' preferences, goals, and habits. She must know factors affecting the health of each member of the family so that illnesses are prevented, diseases avoided, and sicknesses overcome. Knowledge is needed to further the physical and emotional well-being of the entire family. Resources in the community as well as within the family must be considered in setting goals and arriving at ways of achieving them. The resulting complexities may call for compromises between the optimum for accomplishing work and the optimum for each family member or for the entire family. Appropriate courses of action must be determined.

An awareness of the range of knowledge that homemakers bring into play will have to serve our purposes for the present. Of more immediate help in our study of the cognitive component of the homemaker's input is some understanding of how knowledge is organized. This is important because the organization of information is related to what must be done to use it, i.e., to think.

Some of our knowledge is organized as concepts. In our efforts to condense the mass of information in the world around us in order to obtain a manageable amount of detail, we categorize or arrange on various bases and obtain groups or classes of ideas or concepts. Weiss (1960) has emphasized the importance of absorbing and assimilating scientific knowledge if the body of knowledge is to grow. He makes an analogy to the growth process of higher animals (intake, digestion, assimilation, and utilization): information serves as food; it is analyzed and sorted; some is discarded; some is ordered and integrated into concepts and rules. Through condensation and generalization, the amount of detailed information dwindles and knowledge and understanding grow.

Upton (1961:22) says ". . . when we persistently and consistently ask and answer the question of sort, the results are what we call *classifications. . . .*" He points out:

"The logical operations of analysis are extremely simple considering the indescribably complex organ that performs them and the astounding achievements that sometimes result from their application. For there are only three sorts of analytical questions that the rational intellect may propose and three sorts of rational answers it can get. It can ask (1) 'What is this a sort of, or what are the sorts of this?' (2) 'What is this a part of, or what are the parts of this?' (3) 'What is this a stage of, or what are the stages of this?'

. . . .

". . . Now when we persistently and consistently ask and answer the question of sort, the results are what we call *classifications* . . ."

Bruner, Goodnow, and Austin (1956) believe that categorizing is an operation common to judgment, memory, problem solving, inventive thinking, esthetics, perception, and concept formation. They give five achievements of categorizing: reduces the complexity of the environment; provides the means by which the objects of the world about us are identified; reduces the necessity for constant learning; provides direction for instrumental activity; and permits ordering and relating classes of events. Thinking requires the recognition of patterns (or of characteristic qualities among them) and the linking or association of ideas, especially in the production of ideas and solution of some problems. Concepts provide suitable material for thinking.

Some of our knowledge is also organized as plans. Plans can be thought of as part of our knowledge as well as one method by which our knowledge is organized. Plans provide a set of instructions that guide our actions. We need to control the order of sequences of operations, and plans provide the directions. They are similar to a program for a computer (Miller, Galanter, and Pribram, 1960). Plans vary in form from those that have become comparatively fixed because they have been overlearned to those that are broad and have little detail. Learned plans are stored and thus become part of our knowledge.

Habits and skills are plans that have been established; a sequence of actions has been overlearned and has become more or less automatic. Knowledge has been organized and learned in order to determine the manner of proceeding. Habits are more or less standard ways of proceeding when similar situations arise. Habits are also called standing rules. Having a standard way of proceeding has both an advantage and disadvantage. The advantage is that we do not have to use our minds to determine exactly how to proceed or what to do in routine situations; our minds are left fairly free to attend to nonroutine matters. The disadvantage is that we may overlook new factors in the situation that should be taken into account. This suggests that we need to examine our habits occasionally to determine their current suitability.

In contrast to the knowledge that has been overlearned and established as habits and skills, we have broad outlines of plans that provide the raw material for producing other plans—plans that are detailed enough to direct our actions. Knowledge must be incorporated into broad plans to determine more specific ones that can be followed.

THINKING

Knowledge is brought into play as plans are made, work is done, problems are recognized and solved, judgments are made, and decisions are carried out. Thinking is required when a gap exists between where we are and where we want to be (Bartlett, 1958). What must be done to use our knowledge—to help us get from where we are to where we want to be? What handling or processing of information is done?

An examination of the literature suggests that thinking is a generic term while problem solving, judging, deciding, creative thinking, and so on are subgroups or forms of thinking with only certain characteristics and processes in common. The product (a decision, a solution to a problem, an idea) rather than the process may be a distinguishing characteristic (Taylor, 1962).

Both the importance of thinking and the puzzlement concerning the processes were noted by Guilford (1960:6–7) in his discussion entitled, "Basic Conceptual Problems in the Psychology of Thinking":

"Of all the baffling problems that have fallen to the lot of the psychologist, those pertaining to human thinking have been the most frustrating. Nevertheless, no psychological problems are more important. The critical, general human problems presented by the world in which we find ourselves call for the exercise of thinking as never before. If we are to make the most of our intellectual resources to meet the challenges that daily come our way, it is imperative that we understand more about the processes of human thinking.

. . . .

"What are the phenomena that exists in the domain of human thinking? What are the different kinds of operations or processes? Much experimentation has proceeded on the basis that we know what the fundamental kinds of operations are, too often without questioning whether we could not have better conceptions. There is even inadequate definition of the operations that are assumed to exist, for example, that most frequently mentioned term 'problem solving.' What is the unique referent for 'problem solving'? No one can answer this question. Furthermore, psychologists have all too often fallen victim of the fallacy of assuming that one name means one process. They have also not demanded empirical concepts, which are essential for unambiguous communication."

Guilford uses his parametric model of intellect, based upon factor analysis, to explain what thinking operations exist and to provide concepts for describing thinking. About 55 factors of human intellect had been identified at the time of his speech in December 1960.* "The factors differ in at least three major ways: in the kind of operation involved in the task, the kind of material or content, and the kind of product or outcome" (p. 9). These differences provided a three-dimensional model (Figure 3-1). Guilford (1960, 1966) believes that all thinking processes can be included within a theoretical cube, and that (with adequate examination) processes can be identified to fill all sections of that cube.

Guilford and his associates (Merrifield, Guilford, Christensen, and Frick, 1960) explain that the operations or processes are the things that the person does with the raw materials of information, information being "that which the individual discriminates." They have identified five kinds of operations: cognition, memory, divergent production, convergent production, and evaluation.

". . . The cognitive operation provides discovery, comprehension, or understanding, in other words, the awareness of information. The memory operation is the storage of information. The two production categories involve the generation of information from given information. In the divergent form of production, a variety of answers is produced; in the convergent form, unique or rather fully determined answers are produced. Evaluation means decisions as to whether information that is known, remembered, or produced meets certain standards or goals" (Guilford, 1960:10–11).

* Fourteen factors were identified in a study (Berger, Guilford, and Christensen, 1957) of planning abilities and named as follows: verbal comprehension, numerical facility, visualization, general reasoning, logical evaluation, ideational fluency, eduction of conceptual relations, judgment, originality, adaptive flexibility, ordering, elaboration, perceptual foresight, and conceptual foresight. Only the last four were new in this study. See Guilford (1959) for other details.

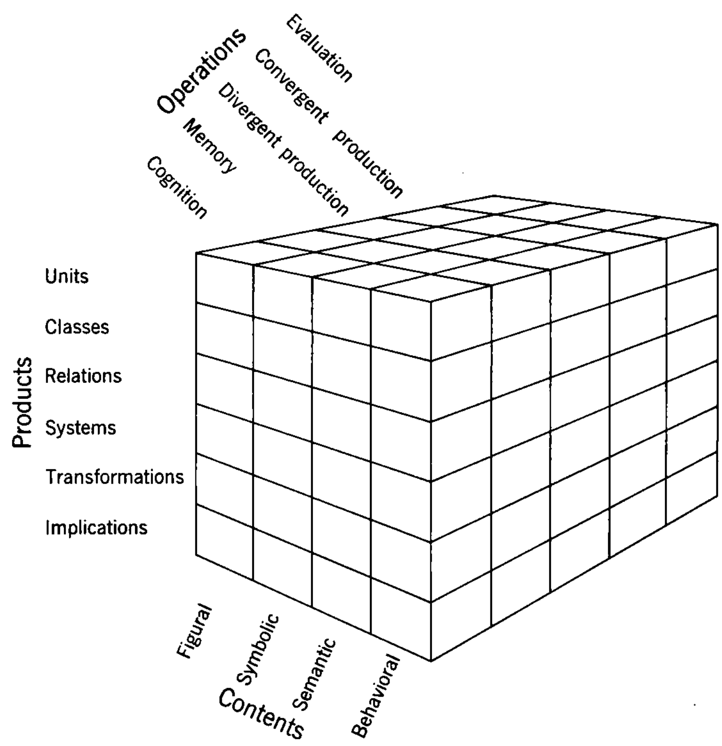


Figure 3-1. Model for the structure of intellect. (*Source.* Guilford, 1960, p. 10.)

Four categories of content have been identified: figural, symbolic, semantic, and behavioral. The explanation follows:

"The categories of content are what might be called the broad varieties of information. Abilities to deal with concrete (perceived) information are put into the category called 'figural.' Two content categories deal with abstract material: symbolic and semantic. Symbolic material is in the form of letters, numbers, and the like. Semantic material is meaningful or verbal-conceptual. The category of 'behavioral' has been added on a purely theoretical basis, no such factors as yet being known. It covers what has been called 'social intelligence.' The phenomenon often called 'empathy' probably belongs in the area of cognition of behavioral content" (Guilford, 1960:11).

Six categories of products are given: units, classes, relations, systems, transformations, implications. Guilford (1960:9–10) explains:

"The categories of products are perhaps the most interesting and revealing. They represent the forms in which the individual casts his information, regardless of the kind of content, and also the forms in which information is used. Units of information are relatively segregated items with 'thing' character. Classes are sets of items of information the members of which have certain common properties. Relations are various kinds of connections between items. Systems are organized groups of interacting items. Transformations are changes, shifts, or reinterpretations. Implications are extrapolations of information to antecedents, concomitants, and consequents."

This framework proposed by Guilford for describing thinking has been given here in some detail because it seems to provide a more plausible approach toward our understanding and study of thinking than the more specific studies of thinking, such as "creative thinking" and "problem solving" and studies of the various dichotomies of types of thinking. Throughout the remainder of this chapter, we shall draw on his model.

Of Guilford's three dimensions of intellect and thinking (operations, products, and contents), the dimension of operations or processes is of particular importance to us in understanding the demands on the cognitive component. A thorough analysis of housework could well be made for all three dimensions of thinking. For the present, however, we shall focus on the processes that appear to be used by considering two types of situations with which homemakers cope in accomplishing housework —routine and unusual situations. Guilford's processes will be related to planning.

✓ Planning

Typically, some of the homemaker's thinking centers around the organizational aspects of accomplishing housework and coordinating it with other activities: a general plan is worked out for immediate use; the plan is adjusted later; other plans are developed for the future. Other thinking is concerned with carrying out the plan; this may involve either the actual doing of the work or the delegating of it (delegation may involve the teaching or the supervision of a child). In carrying out the plan, much of the thinking of an experienced homemaker involves analyzing situations to determine the appropriateness of usual plans for proceeding. She may need to consider how much to do or prepare, what quality of product to make, or which supplies, materials, or equipment to use. If the usual procedures are not suitable, she may need to alter them or develop a new plan. Throughout, thinking may be required because interruptions occur, some inherent in the work, some not; more than one task is underway concurrently, causing a division of attention; choices and decisions are required in various matters, including the use of limited resources; problems must be solved. In the background of the homemaker's thinking is the awareness of the family's values, goals, and preferences; over a period of time, she has evolved procedures that are compatible with goals, and constant review is not necessary as routine work is done.

In addition to the usual state of affairs, unusual, unexpected, unpredicted events may have to be taken into account. Often they are unpleasant (sometimes dangerous) situations that require immediate attention: accidental spillage or breakage; equipment breakdown; depletion of supplies; sudden changes in the weather; personal injury; emotional upsets; and fire. Unpredicted, but not necessarily unpleasant events, include incoming telephone calls, visitors, and salespeople. All these incidents require the receipt and mental processing of information not only to cope with the event but also to adjust the ongoing plan that was interrupted.

This brief description of expected and unexpected situations in a homemaker's day suggests the prevalence of planning and replanning. What is involved in planning? Are special abilities needed? What determines success in planning? Can we identify the effects of good planning or bad planning or no planning? Are there different types of plans?

As a first step in our search for a better understanding of planning, let us return to Guilford's (1960) operations—the things that one does with the raw materials of information—and relate them to the homemaker's day. We can identify Guilford's five operations in planning. To plan, the homemaker must understand the situation (cognition)—she must identify where she is now and where she wants to be. She may recall a previous situation that is similar and her manner of coping with it (memory). She decides whether the existing plan will be suitable (evaluation). Or, she may need to develop a new plan; in so doing, several alternatives may be determined (divergent production), each requiring evaluation with reference to the goal and use of resources. Need for a new plan may also result in one solution that neatly brings together the facts in the situation (convergent production) and satisfies the requirements for reaching a goal (evaluation).

Planning, then, would seem to consist of a number of mental activities. This is also suggested in a definition of the verb, to plan: "to consider and decide upon a relatively complex set of activities that seem likely, in the light of all the foreseeable circumstances, to lead to a goal" (English and English, 1958:393. If we analyze this dictionary definition, we can identify not only "consider and decide" as actions but also the elements of uncertainty, the need to bring together facts, and the need to have a goal and to relate the facts and a set of activities to it. Such actions as these permit us to develop a plan—a scheme for action. When we plan, we seek the best or most satisfying course to secure an objective: we look ahead, prearrange essential details, and decide on the best way to proceed. A plan represents the putting together of a number of decisions.

What abilities are needed to plan? Are different abilities needed as different aspects of planning are emphasized? Of help in answering these questions is the investigation by Berger, Guilford, and Christensen (1957). In formulating their hypotheses of abilities necessary to planning performances, they worked within the framework that planning covered a number of classes of activities and was not a unitary psychological function. Their 6 major hypotheses described expected primary thinking abilities involved in various stages of planning: orientation, prediction, elaboration, ordering, ingenuity, and evaluation. Factor analysis of data from a battery of 52 tests yielded 14 identifiable factors, 10 found in previous studies of thinking and 4 new ones. The researchers concluded that their data supported the hypothesis that a large number of primary abilities are involved in planning, while 4 abilities seemed unique to the planning tests: ordering, elaboration, perceptual foresight, and conceptual foresight.

Some explanation of these abilities will help us understand the requirements of planning. Ordering was interpreted as: "the ability to arrange objects or events, or to define an arrangement of objects or events, in a sequence that is meaningful either in terms of time, hierarchical, or causal relationship" (Berger et al., 1957:26). We are all familiar with situations needing an arrangement or sequence of events. Preparation of various menu items must be done in a temporal sequence so that all the items will be ready to serve at a given time. Some tasks involve the ordering of parts of the task or processes; in floor cleaning and waxing, the cleaning and drying must precede the application of paste wax. Getting ready precedes the doing of the task, which in turn occurs before the putting-away activities. Ordering or sequencing receives special attention from the inexperienced or when one encounters situations with unknown aspects, such as in a new recipe.

The concept of elaboration may appear unfamiliar at first, but it has some characteristics of what is involved if we consider alternatives. Elaboration, in the Berger et al. research, included the specification of details, the development of an idea, the production of alternate methods, or variations of an idea which served to indicate the scope. Different ways of handling problems result from elaboration and provide more choice in formulating plans.

The relation of planning to the future rather than to the present is evident in the two types of foresight. Conceptual foresight was viewed as an awareness of possible future events that have a relation to a present situation; different needs that might be connected with the given situation had to be conceptualized; flexibility of ideas was involved. We use conceptual foresight in planning the use of resources.

Perceptual foresight required less abstract ability than conceptual foresight: the individual visually explored possible courses of action, looking beyond the step where he was working in order to select the proper course of action. A homemaker needs perceptual foresight in performance of parts of many tasks; in the preparation of garments for ironing, she eliminates searching and reorganizing during ironing if she groups together items with fibers requiring a similar ironing temperature; if she folds or rolls items so that positioning on the board can be done without rearranging; or if she places at the top of the heap items for which there is urgency. Perceptual foresight is needed during the performance of other tasks, such as food marketing and the various cleaning tasks; the reader can use his imagination and elaborate on this idea.

The four special abilities needed in planning as identified by Berger et al. serve also to describe more clearly the actions or operations involved during the various stages of planning. The more competent a homemaker is in ordering, elaborating, and using foresight, the greater is her chance of developing successful plans. The function of plans is to provide us with sets of directions to help us achieve our goals. The quality of the scheme will determine how easily and how economically we go about this task.

Miller, Galanter, and Pribram (1960) believe that most, if not all, of human behavior is organized by plans. Their definition is "*A Plan is any hierarchical process in the organism that can control the order in which a sequence of operations is to be performed*" (p. 16). They explain that a plan consists of four stages: a test to determine differences between the present and desired state of affairs, an operation to reduce these differences, a second test, and finally an exit when no differences exist. The entire cycle is a TOTE unit (an acronym for test, operate, test, exit).

The TOTE unit shows the relation between our Image (everything we have learned, including values as well as facts) and action:

"The TOTE represents the basic pattern in which our Plans are cast, the test phase of the TOTE involves the specification of whatever knowledge is necessary for the comparison that is to be made, and the operational phase represents what the organism does about it—and what the organism does may often involve overt, observable actions" (p. 31).

We propose that the operational phase of the TOTE unit is analogous to "controlling the plan in action"—one of the steps in the management process. Once the plan is set in motion, subsequent testing is needed to determine progress toward the desired state of affairs. Controlling the plan is a necessary concomitant of planning. The most beautiful plans in the world will not help you reach your goal if you do not follow the planning stage with action.

One of the actions involved in controlling the plan may be adjusting the plan—replanning part of the plan. Maloch and Deacon (1966:33) defined controlling as "regulation of planned behavior." Regulation was described as including "checking, facilitating, and adjusting a series of decisions concerning standards and/or sequence of action." Some checking and facilitating actions in controlling plans will be discussed in connection with paying attention since the limits of attention may determine the devices we use to check and control our plan.

Adjusting the plan may be necessary because new information has been identified due to changes in the situation or because the plan was not sufficiently developed. Gross and Crandall (1963:96) indicated three steps in planning that go beyond the original plan: ". . . an order of importance must be developed in case a part of the plan must be omitted, and so that more emphasis is given its most essential parts; . . . the parts of the plan must be coordinated; and . . . a time sequence for carrying out most plans must be determined." Any one of these might be brought into play in adjusting a plan.

Earlier we indicated that much of our knowledge is organized as plans and that different types of plans are made. Various dichotomies of plans can be identified: long-range and short-range; simple and complex; broad and detailed; old and new. The type of plan would seem to be related to the amount of work required of the planner: long-range plans may require greater use of conceptual foresight than short-range plans; complex plans may involve more ordering and elaboration than simple plans; detailed plans may involve ordering of more parts than broad plans; new plans would need developing while old plans may suffice as they are or if not, would serve as a base for developing a revised plan. Actually, old plans often serve this important function of eliminating some of the work of planning, for a quick check permits us to determine whether or not an existing plan can be used.

The advantages of a broad plan must not be overlooked. A broad or general plan can be developed in greater detail when it is needed; some of our long-range plans, stored in broad outlines, serve adequately as guides for directing our behavior for a period of time.

Some plans are stored directly and are ready for use. Habits and skills are examples of old plans and their usefulness was noted earlier: relatively little new information must be taken into account to get us from where we are to where we want to be. Our mind is freed for other thinking.

Some plans are stored for use in generating others. Miller et al. (1960: 169) refer to these as metaplans—"Plans for forming other Plans." Metaplans help us generate alternative plans; they are sets of rules that can be projected into a variety of situations. New knowledge must be introduced into a metaplan to help formulate a successful plan.

Besides the type of plan, other determinants of personal input may be the amount and timing of our planning. *When* we plan is important in two respects: if we plan ahead, we are prepared for action; if we have some plans made, our planning can then be spaced so that too much planning is not needed at any given point. There is a limit to how much planning we can do at any one time.

The amount of planning encompasses the ideas of quantity or number of plans as well as the extent of planning. As we gain experience with a situation, we should be able to draw on details of existing plans and avoid the work of enumerating every step used previously.

Economy in the production of plans for a particular goal may be advantageous when future events do not depend largely on the manner in which resources were used, relatively small amounts of resources are involved, and preferences of family members are not a major consideration. Research is needed to identify optimal amounts of planning (Deacon and Bratton, 1962). It seems logical to assume that a higher input is made by homemakers who develop too many plans for fairly routine situations or who initiate action on one plan, reevaluate the plan, and change to another having no clear advantage. The higher cost would come partly from the continued concern for the appropriateness of action, partly from duplication of action. Clearer bases for choice may be needed or firm acceptance of one way of proceeding even though other plans appear equally attractive. Our efforts might better be saved for those events with more far-reaching consequences.

Planning and Problem Solving

Our discussion of planning would not be complete without a comparison of planning and problem solving. Planning and problem solving seem to be interwoven as the homemaker handles both routine and unexpected situations. Indeed, we find it difficult to separate them if we interpret the two terms broadly. Note that we are using verbs rather than nouns. When the nouns are involved, the distinction is clear: a plan is a solution, but a problem needs a solution. When verbs are used, a difference is not clearly apparent: "to plan" and "to solve a problem" require development of at least one solution—a solution to help us get from where we are to where we want to be.

In both planning and problem solving, certain steps are similar: identify the goal or understand the problem; produce alternative plans for reaching the goal or alternative solutions to the problem; and evaluate a tentative choice of a plan or a solution to a problem. The analogy can be carried further: if we know how to reach a goal, we have a plan and planning is not required; and, as Johnson (1955) pointed out, if we attain our goal on the first try, even though it is a lengthy try, we have no problem.

Guilford (1960:18) stated: "Planning partakes of some of the properties of problem solving, for a plan is often a means of solving a problem." Simon (1962:479) appears to be saying somewhat the same thing: ". . . the activity called human problem solving is basically a form of means-end analysis that aims at discovering a process description of the path that leads to a desired goal. The general paradigm is: given a blueprint, to find the corresponding recipe." D. W. Taylor (1960:59), in his discussion of human problem solving and of the computer simulation of it as developed by Newell, Shaw, and Simon, identifies the "corresponding recipe" as planning:

". . . The program employs two general problem solving techniques or heuristics: means-ends analysis and planning. The first involves essentially comparing what you have with what you wish to obtain, determining a difference between the two, finding and carrying out an operation which may reduce the difference, repeating this procedure until the problem is solved. The second involves essentially simplifying the problem to be solved, solving the simpler problem, and then using the procedures successful in solving the simpler problem as a plan for solving the more complex problem."

Duncker (1945:1) clearly defines a problem: "A problem arises when a living creature has a goal but does not know how this goal is to be reached. Whenever one cannot go from the given situation to the desired situation simply by action, then there has to be recourse to thinking." Johnson's (1955:63) definition is similar: "*A person may be said to have a problem if he is motivated toward a goal and his first goal-directed response is unrewarding.*" Upton (1961:144) says that:

". . . a problem . . . is a state of mind characterized by the momentary awareness of a need to know something that is not then in the consciousness. It is an instant of uncertainty concerning what is to happen next if the event is to be one of our own choosing.

"There are two sorts of problems: the kind that, for all practical purposes, are solved when clearly formulated, and the kind that we call puzzles. . . . a puzzle is a problem the statement of which confronts the mind with two or more avenues of solution."

Upton's "puzzles" are the sort of problems in which a choice of solution or decision making is difficult because the relative merits of the solutions or their outcome are not clear.

Guilford (1960:14) has suggested that "problems are extremely varied and their solutions involve different operations, contents, and products, depending upon the circumstances." In 1954, he had offered the following proposition: ". . . *the term 'problem solving' has no fixed or stable meaning.* It is a term that covers a multitude of events of many kinds. There are numerous kinds of problems and for each kind of problem there are usually numerous possible operations by which they can be solved" (p. 197). He then gave examples of problems which were mechanical, economic, psychological, and sociological. We might enlarge his list to bring in more specific aspects connected with housework and the responsibilities of the homemaker by adding problems concerned with the work—process, product, procedure; the worker—knowledge, skill, time, energy; and the family—child development, human relations.

Making Judgments

The recurrence of judgment, evaluation, and choice throughout planning and problem-solving activities and other thinking should be emphasized, for each requires thinking and therefore constitutes a cost to the homemaker. When we make a choice, we are selecting among two or more alternative objects or actions; a period of deliberation may be required. When we evaluate, we are comparing something against a standard to determine the relative importance of the act or object. To judge is to make a critical evaluation of a person or situation.

Homemakers are continually involved in a judgmental or decisive process. Objective information helps us make a decision more easily because the facts are more clearly apparent and a simple comparison permits a decision. Objective checks are used to help arrive at decisions; the thermometer in a roast provides information about extent of doneness, or the thermometer in the candy indicates the point at which it can be removed from the heat. However, many decisions entail judgment that is more complex because the facts and consequences are not clearly known, and the decision depends partly upon estimates. The importance of making good estimates suggests that we should examine in more detail what is involved in making judgments.

We have already noted that to judge is to make a critical evaluation of a person or situation. It includes three processes: appreciation (the meaning or significance of something), comparison, and appraisal of values (English and English). To judge stresses careful, critical examination of evidence in attempting to arrive at a wise or fit conclusion; it is a synthesis of evidence; it is necessary to estimate on the basis of a comparison of facts or ideas (Webster). Abercrombie (1960:14) states: "We are continually selecting from the information presented, interpreting it with information received in the past, and making predictions about the future."

Judgments are required when information needs interpretation before we can make a decision. The results or outcome are somewhat unpredictable. It is necessary to add the newest information to existing items of information and to pull together this variety. Thus, old information and new information are related to help resolve the problem. The judgment is the resolution of uncertainties in the situation and determines new procedures, modifications of standing rules, or continued use of standing rules.

Actually, judgment is exercised in another way before the resolution of the problem. In receiving information from a given stimulus pattern, we select from the total amount of information available and from our own store of information. The receipt of the information involves making a judgment, often done rapidly and automatically. Our control of the information we receive relates to the quality of our judgments.

Abercrombie (1960:17), in addressing herself to medical students, stated: ". . . we may learn to make better judgments if we can become aware of some of the factors that influence their formation. We may then be in a position to consider alternative judgments and to choose from among many instead of blindly and automatically accepting the first that comes. . . ."

Crossman (1964:35) made a point similar to Abercrombie's in his discussion of prediction and planning as it related to information processing in human skill. He believes that prediction or foresight is quite important in skilled performance because it permits planning in advance of action. Preliminary conclusions from current research indicate that a better understanding of the manner in which a system operates is important in being able to predict or judge what is going to happen. A knowledgeable idea of the working model of the system is better than experience with little understanding, for the exact situation may not occur again.

Judgment is identified by Johnson (1955, 1961) as one of three groups of problem-solving activity; they are: preparation or survey of the problem and analysis of goal (stopping routine activity, identifying the problem, getting ready to produce solutions); production of promising solutions (trying one approach after another, rearranging); and judgment or evaluation of attempts (evaluate or criticize solution—conclusive process).

Judgments range from simple to complex. The clearer the course of action, the more simple the judgment. Complex judgments occur when the information creates uncertainties and the course of action is not clear. The decision to use a standing rule suggests less new information and less ambiguity about the outcome—a simple rather than more complex judgment. In a complex judgment, at least two general types of action are involved: determining alternatives and choosing among alternative courses of action.

Johnson (1955:292) explains judgments of complex materials as follows:

"By a complex judgment we mean one in which the stimulus material is heterogeneous, with no one prominent aspect or dimension to which the judge can be easily prepared to respond. The response is therefore correlated with more than one aspect of the stimulus material.

"Complex judgments are made in many practical situations, as when a cook decides that a cake should or should not be removed from the oven, when stockmen judge cattle. . . ."

How many complex judgments does a homemaker make during the course of a day? We can get some idea of the judgment a homemaker makes in performing homemaking work by examining some situations needing judgment. She frequently needs to determine the quantity needed; her knowledge of her family's eating preferences and appetites would be taken into consideration in estimating the amount of mashed potatoes to prepare, or salad, or a casserole for the main dish. In planning her work for the day, she must often determine the order of doing various tasks and of doing the parts of tasks; differences in the health of family members, her activities outside the home, or the weather may need consideration in judging the best sequence. Occasionally she must judge whether it is appropriate to do the task herself or to delegate it to some other member of the family or to services outside the home;

her judgment of the personal costs of doing the task might be a major factor to include in the decision.

For the task of washing clothes, a number of factors require judgment for there are alternatives for each: the length of washing time for laundry; the condition of wash water for a second load; the water temperature; care of new items in the wash; treatment for a new type of stain or spot; identifying soil or stain; how to use new supplies; the size of wash load; the total quantity of clothes to be washed; characteristics of clothes to be washed—color, type of soil, textile fiber, and bulkiness suitability of weather for drying clothes; and the total time available for drying clothes in relation to the weather.

In another household task, care of house, a variety of situations require the homemaker's judgment: what to pick up; what items to remove during cleanup; the type of cleaning necessary; and the best equipment to use for special cleaning jobs.

The preceding household tasks, as well as others, could be studied in more detail to illustrate the use of judgment by homemakers. Many of the situations suggested may seem trivial, but the impact on the person in terms of attention used and responsibility assumed for the choice of action and the consequences for the choice cannot be overlooked. The quality of product that is obtained is frequently determined by the quality of judgment exercised by the homemaker. The responsibility carried by the homemaker for her discretion has received insufficient credit or acknowledgment; the personal cost that is involved from this responsibility is generally overlooked. If we think of Jaques' (1961) idea of payment being equitable if it is in relation to the time span of discretion, then we need to give further consideration to time span as an index of the homemaker's input.

A relationship between exercise of discretion and number of different tasks was identified in a study of hospital employees (Bell, 1966). Amount of discretion was measured by use of judgment about whether or not to perform tasks, how, and in what order. Hospital supervisors who exercised much discretion tended to perform a large number of different tasks; Bell defined the latter as a large span of attention. Bell (p. 168) explained that "after solutions to a problem have been established they evidently do not reduce supervisors' spans of attention. . . . he . . . tends to take on more problems or keep on improving past solutions . . . [and] retain responsibility for the original problem." Is this practice analogous to that of some homemakers? Certainly a large number of tasks and exercise of discretion characterize the homemaker's job.

Three important techniques contribute to better judgments and can help us gain facility in making judgments: learn how a thing works—why it works as it does so that better predictions of outcome can be made; identify those factors which make a difference in a situation; keep alternative hypotheses in mind for making better or more correct judgments. Other supporting guides include: become familiar with supplies and equipment; know procedures that will yield specific results; use devices—measuring cups, spoons, scales—that will eliminate the need for estimating quantity of supplies; use guides, such as thermometers or timers, for determining the point at which a process has continued long enough. In some instances, these devices will facilitate the making of the judgment because they provide a particular amount of information which, in turn, will provide a base for further thinking. Information thus gained contributes some facts to include in the light of other known information.

PAYING ATTENTION

Paying attention is part of the process of acquiring and using knowledge. Paying attention provides a link between external and internal sources of knowledge. Paying attention is a selective process. A most important part of our learning is the selection of the particular information which is going to be most useful to us at any particular time. The information we select actually determines the kind of person that we are. The reverse is also true.

What do we mean when we say, "I'm paying attention to this"? Attention is defined as "the active selection of, and emphasis on, one component of a complex experience, and the narrowing of the range of objects to which the organism is responding; the maintenance of a perceptual set for one object and disregard for others." The act of attention is "the process whereby part of the field of awareness becomes clearer or more emphasized" (English and English, 1958:49).

The trend in household work is toward a decrease in strenuous physical activity and an increase in mental input. Technological advances have provided labor-saving equipment, preprocessed foods, and improved supplies to do better cleaning jobs more easily. The consequences are an increased proportion of head work and a decreased proportion of back work in the homemaker's life.

This is the situation in industry also. At a symposium, Lockspeiser (1954:3) noted the increasing importance of the mental load in industry:

"But in these matters of human activity at work, regard must be had to the whole man and particularly to the integrated action of the sensorimotor system. The *reduction* of the load placed on the motor system (that is, the reduction of muscular effort) has very often involved an *increase* in the load imposed on the sensory side. The operator is required to pay increasing attention to dials, indicators and controls, to an extent that is liable to overload the sensory side of the nervous system or to call for excessively intricate co-ordination of sensory and motor functions."

Such concern for the importance of perceptual and central organizing activities in sensory-motor performance has been increasingly recognized (Welford, 1960; F. V. Taylor, 1960). The work of the process-operator in automated systems has also brought into sharper focus the demands on and the contribution of the cognitive component of the worker in certain industrial situations. Crossman (1956a:42) says that a worker concerned with process control "uses very little muscle power and much of the time is not working in the true physical sense. His function is to absorb information from sight, sound and smell, and combine it with stored information from records or experience, and translate it into appropriate, accurate action."

The homemaker also must focus her attention on the task or tasks she is doing. The nature of household work often involves carrying on multiple activities—and necessarily spreading attention. One of the busiest times for many homemakers with young children is late in the afternoon—during evening meal preparation; the homemaker's attention is divided among the children's requests, their activities, and the several parts of meal preparation. "Attentional fatigue" may be the key to identifying causes of much of the fatigue from work and ultimately minimizing or eliminating these causes.

Knowledge of the dimensions of attention may be applied to the analysis of household work to yield knowledge basic to practical organization of tasks and design of each separate task. The word practical is used here to mean a reasonable demand upon the cognitive component of the worker. The attention required in the performance of household work and, in fact, much work in industry has not been the object of intensive study. Certainly, there is enough variation in many household tasks to require more than surface attention part of the time.

Evidence is not clear concerning the relationship between intrinsic interest for a task and attention. Vernon (1954:86) states: "It is generally found that the most fatiguing tasks are those which require some degree of attention and thought—they cannot be performed entirely by routine habit—yet the thought which they necessitate has no intrinsic interest." Maloch (1962) did not find any relationship between the homemakers' ratings on the amount of attention required and task preference in her study of most liked and least liked tasks.

The idea of some information being of more interest to us is apparent in Hunt's (1963, 1965) theories that "intrinsic motivation" or "motivation inherent in information processing" is responsible for our perceptual interaction with the environment. An incongruity arises between inputs of the moment and some standard within the person. When a system offers too little incongruity, i.e., when the inputs from a situation are too similar to the information already in storage, boredom results, and we withdraw from that situation to seek another one offering more incongruity, stimulus-change, novelty, or dissonance. Hunt's ideas suggest that those tasks disliked by a homemaker may offer too little new information that must be taken into account during performance of the task. This may be one factor with respect to disliked tasks that is in need of study.

What are the problems in paying attention? In brief, one of the limiting factors in paying attention is the "channel capacity" of the worker. Theoretically, there is a limit to the quantity of information that can be transmitted through a given channel in a given time. Also, there is only a certain amount of space in which instructions and information can be stored. Only so many messages can be handled at one time, and there is a limit to the number of things that can be attended to at any one time. In the section that follows, we shall discuss the selectiveness of attention and ideas about the mechanisms of selecting and processing information.

Let us first briefly examine some of the factors that are important in paying attention and relate them to performing household work and especially the checking and facilitating actions in controlling plans. Certain actions are required of the worker as he pays attention: select information, process it, and sometimes use short-term memory.

One factor influencing the act of paying attention is: the amount of information that must be taken into consideration for the performance of a task. For the homemaker's work, we ask such questions as: How many things must be taken into account before a task can be started and afterwards to keep it going? Which things must be checked to determine whether or not the action is proceeding as expected? In ironing, are the temperature, size, texture, dryness, or dampness all a consideration? What controls must the homemaker use to obtain her desired product? Must ironing temperature and fabric be matched?

A second factor important in paying attention is the similarity of signals, cues, or clues. These terms are used in the sense that they are identifying marks that permit discrimination or recognition of a stimulus pattern. What are situations in household tasks in which the cues are similar? In laundry: sorting clean T-shirts, socks, and other clothing when the wearers are about the same size. In cooking: choosing the correct dial on the range when the dials for the right and left surface units or the front and back units are similar or distinguishing labels on some packages so that the preferred cooking technique can be used. In the grocery store: similarity of labels on cans or packages requires attention for correct selection.

A third factor, the fineness of discrimination is similar to the preceding factor, but the precision needed is emphasized here. How carefully must we note differences as we work? Matching color of thread, buttons, and patches requires careful discrimination if they are to be used in conspicuous places and on important garments or items. Precision in measuring some foods for various menu items is important; the measuring level must be noted carefully.

A fourth factor, the period over which attention must be given, relates to all three actions required of the worker as he pays attention and, in some instances, especially to the one of using short-term memory. Two questions are important here: What is the duration of attention? Is it continuous or intermittent? The answers to these questions give us information about four aspects that relate to the person's input: the period over which attention must be given may be associated with the amount of information that must be taken into consideration, or it may mean that information concerning other tasks must be stored until action can be taken; in contrast, if the task requires repeated action then the cues to which the person is attending may become fatiguing—the same process may be required too frequently in succession to permit continuing attention to a degree that is desirable, or the person must use short-term memory to attend to the task at various intervals because action cannot be continuous. Logically, then, the longer the period over which attention must be given, the greater the chance for other matters to need attention, or the greater the need for short-term memory, or the greater the chance for fatigue to begin to accumulate.

A few examples are needed to illustrate these points concerning the period over which attention must be given and the effect on the person. Folding of clothing of the same type may be an example of the repetition of the same signals with accompanying fatigue. In contrast, ironing may continue over such a long period of time that either other household tasks must await action and be remembered, or the similarity of action becomes fatiguing. (Of course, we know that there are other sources of fatigue, such as the physiological effects on circulation from standing in one place for a long time. See Chapter 6.) Line drying of clothes may require short-term memory when repeated checking for dryness is needed and/or to remember to bring in the clothes. Machine drying of loads of mixed fibers may also require short-term memory if clothing of synthetic fibers must be removed before cotton items are dry.

A fifth factor, period of time over which information must be accumulated, differs from the period over which attention must be given in that the information may be incomplete at the start of the activity or time period. The total plan cannot be developed in detail before action starts. Two examples will be familiar to many of you. Construction of a garment may require adjustments in some parts of a pattern during the cutting and subsequently during basting or stitching; the adjustments on one part must be remembered so that possible effects on connecting parts of the garment can be determined as the work progresses. In shopping, comparison of quality, design, and color of items at several stores is done progressively and possibly not all in one day. Stores in more than one city may be used, and this could add to the period of time over which information is accumulated.

A sixth factor is the spacing of signals. Here we are using signal to mean a sign that indicates that the time and place for a certain action are at hand. Of importance is the rapidity with which the signals occur; is there opportunity for action between signals? When signals come close together and each requires action, the worker may not be able to attend to all of them at the same time. Some of the information may be forgotten, and some of the quality of the product may be affected when there is a delay in acting on the signal. The pressure of needing to attend to many things and having to make a choice among these things may be a challenge or a discouragement to the individual.

The activities toward the end of meal preparation provide a potential situation for close spacing of signals and need for quick action. We can easily imagine the variety of things that may happen when one is completing a meal with several menu items that need attention almost simultaneously. Other examples of the need to take action may be found in situations in which tasks are dovetailed, i.e., from among tasks in different task areas rather than within a task area such as meal preparation.

One more factor, storage of strings of items of information, is important in our paying attention. In household work, must information be stored in a particular sequence? Must a certain sequence of action be followed for some tasks? Does future action depend on previous parts of a task? A telephone number is a very common example of sequencing; this must be recorded or remembered in a correct sequence. Other examples can be found also. Preliminary to starting equipment such as a dishwasher or clothes washer, the loading and/or setting of dials must follow a certain sequence. In meal preparation and particularly in baking, the items which have been measured must be kept in mind and the order in which the operations must be performed must be remembered or constant referral to the recipe or directions is required. Many of the preprocessed foods also require a sequence of action.

The preceding survey of some of the factors involved in paying attention and the application to household work should provide the reader with an overview of the immensity of the topic and the potential for application to everyday activities. With this background to provide an appreciation for the problem, let us review the literature that provides some of the theory concerning selecting and processing information.

Selecting and Processing Information

Earlier we stated that one problem in paying attention is the limit to the quantity of information that can be transmitted through a given channel in a given time. Why is this? What can we do to get around this problem? Broadbent (1965) notes that if we understand what is done, then we can look at procedures for economizing in mechanisms. First, we need to explain some technical terms that we shall be using.

Channel capacity is defined in information theory as "the maximum transmission of information that a channel can provide," while a channel is "a complete system for transmitting a signal from an input location to an output location. . . . The channel may be an organism, in which case the sense organ is the input location and the motor mechanism is the output location" (English and English, 1958:83).

Crossman's (1956b:143) explanation of our channels may help clarify the meaning of the preceding definitions:

". . . *Information.* The normal operator has six main channels through which he gets sensory information: a pair of eyes, a pair of ears, a skin sense registering shape, pressure and heat in each hand, and muscle-joint or *kinaesthetic* senses in each limb, which signal the position, rate of movement, and resistance for each arm-hand combination. Of course, if feet are used for an operation, or if smell or taste come into play, there will be more channels. A channel can only be occupied with one signal at a time. Thus different visually-controlled hand movements cannot be carried out with both left and right hands simultaneously.

"*Decision.* The human brain can handle only one decision at a time, so that it is single-channel, but a distinction must be made between two different kinds of decision or control, namely 'symbolic' and 'non-symbolic'. The non-symbolic type of control occurs when a single quantitative error-signal is present to indicate how far from its goal the action is. Steering a car, tracing a drawing, or reaching for a visible object, are all controlled by non-symbolic processes. The decisions made are not expressible in words and non-symbolic control is often easily learnt. The symbolic decision process, on the other hand, involves translation or recoding between the incoming information and the appropriate action. Copy-typing, many inspection operations, and obeying verbal instructions are symbolic decision processes. They are usually harder to learn, and take the brain longer to perform, than non-symbolic ones."

Important points to remember are that we have many channels of sensation supplying information to our brain but only the brain makes decisions and only one at a time. The brain must acquire information, classify, send directions, and interpret what happens. The number of stimuli and the complexity of the ways they are classified and analyzed cause difficulties (Treisman, 1966).

Theoretically, there is a limit to the quantity of information that can be transmitted through a given channel in the brain at a given time (Broadbent, 1958, 1965; Crossman, 1964; Deutsch and Deutsch, 1963; Neisser, 1963; Poulton, 1958; Treisman, 1964, 1966; and Welford, 1958, 1960). The brain cannot deal with all the incoming information. One consequence is that we are selective in stimuli to which we respond. We necessarily ignore much of our surroundings. What is not selected is often as important as what is selected.

Treisman (1966) suggests three possible strategies for selecting information: the selection of questions, source, and meaning. We can limit the types of questions we ask, such as what color or shape or size, with the result that we perceive only one sensory feature of an object. When we restrict our questions to those about a particular person or object, we perceive all features of that one particular object; this may be our most common strategy. With the third strategy, our leading questions are relevant to a particular goal we have in mind, such as an object on which we can sit. Treisman explains that the meaning of the stimuli is important here rather than any particular physical characteristic. It is not difficult to project these strategies to situations connected with doing household work.

What are some of the highlights of the theories that might explain the mechanisms underlying selection of information? In brief, the selectiveness of attention is explained by Broadbent (1958) by the filter theory, i.e., a filter at the entrance to the nervous system filters sensory information, selecting some messages on the basis of characteristics toward which it has been biased. Following the filtering of messages, the ones selected are passed on to a single decision channel of limited capacity. This channel has access to long-term memory store.

Deutsch and Deutsch (1963) propose a mechanism other than the filter theory: the existence of a shifting reference standard which takes up the level of the most important signal. They state that: "The selection of wanted from unwanted messages requires discriminatory mechanisms of as great a complexity as those in normal perception . . ." (p. 80).

Treisman (1964) indicates that part of the difference between the Deutsch and Deutsch and the Broadbent theories concerns the stage at which full analysis of messages is made. Another difference is whether all messages are fully analyzed; their ideas of "link-analyzer units" and "analyzers" are somewhat different. Further research in psychology and physiology is needed to explain the mechanisms of attention.

A second consequence of limited channel capacity is that we use the device of coding and combining "bits" of information to increase the amount that is transmitted at any moment. A bit of information is a unit measure of amount of information. Crossman (1964:33) explains that: "Usually coding, i.e., exchanging one message for another conveying the same information, is required to adapt a message for transmission, and this implies the existence of a 'code-book' or dictionary common to both ends of the channel." That is, a message is converted by an encoder and transmitted; the output is received by a decoder and converted into a message.

Miller (1956:95) emphasizes the importance of recoding:

". . . recoding is an extremely powerful weapon for increasing the amount of information that we can deal with. In one form or another we use recoding constantly in our daily behavior.

"In my opinion the most customary kind of recoding that we do all the time is to translate into a verbal code.

. . . .

". . . Our language is tremendously useful for repackaging material into a few chunks rich in information.

. . . .

". . . the kind of linguistic recoding that people do seems to me to be the very lifeblood of the thought processes."

As an example of recoding, Miller described the learning of the radio-telegraphic code. Each *dit* and *dah* is first heard as a separate chunk, then organized into letters, then into words, then phrases. Many of us are more familiar with the same situation in learning to type skillfully. The advantage of having more information in each chunk is that it not only increases our memory span and the amount of information that is transmitted in a given moment, but it also increases the amount of information that we can store.

The device of recoding to increase the amount of information that we can store is important because our storage capacity is limited. As pointed out earlier, we condense the tremendous amount of detail and information by classifying. This is one method of recoding. Generalizations are another. These may appear as rules for action and metaplans (Plans for forming other Plans); they are easily stored and can be projected into a variety of unforeseen situations (Miller et al., 1960).

The storage capacity of our minds has been compared to that of computers. Neisser (1963:10–11) points out:

"Any given machine has a finite capacity. There is only a certain amount of 'space' in which instructions and information can be stored. More complex programs take up more space. If two programs are executed simultaneously, each has less space available than if it were being carried out alone, and is thus more limited in what it can do. There is no way for human thinking to escape this principle. If several processes occur together, none can be as complex as the subtlest possible single processes."

What are the practical consequences of limited storage capacity? Because we can handle only a certain amount of information at a given time, there is a limit to the number of things to which we can attend at any one time. We are all familiar with situations in which we listen to two conversations at the same time, or carry on both an activity and a conversation—sometimes successfully, sometimes not.

Neisser (1963) suggests that human thinking is a multiple action, and that one of the main sequences is the maintenance of orderly and adaptive sequence in our own behavior. He theorizes (pp. 12–13) that: ". . . two things can be done at once only if (a) they do not both require response; (b) they do not both have a high level of complexity; (c) at least one of them is 'automatic' enough to be outside of consciousness."

Neisser's three points concerning what can be done at once could be used as part of a framework for analyzing homemakers' organization of work; both the proposed plan and the execution of the plan could be studied. However, task organization should be examined for other factors besides our limits of attention; these might include place proximity, house plan, urgency for task completion, and the discontinuity inherent in the task.

Some activities are done separately, some together. Schouten, Kalsbeek, and Leopold (1962:251) explain how some tasks are done concurrently:

". . . few perceptual tasks provide a truly continuous load on the subject's perceptual faculties. Thus in many cases the two tasks will not be truly simultaneous but rather an interwoven pattern of alternating subordinate tasks. In fact the acquisition of many of our skills (like e.g. car driving) depends on the very faculty of adequately timing a number of actions in response to simultaneous stimuli."

These points and Neisser's suggest aspects of housework to examine for a better understanding of which tasks to combine. Further analysis of organization of tasks is included in Chapter 10.

Another factor in determining the number of things that we can handle together is the rate at which messages arrive or the spacing of the signals (Broadbent, 1958). When information arrives for two tasks at once, there is interference; only one of the signals can be dealt with at a time. The signal may be a single one or a coherent group of signals (Welford, 1953). Approximately 0.5 sec is needed to receive a message and to act on it (Vince, 1948; Welford, 1959). A certain amount of this time is needed for dealing with the information; this is organizing time or the "psychological refractory period" (Welford, 1952, 1959). The channel also becomes engaged in monitoring the responding action. Thus, when two signals arrive together, one must be held in storage.

Errors occur when too many signals arrive at once or when the channel capacity is overloaded, for some signals may be forgotten and others may be combined, leading to the wrong response, or the right response at the wrong time, or approximation rather than precise response (Miller, 1961). Vigilance and tracking studies have contributed information on the effect of signals arriving too rapidly as well as data concerning the time for handling signals.

In the vigilance studies (where signals must be reported) and tracking studies (where signals must be noticed and adjustments made in controls), performance has been improved by feedback (knowledge of results), the shifting of attention, and the alternation of rest and monitoring. Although the vigilance situations are quite different from housework (where typically the homemaker deals with a number of problems at the same time), the vigilance studies do contribute to understanding of attention and suggest factors to study. For example, after prolonged observation of one source of information, a person shows brief intervals in which he takes information from other sources or fails to respond to important cues (Broadbent, 1958; Vernon, 1954). The balance between work and rest, or work on one task and alternation with work on another, seem to be related to maintenance of attention (Payne and Hauty, 1957). Thus, the breakdown of attention may provide cues concerning optimum duration of work in the home, especially those tasks requiring close attention and precision.

The time needed to specify a motor response also limits the rate of motor performance. Fitts (1954), using his data and that of Fenn's (1938), concluded that rate of performance is not limited by muscles but by the fixed capacity of the central mechanisms for monitoring the results of the ongoing activity while at the same time maintaining the necessary degree of organization with respect to the magnitude and timing of successive movements. Welford (1953) has stated a similar conclusion.

Crossman (1964:36) points out that if advance information is available, the time lag between receipt of information and action can be canceled. Advance information is important in skilled performance; a lack of advance information produces jerky rather than smooth movements. Treisman (1964) also emphasizes the value of anticipating information because it reduces the number of questions the brain must ask to identify the signal.

The preceding review suggests the variety of factors important in selecting and processing information—in paying attention. A potential area of research for the design of housework is the study of attention: the essential cues that are selected; the rate at which information arrives or the spacing of the signals; the amount of information that requires analysis; the critical points in tasks; the fineness of discriminations; the period of time over which information must be accumulated; and the duration of the work period. All of these may be factors influencing the ease of doing work and which tasks or which parts of tasks can be done concurrently and which not. Results from such research would have practical application in teaching principles of organization of housework, methods of preventing fatigue, and development of skill.

Measurement of Attention

What techniques hold potential for the study of attention in carrying on the work of the home? A few researchers are working on this problem in other fields and seem to be using two main approaches: an analysis of perceptual load and an indirect measure of mental load through use of a subsidiary task.

Crossman (1956a, b) has worked toward the measurement of perceptual load—the sensory and mental work—in repetitive operations. He proposes "Perception Study" as a compliment to orthodox motion nd, select, and plan) but the part played by the senses was not fully ecognized in other therbligs such as move and reach. (A therblig is a ingle element of motion.)

Control of movements is important in finger work; overt muscular ork is controlled by the senses and brain. Crossman identifies three ypes of work—sensory, mental, and physical—and explains that sensory ork provides information, mental work provides decisions, and physical ork provides action. Information leads to decisions, decisions lead to ction. Perceptual work can be divided into planning, controlling, and hecking, but in a sequence of action they overlap:

". . . the perceptual control required to turn random movement into seful activity extends both before and after the movement itself. In ny sequence of actions, except in the earliest stages of learning, the lan, control and check of different movements overlap each other and he movements themselves, making that intricately interwoven pattern f physical and mental activity which we know as skill" (Crossman, 956b:143).

The two main sources of perceptual load according to Crossman are ycle-to-cycle variations in the work and the need for accuracy. The ycle-to-cycle variations would seem to be a main source of perceptual oad in housework; the need for accuracy may not be as important; for xample, in paring apples (or peaches or potatoes), differences in qual-y lead to variations in work from one apple (cycle) to another, but a ack of accuracy in removing all peel can be corrected.

In "Perception Study," the charting of every action in terms of per-eptual and physical elements helps us to understand points at which kill is particularly needed and improvements can be made. However, he measure of perceptual load requires more developmental work.

Other attempts are also being made to assess the mental load of the perator. One approach has centered around an analysis of the types of nental activity required of the operator. In some cases, the operator's ork has been to monitor processes that are continuous. The background nental load—the number of things that must be remembered and rought to bear on decisions—and the decision-making load seem par-icularly important but need further study (Kitchin and Graham, 1961). knowledge of the working of the system improves the timing of the ecisions (Crossman, 1964). The frequency of obtaining information rom dials seems to be related to the knowledge of the system: when uncertainty reaches a critical level or anything happens to increase uncertainty, the rate of sampling the displays increases (Crossman, Cooke, and Beishon, 1964). In the home, somewhat comparable behavior may be found in connection with certain cooking processes and menu items although dials may not always be an adjunct.

Another method of measuring mental load involves the use of a subsidiary task. A subsidiary task is secondary to the primary or main task that a person is to accomplish. The extent to which errors or changes occur in the timing of the subsidiary and/or primary task measures the loading of the channels. Criteria for choice of subsidiary task include a difference (compared to the main task) in senses or limbs needed to carry out the subsidiary task and the known difficulty of the secondary task. The idea is that few perceptual tasks require full use of perceptual facilities. The more information needed to carry out the primary task and the more decisions needed, the greater the channel loading and less opportunity to process information in parallel or alternately for the secondary task. When the secondary task also requires decisions and close timing, errors occur because a stable pattern of interwoven decisions is not possible.

Examples of the technique of using a subsidiary task to measure the spare mental capacity of the operator can be found in Brown (1962) and Brown and Poulton (1961); in these studies, the driver of an automobile was asked to do a mental task. Poulton (1958) measured the relative difficulty of two tasks through use of a subsidiary task of known difficulty. The work of Kalsbeek (1964) and Schouten, Kalsbeek, and Leopold (1962) in Holland has also contributed to the study of mental load of perceptual tasks.

The task of studying mental load in household work remains to be done. Careful analysis of tasks to determine mental load and means of reducing it through devices to help control action ranks high on the list of needed research.

SKILL

Most of us have had the delightful experience of watching a skilled person at work or play and noting the high quality performance and product. We may have thought, "He knows what he's doing." The timing was perfect, the movements adept and precise, one sequence of movements followed another smoothly, and changes in the situation seemed to be taken into account without a change of pace. Although this suggests that much of the background information on skills belongs to the physical component of the worker, the discussion is included here.

The importance in skill of the storing, receiving, and processing of information influenced our choice.

Skills are evidence of knowledge. The sequence of operations, motions, timing, or processes required for the smooth performance of tasks is based on knowledge that has been acquired over a period of time. Skill is defined as the "ability to perform complex motor acts with ease, precision, and adaptability to changing conditions. Skill is evaluated in terms of end results" (English and English, 1958:505). H. W. Johnson (1961:163) defines skill as *"the ability to execute a pattern of behavioral elements in proper relation to a certain environment."* He cites four dimensions of skill: speed, accuracy, form, and adaptability. In testing skill, the process is often evaluated for speed, form, and adaptability, the product for accuracy.

Are skills, then, only motor skills? Do we also develop mental skills? Some of the latter are called "basic skills" and are defined as: "those activities learned in school which are necessary for the carrying on of other school activities, esp., the mechanics of reading, spelling, writing, and the primary processes of arithmetic" (English and English, p. 60). Mental skills provide tools for acquiring and using knowledge.

We must not limit our concept of skill to the visible evidence in task performance; rather, we must enlarge our concept of skill to include the combination of mental work and motor performance for a given task or concurrent tasks. Recognition of the mental activity required for skilled performance will give us greater appreciation for the contribution of skill in the management of the home.

The importance of skill is that it expedites work. Skill, broadly speaking, is important in the determination of plans, their execution, and control. Skill, more specifically, is essential in the performance of each task. Since we can handle only a certain amount of information at a given time, we must develop routines and subroutines to free our minds to cope with the changing factors in our situation. We use knowledge to develop plans for proceeding; overlearning plans to the point of skill provides the routines so essential to control of activity.

The homemaker's job is a varied one; in addition, some aspects of any one task differ from time to time. The ability to identify changes in the situation, anticipate what these might be, and know how to adjust to them enables the homemaker to keep a task going smoothly while she dovetails other tasks and nonhomemaking activities. Part of homemaking skill includes being able to shift from one task to another. If all or a major portion of her attention had to be given to a single task, the homemaker could probably not accomplish the work of the home; in addition, it would not be possible to subordinate work, making it secondary to other activities—at least some of the time.

The practical significance of skill in the management of a home deserves more recognition. The acquisition of skill has necessarily been banished from many college curricula so that time can be spent on the why rather than the how. To be successful in helping homemakers, however, the work management specialist must gain competence also in planning and performing tasks. Theories and principles provide the necessary foundation, but practice and experience can provide further identification of the problems and their solution and an appreciation of the value of skill to the homemaker.

Let us turn our attention again to the question of what skill is so that we can better understand what it requires. The technical explanation of skill by Welford (1958:18) provides a good starting place:

". . . all skills, industrial and psychological, motor and mental, appear to possess three characteristics which provide us with a convenient framework for discussion:

"A. They consist essentially of the building of an organized and coordinated activity in relation to an object or a situation and thus involve the whole chain of sensory, central and motor mechanisms which underlie performance.

"B. They are learnt in that the understanding of the object or situation and the form of the action are built up gradually in the course of repeated experience.

"C. They are serial in the sense that within the overall pattern of the skill many different processes or actions are ordered and co-ordinated in a temporal sequence."

The relationship between the characteristics of skill and the selecting and processing of information as we pay attention and use plans should be apparent. To carry on a skilled performance, we pay attention—we select information that is appropriate to our goal; we draw on a stored plan of action, adjusting it in the light of new evidence; we anticipate the future situation from our past experience and our knowledge of important factors in the situation and adjust and control our plan.

Skilled work, then, comprises complex, coordinated, and accurately timed activities. It is not a single, simple action, but a series of events. Patterns have been set up, each containing a number of units of performance. As activity occurs, the units are so spaced that they are fitted together in a proper order at the optimum time. The worker uses certain cues to signal continuation or change in performance. He is able to ignore nonessential information. He anticipates the need for change, meeting small changes with a minimum of interruption. Unusual information leads to an interruption, for a sequence or series of movements has not been triggered. This type of interruption from within the task is not commonly recognized.

Crossman (1959) suggests that the skilled worker has the ability to know exactly the right method to use in each situation that arises rather than having superior coordination, acuity, or timing. Through practice, those patterns of action have been selected that are quickest. This latter point is similar to the tentative conclusion of Cohen and Strauss (1946): two operators may perform with the same general method, but the more skillful will almost certainly have a much better detailed method, having improved the series of basic operations performed. Annett and Kay (1956) have noted also that the skilled worker has identified cues which will give a maximum of information; in an invariant series of events, the skilled person receives all of his information at the beginning and therefore has more time in which to act.

Many situations for household tasks are variant rather than invariant, or open rather than closed. The situation changes during the performance of the task as well as from one task performance to another. In open situations, we pay attention over a longer period of time because all information cannot be received at the start. Moreover, sufficient information may not be available in advance of need and a time lag may occur, causing delays or uncertain movements. Examples of open situations include some phases of meal preparation where the quality of the supply varies and cannot be determined at first, such as in paring fresh fruits and vegetables. Other examples include loading a dishwasher, mending rips, hanging laundry, and child care.

A skilled person generally has difficulty in identifying details of his skilled actions, for they have become automatized (Miller et al., 1960). The separate motions, the separate parts of the overall plan have been fused; a hierarchy of behavioral units has been constructed.

Acquisition of Skill

Seymour's (1962) six stages in the acquisition of skills in repetitive industrial tasks has provided the basis for our study of the acquisition of skill. The task used to illustrate these six stages in skill learning is ironing men's shirts. Other household tasks could be analyzed also for skill requirements: clearing the dinner table and loading a dishwasher; organizing and storing groceries; laying out a pattern, cutting it, and constructing it; making and changing beds; bathing an infant; feeding a baby; dressing a child; folding and storing laundry; and pressing garments after drycleaning.

Shirt ironing is repetitive and homemakers use their rate of performance as one criterion of skill, just as Seymour did in his experiments. To illustrate some of our points, Weaver's (1959) method of shirt ironing is included in the Appendix. Once learned, it is a quick and simple way to iron men's shirts. The amount of shirt handling is reduced by using a 20-in. wide board which can be placed over a regular ironing board.

Stage 1: Learning the Sequence of Activities

Identify what is involved without details of how it is done.

In ironing a shirt, four sequences, each fairly gross, can be identified readily; each sequence also entails another sequence, also fairly gross:

> Get clean shirt ready to iron (dampen and arrange–interwoven; allow time lapse for spread of moisture).
>
> Get workplace and equipment ready (set up ironing board; heat iron to proper temperature).
>
> Iron shirt (arrange shirt on board; iron until dry; repeat; final touch up).
>
> Care after ironing (fold or hang; store).

Within each of these parts, a particular, more specific sequence is followed. For dampening, a container for water is procured, filled, and placed for use; the shirt is selected, then spread and arranged on a surface for dampening. In the actual dampening of the shirt, a sequence is followed so that all parts receive the desired amount of water and are arranged properly. Knowledge of the sequence used in ironing the shirt may help us to remember how to arrange the shirt during dampening because we know the reason for the arrangement. Skill is developed in the handling of the shirt.

Stage 2: Determining the Sensory Channel for Each Item of the Activity

Seymour explains that at first a person needs to recognize the locus for obtaining information; then, receptivity in the channel has to attain the correct "set"; one must achieve the appropriate perception of meaning from the stimulus. As higher levels of skill are attained, the sensory channel may be changed to provide information more immediately or to free an otherwise overloaded channel for reception of other information.

In our application of this stage and the successive stages that he gives to the task of shirt ironing, only two aspects will be discussed—arrangement of parts of the shirt and amount of moisture. Of course, these are not the only aspects requiring skill.

Arrangement of shirt during dampening: vision is quite important at first; reference to directions may be necessary; a motor pattern must be established; as it becomes established and a part of the memory, the visual channel becomes less important.

Arrangement of shirt during ironing: visual channel relied upon heavily at first; reference to directions for sequence necessary at first; seeing that the shirt is positioned correctly is essential; motor pattern must be established.

Amount of moisture during dampening: visual channel used; motor pattern developed to control amount of water and its distribution; actual check may be necessary.

Amount of moisture during ironing: visual; tactual.

Stage 3: Attaining the Right "Set" in the Sensory Channel

Here, "set" was defined as the appropriate state of adaptation.

Arrangement of shirt: motor pattern established and coordinated with vision; sense of organization of parts of shirt developed.

Amount of moisture during dampening: motor pattern established and sense of control of pattern of motions and amount of water distributed; some visual and tactual judging of amount distributed.

Amount of moisture during ironing: appearance of fabric when dry and absence of steam for short period of time; feeling a seam after it has cooled as a check.

Stage 4: Using Information More Efficiently

Seymour (p. 19) states: "With practice, the information . . . tends to be obtained with increasing efficiency, attention being directed more exclusively to the essential cues while others are ignored, and reception of information being timed better in relation to action so that the latter is not delayed by the former." It is at this stage that the sensory channel for deriving particular information may be changed or rearrangement of use of channels may take place. Kinaesthetic feedback becomes more important, visual inspection less important.

Arrangement of shirt: amount of visual checking less necessary as motor pattern is established. The size of the shirt (man's or boy's) and style of shirt (long or short sleeves) are essential visual cues that might alter the amplitude of motions but probably not the sequence.

Amount of moisture: essential visual cues here include the fiber, the weave, and any special treatments which affect the amount of dampening needed and time required to remove the moisture from the shirt while ironing; the weight of the fabric may be another essential cue. A sense of the time necessary to remove the wrinkles and moisture can begin to replace the need for visual and tactual inspection.

Stage 5: Structuring Sensory-Motor Patterns

Seymour (pp. 19–20) explains:

"Once the appropriate channels, and the 'set' in these channels, have been determined . . . the operator in acquiring skills begins to establish a new and more permanent sensory-motor pattern. The two aspects of such a pattern are inter-dependent; the change in sensory channelling may often necessitate a change in movement pattern; again, a change in body member used to execute a movement (*i.e.*, use of second finger, instead of first, and thumb to grasp) will involve a change in the locus of the sensory cue.

. . . .

"This pattern [of related sensory-activities and motor actions] is developed into a 'structure', but not without some temporal adjustment. Such adjustment consists primarily in providing information slightly in advance of its use. . . . The structure patterning is thus arranged to provide the most satisfactorily temporal relationship between the intake of information and its use. The visual information required for grasping an object prior to picking it up is often most conveniently obtained before the hand reaches it, and it is not uncommon for the glance of a skilled performer to have left the object before the hand grasps it."

Arrangement of shirt: decrease in precision of motions and development of speed in executing the pattern. A flip of the sleeve with the right amount of force and direction may swing it into position instead of through a more careful placement. Manipulation more effective. Ambidextrous motions used.

Amount of moisture: long, smooth, slower strokes with the iron replace short, repeated motions for more effective work in removing moisture.

Stage 6: Diminishing Conscious Attention

Seymour (pp. 20–21) states:

"Once the pattern of skilled performance has been determined both spatially (in terms of consistent repetition of body member movement, muscle group innervation and location of proprioceptive cues) and temporarily [*sic*—i.e., temporally] (in terms of the consistent time relationship of events, *i.e.*, rhythm) its variability is decreased, and repetition is increasingly precise and constant. Where small changes in the task itself occur, they are anticipated and the appropriate additional response selected and employed with a minimum of interruption.

". . . A final integration of performance occurs when the operator 'triggers off' a whole series of responses to single signal (as when the driver depresses clutch, engages gear and operates accelerator as a series of activities 'triggered off' on receiving the signal that the traffic lights have turned to green).

. . . .

". . . it would appear that the performer continues to 'trigger off' a series of movements, the completion of each of which constitutes the cue for the next. While this goes on, incoming information is ignored, unless it is unexpected, as when the knitter stops and looks at the knitting because of a knot in the wool.

"There is thus developed a 'control by exception' whereby the pattern of movement recurs if information matches expectation, but when the exceptional occurs conscious attention—and usually vision—are switched back to the task."

In either the arrangement of the shirt or control of amount of moisture, unusual information that might interrupt the timing includes the need for mending a tear or replacing a button before putting the shirt away, taking care of a spot or stain, or accidentally ironing in a crease.

In skilled performance of the very specific task of shirt ironing, the importance of timing, anticipation, sequence, and adaptability have been noted. These aspects are achieved through the building of units of performance, integrating them into sequences of actions, developing a time schedule, and identifying certain cues to trigger a pattern of motion or to alter the one in progress.

At this point, we might logically ask if these same factors are important in an activity that comprises more than one task, for the homemaker needs the skill to simultaneously control a number of tasks as well as the skills for specific tasks.

Skill in Controlling Processes

Important in the control of plans is regulating, which includes checking, facilitating, and adjusting (Maloch and Deacon, 1966). Skill in these actions can determine the successful outcome of planned activity.

One factor that must be controlled is the process used in a household task. Some of the processes in household tasks are controlled by machines, some by the homemaker, some by devices such as automatic timers on washers and thermostats on ovens. Thermometers and minute minders are devices which provide objective information to facilitate judgments about subsequent control measures. Other devices mechanically control or terminate a process, relieving the homemaker of some mental work (thermostats; timers on laundry equipment).

Some of the machines that control processes include vacuum cleaners, floor scrubbers, and polishers—each of which must be moved slowly enough for the machine to do its work. In these cases, the homemaker attends the machine with some pacing of her rate of work.

In many other instances, however, the processes used in tasks seem to require the homemaker's control. Frequently, her action is intermittent rather than continuous because time is needed for the process to take place (Steidl, 1963a). Partly because intermittent control action is needed, homemakers do tasks concurrently; other reasons relate to the number of tasks that must be done and the variety of processes involved in some tasks. Food preparation is one task that may have several processes done concurrently (broiling, boiling, chilling). Skilled control of the processes in these tasks is an important contribution of the homemaker.

Some of the work of the process operator in industry, and especially in automated plants, seems analogous to that of the homemaker. A process operator regulates and controls the series of processes involved in the treatment and alteration of supplies or materials for a desired result. In the oil refinery studied by Spencer (1962), the process operator controlled a two-treatment process to remove impurities in the crude oil. Each treatment was completed in two stages. In the home, several processes are often included in a grossly defined task: the boiling, broiling, and chilling in food preparation; and the cleaning, drying, waxing, and polishing in floor cleaning. Certainly not all the work of either food preparation or floor cleaning is exclusively processing, but enough of it is to merit consideration of the skills of process operators in industry for a better understanding of the skills in controlling concurrent tasks in the home.

Crossman (1960) identifies the control skills that the process operator must exercise as: regulation or stabilization; optimization; changeover; avoiding breakdown, or if one occurs, regain normal running as soon as possible. More specifically, he says that control skill comprises: 1. sensing—detecting signs and indications (noises, smells, appearance) which indicate how the plant is running; 2. perceiving—ability to interpret these signs and instrument readings in relation to one another, and to infer what is happening; 3. prediction—of what is likely to happen in a given situation if controls are left alone; 4. familiarity with controls—knowing what means can be used to influence the process, what their effects are, and how they interact with others; and 5. decision—ability to select control action most likely to achieve the desired result in the given circumstances or to avert unfavorable developments when they threaten. He notes that this last item is the central feature of the skill. He goes on to say that skill at remote control seems to comprise selective vigilance, translation of data, decision, and short-term memory.

Spencer's (1962) conclusions, after a field study of control behavior in an oil refinery, complement those of Crossman: two factors are largely responsible for skill in process control work—the scope and precision with which operating procedures are defined in operating manuals and the complexity of the plant controlled; the latter includes both the number of variables together with their interactions and the number of process stages under the operator's control.

Kitchin and Graham (1961) attempted to devise a method to analyze and assess the mental load of process operators. As they examined the types and complexity of mental activity and the frequency, they realized that one type had not been recognized: background mental load—the "load continuously imposed on an operator by virtue of his having to bear in mind the state and significance of a number of concurrent variables relevant to the process being controlled" (p. 10). They propose that a count of the number of concurrent sources of information in the process might give a rough approximation of background mental load. Although they suspect that the decision-taking load is probably the more important both in effect on the operator and as a satisfactory expression of total mental load, further study is necessary.

To relate these studies to the homemaker's work: both within a task and among tasks, a homemaker often controls a number of processes; she uses short-term memory, for she must carry in her mind what tasks are being done and the need to attend to them again; she is alert to certain signals which may substantiate her estimate of when attention is needed or which may indicate that attention is needed earlier or immediately; she has a background mental load from carrying essential information about the stage of each process—so necessary for complex judgments; and decisions are made throughout. All of these contribute to the complexity of controlling housework. Research is urgently needed to increase our understanding of control of processes.

We can conclude that many of the factors important in skilled performance of one task in the home are also important in skilled control of concurrent tasks.

CHAPTER 4

The Temporal Component

The time contributed by the homemaker in doing the work of the home is part of her nonphysical input. So is her time for employment work. The time contribution includes not only the total amount of time for action but the timing of the events. Too often the total amount of time and the allocation among homemaking tasks is considered the total contribution. This is too narrow a view, however, since the spacing of the units of time for work requires attention and planning, and judgment and thinking are needed to estimate the duration of the various events. Another cost of the spacing of the units of time for household work is the limitation imposed upon the free time of the homemaker.

We live in time. Time provides an organizing medium for our lives—a common denominator within which we operate. Time does not change with the events that take place within it. Time represents a succession of events and, therefore, change. Appreciation of some of the consequences of living in time provides a frame of reference. How do we react to time? What must we do to cope with the situation of living in time? How can we have control over our use of time so that we realize our choices? An objective of studying the temporal component of the cost of work is to identify those underlying operations that will permit us to gain the most satisfaction from use of time.

CONTROL OF TIME

To control is "to exercise restraining or directing influence over. . . . Control implies a regulating or restraining in order to keep within bounds or on a course" (Webster). How can we keep our use of time within bounds—bounds determined by the mediated preferences of the user?

Time represents changes. We must adapt to change and take change into account as we plan for the present and the future. Fraisse (1963:

10) points out that as we adapt to temporal conditions we have temporally organized behavior: "Basically these temporal conditions all stem from the fact that we live in physical, technical, and social backgrounds which are changing all the time. We do not only undergo these changes, we create them, for our own activity is itself nothing but a succession of changes." What then can we do to control the succession of events and achieve the way that we want to live in time?

Control of time requires a recognition of the interrelatedness of the past, present, and the future. The past, present, and future are represented in the succession of events. The present is always changing to become part of the past, and the future is always changing to become part of the present. The passage of time shows the constant change that is taking place. Fraissé indicates that true control of time demands that a man have a vision which covers all the experience he has acquired in the past and all of the plans he can foresee in the future. Kümmel (1966:50) discusses our existence within an open relation between the past and the future:

"No act of man is possible with reference solely to the past or solely to the future, but is always dependent on their interaction. Thus, for example, the future may be considered as the horizon against which plans are made, the past provides the means for their realization, while the present mediates and actualizes both. Generally, the future represents the possibility, and the past the basis, of a free life in the present."

One of the costs of the temporal component is the integration that we must make of the past and present and the anticipation of the future. We must call on the future to meet the demands of the present. To be in command of change we must organize the present in relation to both the past and the future. The past is in our memory and the way it is organized is related to our particular interests and goals. We order events that have occurred so that we can place them in perspective. The success of the order that we have used in the past may be called upon in planning for the present and the future.

In our lives we must have some stability as well as some variation. The proportion may well vary from time to time and from person to person. Our orientation is to the future when we have goals or projects on which we plan to work. If we are too much involved in meeting the demands of the present, we do not have sufficient thinking time to look ahead to the future. The optimal balance in the use of events from the past will vary. The objective is to organize our lives so that we can procure situations which will produce the most satisfaction for each of us

Organizing Techniques

One technique for control of time is to work out a structure or framework around which other events are organized (Fraser, 1966). By building a certain rhythm into our lives we can have an element of predictability (Moore, 1963). Ordering our lives contributes an element of security and serves certain purposes in the mental health of individuals (Moore, 1957). In Tasker's (1962) study of organization of homemakers' work, one homemaker said that she never knew what was coming next and could not plan; she was at the beck and call of her husband and young children. By identifying certain stabilities in our lives, we have a base around which we can anticipate the possibility of nonroutine events taking place.

Routines provide stabilities in our life. The merit of routine in this case goes beyond the decreased need to plan. As we noted in the cognitive component, routine or standing plans mean that we do not have to do as much thinking. When we have certain routines worked into a structure or framework, we reduce some of the element of change in our life. This is not to say that nonroutine events do not have merit. The variation from the usual rhythm of our life can be a welcome change. We all know from personal experience that the change in tempo during a weekend provides a welcome relief from the routines and expected events during the workdays that precede the weekend.

Our lives have certain rhythms or cycles; these are related to the time span which we consider. Rhythms help us to perceive change and permanence and let us respond to the varying and enduring content of our lives. We have more than a cyclic repetition in our lives, but we should identify any cycles so that we can anticipate the future and reuse any suitable plans. One rhythm in our life is that of eating; we usually have some food in the morning, at noon, and in the evening. The repetition of this pattern on a daily basis provides a stable element around which we can fix other events. On a longer time span, the periodic change in the school year represents another rhythm. The months when the children are in school and out of school form part of the change; holidays represent another aspect. In the temperate zone the change of seasons generally brings different activities and some variation in the rhythm of our lives.

Awareness of the consequences of our choices helps us control the rhythm of our lives. Choices influence future uses of time and future constraints on the use of time. The number of commitments that we make may introduce too many competing claims on time. Some homemakers have indicated that time was a difficult problem because of change in family life cycle (Hunter, 1961). The interests of older children increased participation in outside activities. The homemakers expressed great concern for the trend toward increased outlays of both money and time for outside activities and transportation. They pointed out that too often families drifted into a pattern which increased consumption of time and money gradually and without adequate thought for the future. This suggests that we need to give serious consideration to the consequences of commitments before we make them and to determine what number and which ones are reasonable to make. The optimal number of commitments may be related to the kind; exactly how should be considered. The object is to identify which actions will make the present livable and will form the structure for a future that will also be acceptable. The chain of consequences created by certain decisions is often overlooked.

Just as we need to identify the stabilities in our life—the recurring events—so do we need to identify the changes in our life. One way of looking at this question is to consider the sources of change. What technological changes occur that have repercussions on the work in homes? What changes in supplies and equipment have an impact on the present and the future use of time and in what ways? In the supplies that are available for meals, for instance, the amount of prepreparation done before the food reaches the market makes a difference in both the amount of time that the homemaker allocates to preparing meals and the timing of the work.

Another source of change is our culture. What changes in society relate to the structure of events in the lives of the family and especially of the homemaker? Have the hours for work or the type of organizations and meetings been changed? In what ways do these changes affect the management of the home?

The homemaker and her family are another source of change. Interests fluctuate from one period to another and may even change radically; variations in interests affect activities. This is especially noticeable as children grow up.

The impact of change on our life style may be gradual in some instances and sudden in others. Identification of sources of change should be helpful in control of time since several changes may come from a given source and cause a complex of changes rather than a single change; together, the changes may make an important difference in the structure of time.

If we are to control time, we must also have a certain awareness of time. This is one of the consequences of living in society in the United

States. We live according to the clock. Events in our lives are coordinated according to a common measuring system—60 seconds equal 1 minute, 60 minutes equal 1 hour. Within our own country and in other countries, cultural and regional differences exist in the importance attached to time and the manner in which the basic time system works. Hall (1959) identifies three systems—formal, informal, and technical. As the importance of punctuality increases within the formal system, the importance of being aware of time also increases. The subtle operation of the informal system also requires some awareness of time and the timing of our actions.

Having to be aware of time constitutes a personal cost of work to the homemaker. Time awareness can be classified as a cost because we do not perceive time unless we put our attention on it. We lose track of time when we are absorbed in an activity. Our interest and our motivation are matched, and we are not concerned with the gap between where we are now and where we would like to be. When a homemaker must be aware of time, she cannot become absorbed in her activity; she loses the freedom to pursue it without restraint.

A homemaker must be aware of time so that events within the home can be coordinated with those outside. Control of events within the home also requires attention to time. A homemaker must constantly pace herself and regulate activities so that they occur at a particular time or are completed by a given time. The nature of much household work is such that processes require intermittent attention. In addition, the homemaker must coordinate the parts of various tasks.

TIMING

Timing refers to the "selection for maximum effect of the precise moment for beginning or doing something" (Webster) and, we would add, for completing or finishing it. Timing concerns when events take place—calendar when and sequence when; these are the grosser aspects of timing. On a more specific level, timing concerns the spacing of time uses or time inputs within a given task and among tasks.

The timing of events comprises a cost to the homemaker because she must key events to various inflexible aspects of her situation. She must plan the order of events within a given framework, taking into account family preferences, her own preferences, the relative urgency for completion of various tasks, the nature of the work to be done, and other demands on her time and on the family's. A further cost stems from the timing of the parts of the task, for the homemaker must pay attention to what is going on so that she can space the action to advantage. Timing is an essential part of controlling the plan in action.

Constraints on Timing

How much freedom does the homemaker have in determining the timing of household tasks? A homemaker has a certain amount of freedom but a number of constraints are operative: inflexible events, the nature of household work, and the homemaker's preferences.

Inflexible Events

The inflexible events in the life of a family limit the homemaker's freedom to time household work. The degree of inflexibility of events, however, should be considered as relative rather than absolute. The reader is urged to imagine a continuum from inflexible to flexible on which various events might be placed. It is assumed that comparatively few events would be at the extremes of the continuum but some would be close to the extremes. For our purposes, it is simpler to use the dichotomous terms than qualified ones.

The inflexible events in the framework of our lives have already been identified as a contributor to a certain amount of stability in our lives. The inflexible units also work as a disadvantage in that they are events around which we must organize other events. In addition, the inflexible units in our lives create time boundaries for other events; the duration of the time period for more flexible events is determined by the space between successive inflexible events.

One set of inflexible units belongs in the biological–physiological category. We need food and sleep periodically. Although our physiological rhythms vary somewhat, there are more similarities than differences among us. We can go without food and without sleep over the long haul for only limited periods of time. The time between these food and sleep requirements provides a time span for other events.

Our interaction with other social groups also provides a number of inflexible units around which we must organize other events. The work hours of the breadwinner and of the employed homemaker provide a major set of inflexible units. The time for being at work is inflexible for most employees as is the total period of time at work. The fixed start and end of the time periods for paid employment have important repercussions on the timing of other events.

The hours when children are in school—the start and the end of the school day—contribute another set of inflexible time periods. For those families whose children must be ready for the school bus, the start of the school day is actually signaled by that moment when the children must leave for the pickup place. When children live close to school and come home for lunch, another set of inflexible time units is added to those which influence the homemaker's timing of other events.

In addition to these major inflexible time periods against which we plan, there are a number of other events which must be fitted into the availability of business and professional services. If we want to shop, we must determine the hours during which the store will be open. The same is true of other services, such as the gasoline station or the garage. Appointments with physicians and dentists for their professional services are ideally scheduled during their regular office hours. However, they often must deal with problems that do not operate on a temporal basis. This is also true of some of the problems which confront the homemaker. The child who becomes ill at night is presenting a problem that is not on a temporal schedule. It is an unscheduled event, a change that must be coped with when it happens.

This brief examination of inflexible events suggests the scope of the situation. The number of things around which a homemaker must plan and how she does this could be the object of formal study. The deadlines for the start of certain events, such as work or school, contribute to constraints on timing. These and other fixed events create some of the structure for a family's pattern of living. A family further develops its own rhythm within the spacing of fixed social and internal events because an element of choice for timing exists with some activities.

Freedom of timing operates in varying degrees in connection with household work. Household tasks are such that they can be placed in various locations on the continuum between inflexible and flexible timing. Such variation is helpful for it provides a cushion for taking care of the unexpected. However, if certain tasks are not completed by a particular time, the immediate need passes or is met in an improvised way.

Tasks that meet the physiological needs of the family members are comparatively inflexible in regard to when they can be done. Timing of related tasks may be more flexible. Grocery shopping and dishwashing are essential to the preparation and serving of meals, but their timing does not have to match the clock regularity of hunger. Other factors can function more freely. The timing of the service activity of providing clean dishes for a meal may be influenced also by the available space in the kitchen and the available supply of eating and cooking utensils.

Tasks related to other inflexible events, such as leaving for work or school, may have a large element of inflexibility in when they can be done. The washing and drying of clothes must precede any touch up pressing. These tasks must be carried on to at least a minimum point of completion so that family members will be appropriately clothed for their day's activity.

The timing for care of the house tends to be more flexible than for other tasks, such as food preparation and child care. There are limits, however, for most families in the extent to which cleaning can be postponed. There are also limits with respect to when it can be done in those households where the noise interferes with the children's nap or the rest and relaxation of other family members. Nonpostponability in performance of tasks is evident in varying degrees among tasks.

Nature of Household Work

(The nature of household work imposes a second set of constraints on the freedom of the homemaker to time the household activities. Of particular importance are the total time period or time span needed for completion of a given task and the characteristics of the total time period.)

The total time period needed for completion of a household task is variable. It may cover only a 5-minute span, a 30-minute period, 45 minutes, 2 hours, or all day. Variation is associated with a number of factors. The task definition is one. Preparation of a simple dinner requires a shorter period of time than a complex dinner, and the quality of product desired may also affect the total time needed.

The time span may vary with the size of the task. The greater the number of loads of clothes to wash or to hang out, the longer the total time period required.

Supplies used can affect the time span needed. For instance, if the cleaner, wax, and polish used in the care of floors are in one solution, the time span required is shorter than if each process must be done separately. In food preparation, the packaged cake mixes eliminate much of the active preparation time.

Other factors, more difficult to predict, also influence the total time needed. The weather may be favorable or unfavorable for drying clothes, mopped and waxed floors, or painted surfaces. Unexpected interruptions may prolong a task. The weather may change suddenly, the children need attention, or a friend may come to visit. The standards for quality and quantity of work may be raised or lowered.

One consequence of the variation in the total time period needed between the start and completion of tasks is that the homemaker must match the time span needed with the time spans available. Knowledge of the total time period required for completion of tasks and factors causing differences enables the homemaker to plan sufficient time between initiating action on a given task and the desirable time for its completion. The latter may take into account her preferences or family needs for food, clothing, freedom from noise of equipment being used, and the like.

The characteristics of the total time period impose further restraints on the homemaker's timing of action. Three aspects of continuity are important. The first of these is the number of subunits of time that are needed for a given task. Some tasks are made up of processes that require intermittent work, i.e., discontinuous action on the part of the worker. Other tasks require continuous action from the homemaker. Vacuuming demands the worker's continuous presence, for the action does not go on without the worker. In another task, meal preparation, many foods that must be cooked require that the worker provide intermittent action. Broiled chicken requires time for cooking and the homemaker does not have to remain at the range during all of this period. The elapsed time while processes are going on without the homemaker's presence is termed an inactive work period.

The second characteristic of the time span for tasks that constrains the homemaker is the duration of the subunits of time for both active and inactive work periods. This characteristic is closely associated with the number of subunits of time needed, but it can be isolated as a separate factor. The duration of the subunits of time has direct implications for the amount of dovetailing of various tasks that might be possible or necessary. If the duration of subunits of time for action are comparatively small but the elapsed time while the process goes on is comparatively large, a homemaker could plan a concurrent activity that might have the opposite characteristics. The duration of the subunits of time for a given task may also relate to the ease or difficulty of coordinating the various parts of a given task.

The third factor important as a characteristic of the total time period for a task is the degree of flexibility in timing the subparts. How narrow is the margin within which work must be resumed? Will the quality of the product be affected if the worker does not resume action fairly close to the end of the nonwork period? Will resources other than the product quality be lost also? How far reaching are the consequences of not resuming work? How flexible is the order in which the subunits of action must be carried on? Can the order be varied? Must parts of a task be synchronized? Does the task involve a sequencing of processes in such a manner that one process builds on another?

When the processes must follow in succession, the flexibility for carrying on a task is decreased. In meal preparation, the sequence of subunits of action build on each other. The batter for a cake must be prepared before it can be placed in the oven. The cake must be baked before it can be removed from the oven and frosted. Generally, a time lapse must occur so that the cake is cooled before it is frosted.

Examples can be found in other tasks. In caring for floors, the sensible order is to remove loose dirt before the application of floor cleaner, or floor cleaner and polish if the solution is an all-in-one process. If wax is applied, it must dry before it can be polished. In another task, ironing, the order of pressing the various items may be variable and also, within limits, the order of doing the various parts of an item. As we saw in the cognitive component, skill in ironing a shirt came partly from following a sequence of actions.

The characteristics of the time spans for tasks impose a number of constraints on the homemaker as she attempts to coordinate various parts of a given task or the work on two or more tasks.

Homemaker's Preferences

The homemaker's preferences for the type and amount of personal costs in timing the household work comprise a third major set of constraints on timing. If the homemaker wants to keep work to a minimum, the costs associated with the timing of the work are a consideration. Recognition of the interrelatedness of the temporal component and the other components of worker input can help in their control.

The affective component comes into the foreground in relation to the optimal duration for the subunits of time and for the total time period. What duration is desirable for greatest satisfaction to the homemaker? What is the preferred amount of continuity of action? What duration will provide a suitable amount of traction to facilitate her task performance?

The cognitive component is important with respect to the shifting of attention and the need for using short-term memory. Can the time units be planned in such a way that the homemaker does not have to shift her attention frequently? Can the nonwork time be spaced so that the requirement for short-term memory is not excessive? Are certain parts repeated, and if so, can the time period be planned so that a rhythm can be set up and maintained sufficiently long to benefit from the repetitive parts of the action?

The physical component is important if the total amount and type of physical activity at a particular period are a consideration. If the homemaker wishes to limit the total amount of physical activity, the optimal duration for the time span may have to be adjusted for certain tasks. This would be particularly true if the homemaker wished to limit the type of activity that she did on a particular day. This would be a consideration, actually, in the choice of tasks to do since some tasks have in common the same type of physical movement or positions.

The problem of getting the workplace ready for doing a task is related to the total amount and type of physical activity. How much getting ready is involved before a task can be started, and subsequently, how much putting away is necessary after the task has been completed? Tasks that require an extensive preparation period in terms of getting out the supplies and equipment and getting them into place represent a situation in which the initial input of the worker may not be used to advantage if the task is not carried to completion. A homemaker may choose to schedule a task at a time when she will be able to complete the task without having to stop, put away, and get out again at another time. Tasks that have a nonpermanent setup for carrying on the task are the ones that may be the most important in this consideration. The tasks of ironing and sewing are examples in some homes where the space used for ironing board and sewing machine serves for other activities as well.

Mechanisms of Timing

Knowledge of differences in activities enter into planning the use of time and carrying out the plans. A number of factors make a difference in the timing of events, but what are the mechanisms of timing?

Moore (1963) identifies three dimensions of social coordination or timing: synchronize, sequence, and rate of activity. When we synchronize events, we must link them to other events and in all probability to other persons' time and their events. Synchronizing means having things happen at essentially the same time. Coordinating also means to bring into a common action or movement. Although less precision is suggested with coordinate than synchronize, the terms can be used interchangeably in many instances.

The second mechanism of timing (sequence) concerns the order in which events occur. The order may be on a fairly gross basis so that it is considered among tasks, or it may be on a more refined basis in which the sequence is within a task—the sequence of processes or activities. In actual practice the two areas of sequencing—among and within tasks —are closely related. The correct order of events within a task will have important effects on the possibility of carrying out the planned sequence among tasks.

A practical implication of sequencing is that a priority has been assigned. Those events that are placed early in the sequence might have more chance of being realized; however, the total time span needed for completion would be related.

We often refer to homemakers' dovetailing of household activities. "To dovetail is to fit skillfully to form a whole . . . to fit together into a whole" (Webster). A consequence of the discontinuity of many household tasks is that we must work on more than one task during a time span. A task sequence may be worked out in fairly broad terms but in practice, action recurs for some tasks; the tasks share the same time span or are dovetailed. Dovetailing is a concomitant of sequencing household tasks.

The rate of activity the third dimension of timing, refers to the frequency of events during a period of time or their repetition and the speed with which action is completed. Action that is too fast or too slow will upset the other elements of temporal ordering—synchronization and sequence (Moore).

Studies of homemakers' organization of work provide a description of how homemakers timed events (Ketchum, 1961; Nelson, 1963; Steidl, 1963a, b; Stouffer, 1964; Tasker, 1962; Walker, 1964). The overall structure of the time use was revealed by the broad categories of activities performed and by the number of blocks of activities reported, i.e., the amount of change. The researchers' division of the day into "time spans" (Nelson) or "parts of total day" (Steidl) centered around somewhat inflexible events—meals. Sequencing was described by the spacing of activities in various parts of the day and more specifically by the activities occurring before and after a given activity—a sequence of three. Further identification of timing was obtained through a check on the repetition of activities. Most data gave limited help on this matter since it was not known whether it was exactly the same task that was being repeated or another task within a particular category. A major gap in the data appeared with respect to synchronization; much was implied in the results but not clearly identified per se.

Further insight into the sequencing of tasks was obtained through study of the style of doing activities. Those activities reported separately during a time block (rather than combined with one or more activities) suggest less dovetailing of work. The overlapping activities suggest sharing of time or dovetailing just as the combined activities. The clustering of activities (Tasker, Stouffer) indicates consecutive performance of separate tasks or sequencing; by definition, clustered activities were related by type or place orientation.

A reexamination of some of Kelsey's (1965) data suggests that a majority of the 12 organizational changes rated by the homemakers concerned the timing of household tasks and especially sequencing and rate. The homemakers rated how often it was necessary to make each suggested change during the preceding 5 months. Four changes seem to concern sequencing of activities: time of day when I work, time of week when I work, order of steps required to do a task, and the order of doing tasks. The first two concern broader plans and almost one-half of the 50 homemakers expressed no need to change these plans during the preceding 5 months. The timing within tasks might be exemplified by "the order of steps required to do a task"; a majority of these experienced homemakers did not find it necessary to change the routine they had worked out. In contrast, "the order of doing tasks" was rated by over one-half of the homemakers as needing change sometimes or often; this indicates one aspect of the homemaker's work in timing events, and we might wonder if coordinating household tasks and other events were involved, especially since this organizational change was spread among tasks.

The rate of activity is evidenced in four of Kelsey's changes: one relates to the speed of performing the activity—use of shortcut methods; three relate to repetition—elimination of work, frequency of doing any tasks, and postponement of work. Three of these changes were particularly important in degree of need for change: shortcut methods, frequency, and postponement.

Such data as Kelsey's are helpful in gaining an understanding of the aspects homemakers take into consideration in timing household tasks. They also suggest the need for a closer examination of the problems involved in coordinating, sequencing, and determining and controlling the rate of activities.

Estimating Time

To time events as we want them to occur, we must be able to estimate the time that will be required for activities and the time that has passed as we perform activities. The estimation of time that will be needed is essential to developing a realistic plan for coordinating events and sequencing them. The estimation of the passage of time as we carry on activities is essential to controlling plans.

To structure the future, i.e., to develop a broad plan for coordinating events, we call on our knowledge of the duration of events as they occurred in the past. We use our quantitative estimates of time. Such information must be tempered with identification of new factors in the situation and their probable effects on time. Potential delays stemming from interruptions, such as equipment breakdowns, inclement weather, depletion of supplies, or family activities, must also be considered.

Our quantitative estimates of time are in terms of our conventional units, minutes and hours. Fraisse (1963) indicates that this method of evaluation becomes possible only after long training and never becomes perfect because minutes and hours have no tangible reality. This is one reason that our estimates of duration are often inaccurate. Since we live in the United States, in a culture paced by the clock, we almost always try to use a clock or watch to help us measure time. If we have no watch, we try to replace it with a natural clock, such as the shadows or change in light, or possibly our internal clocks, such as hunger or the need for rest. Radio and television programs and changes in noise from traffic are sometimes helpful as time-of-day guides.

The quantity of work accomplished also serves as a criterion of duration, but this has its limitations for several reasons. We can vary the rate of work, accomplishing a larger or smaller quantity in a given period of time. The conditions for doing a task may also vary, some of which might be foreseen, some not. The quality of supplies, such as fresh produce, might be poor and require more time because extra paring is needed. An unexpected problem with the automobile quickly extends the time for a given quantity of work—doing the weekly grocery shopping. A homemaker probably estimates time needed for tasks with reference to the usual amount of time used for a given amount of work, making allowances for changes in quantity and unusual conditions that she can foresee.

A homemaker also develops her ability to estimate duration of units of activity and of larger groupings of these units of activity through her frequent references to the clock. With experience she builds her knowledge of how long tasks with certain characteristics will take as well as how long the subparts will require. With this knowledge she decides what tasks can be dovetailed and how to coordinate events.

The estimation of time as household work progresses may be especially critical and at times difficult. When tasks share the same time period, the homemaker must be able to perceive the present situation for each task. The duration of events and intervals separating them must be determined to control the plan in action. Quantitative measurement is used, but direct judgments of duration must also be made. Duration is the measure of succession—of changes. To structure the present, a homemaker must be able to identify change.

Continuous and Discontinuous Change

Fraisse (1963:69–70) points out that there are two types of change—continuous and discontinuous.

"Continuous changes result in the perception of a *transformation* in quality or intensity: the darkening of the sky or the spreading glow of the sunset, the growing noise as a car approaches. A change in place is perceived as *movement*. This kind of change is always characterized by its speed, and speed is a perceived fact sooner than a concept which can be defined by measurement (quantity of change per unit of time).

. . . .

"The perception of continuous transformation gives us rather indistinct temporal information because we can only perceive clearly that which is static. It permits us, however, to anticipate the *successive* states or positions of whatever is changing. The amateur photographer who develops his own film can see the negative change more or less quickly, and from this speed he can tell the right moment to take it out of the developer. The perception of speed also permits us to anticipate the moment when a moving object will pass a fixed point; thus the pedestrian knows when it is safe to cross the road and the hunter where to aim his gun to hit a hare or a partridge.

"Through these transformations we can experience what is durable; they suggest this to us by the constant renewal of their evanescence. But we cannot perceive in this any quantitative duration. The latter is always an interval between two phenomena or two distinct states of one and the same phenomenon."

We can identify continuous changes in some household processes. During meal preparation the heat transforms the meat, and the change in color can be observed from the red of the ground beef to the brown as it is cooked; potatoes become less translucent; the change in color of green vegetables becomes evident. The change in the appearance of the floor as it is scrubbed and the clean surface that appears as dirt is removed and as the surface dries provide other examples of ongoing change. The significance for the worker is that he can see the change taking place and anticipate the next state of that which is changing, but he cannot estimate the duration from his observation of these changes. This estimation must come through other methods of judgment.

The other type of change, discontinuous change, also occurs in homemaking work but probably less often. Fraisse (pp. 70–72) notes:

"The perception of discontinuous change . . . raises some very complex problems. Continuous change can be perceived at any given moment, whereas if I perceived discontinuous change it implies that I perceive not only state A and state B but also the transition from one to the other, or their succession. To speak of succession is to say that when a new phenomenon occurs, the old one is no longer present."

Actually, we perceive succession by organizing the before and after—we link the stimuli in such a way that we have a unit of information. Fraisse indicates that we do it so often that we no longer notice it. However, it is the basis of our perception of rhythm, melody, and speech. Perception of succession in units involves a perception of order and a perception of the temporal interval.

The first operation in the perception of succession in units is the perception of order. The perception of order is possible if the successive stimuli can be organized among themselves. Fraisse points out that the stimuli must be of the same nature—sound or light, for example, but not a mixture of the two. The order of succession is perceived and is not a result of an organization imposed on the stimuli. The order is inherent in the stimuli themselves, and Fraisse notes that in the case of rhythm it is practically impossible to reproduce the individual elements in any other order.

The perception of order in household work can be determined from such events as follows. The sound made by some toasters signals that the toasting period has ended and the toast is ready. The red light on some thermostatically controlled small appliances, such as an electric skillet, signifies that heating is or is not taking place. The timer that stops ticking and rings identifies the end of a given period of time. The rate at which the automatic clothes washer is operating may suggest the type of operation—agitation versus extraction; with some washers the stage of the wash cycle may be identifiable as well.

The second operation in the perception of succession in units is the perception of the temporal interval. We must apprehend at the same time an ordered multiplicity and the intervals separating the individual elements. Organization is necessary. When the organization is not obvious, it is difficult to perceive the duration. It is difficult or impossible to perceive the duration of a sound, for example, unless the end succeeds the beginning quickly enough to demarcate one unit of perception. Experiments suggest that the temporal limit of this perception is about 2 seconds. If a sound continues longer than this, we reach the point where we do not perceive a change.

The reader may recall from our discussion of paying attention that the number of stimuli we can grasp tends to reach its limit with 5 or 6 elements; at this point we begin to combine and code so that we can economize on the amount of "space" for transmitting information. These facts concerning the interval between stimuli and the number of stimuli that we can grasp are coupled in the question of the organization of stimuli; they provide a double limitation on our perception of succession in units.

Although the literature on perception of short time intervals is extensive, further information is not included, for most of the results can probably not be generalized to real life tasks.

The perception of the present, i.e., of change, is particularly important in the life of the homemaker as she attempts to carry on tasks concurrently. She must be able to identify the important stimuli, their duration, and the duration of intervals if she is to identify change and control it. Knowledge of present technology used in doing homemaking work suggests that much of the change that takes place is continuous rather than discontinuous. We have examined in some detail the mechanisms of estimating time in relation to the type of change that is taking place, since estimating time is a personal cost of work.

Results of Affective Judgments

Are there other factors that affect our estimation of time? Fraisse (1963) indicates that our affective judgments are also important in estimating the duration of time since our most basic knowledge of duration arises from feelings of time. We do not become aware of duration until we focus our attention on time. When we become thoroughly absorbed in an activity, we lose track of time. We also have a problem of estimating duration when we become thoroughly familiar with an activity, for it requires less attention and we think about other things. When we are aware of duration, the time may seem too long because we are not satisfied with the activity that we are doing. We may also become aware of time because we do not want an activity to end and we concern ourselves with the fact that, after a given period of time, this satisfying experience will terminate.

Duration becomes a psychological reality when the present action does not bring immediate satisfaction. Duration is experienced whenever the present situation refers us to another situation in the past or in the future. In the latter case we are concerned with expectation. Circumstances may impose a delay between first awareness of a need and its fulfillment. This period of delay becomes an obstacle to overcome, and in order to continue a task that has been undertaken we must make an effort to continue the action. This has been termed the "effort of continuity" (Fraisse, p. 203, cites Pierre Janet). There is an expectation of finishing a job but the time must be overcome, that is, the duration for the action must be carried out. Time always seems long if we fix our attention on it.

The number of changes we identify also influences our appreciation of duration. In some instances, the smaller the number of changes, the shorter the apparent duration. Everything that helps organize the different elements of the activity into one unit of purpose—structure, significance, motivation—tends to reduce the apparent duration (Fraisse). Our attitude toward the activity influences the number of changes that we perceive. We are selective in the information that we bring to bear on a question. The information that we select depends on the nature of the task (objective aspects) as well as our attitude. Actually, these can hardly be separated. They are directly related to the appreciation of the number of changes that take place. When we are dissatisfied with an activity, we become aware of more changes. The more satisfied we are, the fewer changes that we notice. The more numerous the changes between us and a moment in the past or the future, the longer the interval thus formed seems to be.

The importance of this idea of the number of changes perceived and the relation to the duration of the task needs further examination because there are implications for the affective component of the costs of work. Recognition of the contribution of change to satisfaction with work may suggest some changes that are possible in the content of the task or in the attitude of the worker to obtain greater satisfaction. Fraisse points out that satisfaction and unconsciousness of duration are two concomitant effects of participation in an activity which is exactly adequate to the present motivation. Inversely, dissatisfaction and a feeling of duration are both consequences of frustration.

When we pay attention to time, we are paying attention to the various changes that take place. Novelty attracts attention and few details escape us. As the action becomes automatic we can concentrate more on its goal. Our attitude can help reduce the number of changes perceived and the apparent duration. The organizing activity of our mind plays an essential part in this reduction: instead of considering each element of the task in itself we can concentrate on its purpose. This purpose is sometimes imposed by the nature of the task, but it may be independent of the task and depend directly on the attitude of the subject. This attitude, in turn, is a function of the motivations behind it. We work toward a goal if we expect some gratification from it. Therefore, alternately our motivation modifies our subjective evaluation. The stronger motivation leads to better organization of the work or, in other words, to greater unity.

In some instances, we pay a great deal of attention to changes because we have to make an effort to accomplish a task which is difficult. This difficulty may be inherent in the nature of the task itself but also in insufficient motivation. Sometimes we are more interested in tasks which offer a greater amount of resistance—without being too difficult—than in the tasks which are quite easy.

The unity of a task cannot exist independently of the person (Fraisse). Unity reinforces motivation and thus introduces a subjective element. Within limits, the more unity a task has the less time it may seem to take, for changes are no longer in the foreground of our attention. The unity of significance may make the task more interesting and the subjective and objective elements reinforce each other.

Homemaking tasks vary in amount of change and a homemaker's view of the changes within a task may vary also. For occasions when a task is considered excessively high in number of changes, the task can be adjusted to provide larger, more meaningful units of activity. In ironing, organize the items into units, such as all shirts, all dresses, all sheets, all items needed immediately, or all items for each person. The similarity among items *or* the common goal will function as a unifying factor. In cleaning the house, one way of organizing into larger units may be according to the process that needs to be done. For some people a larger unit may be obtained by organizing the work by the room. To illustrate: if we do all the hand dusting or all the vacuuming that needs to be done, we may obtain sizable units of activity. Or if we do all the processes in a given room, this may represent a major goal and thus comprise a large unit of action. The individual would need to determine which method of proceeding would provide the greater significance for unity.

Baldamus (1951a, b, 1961), in his discussions of traction, seems to be suggesting somewhat the same thing when he states that a process can carry us along; it can provide greater unity in action in some cases because of the continuing process. Or, in the case of batch traction, it may provide more emphasis on the goal to be achieved rather than on each element in the task itself. Thus, we can structure our tasks so that the duration seems less when we want it to appear to be less.

The preceding considerations concerning the importance of affective judgments on estimates of time suggest an interesting set of questions since homemakers often report a shorter period of time for disliked tasks than liked tasks (da Fonseca, 1964; Hook, 1963; Maloch, 1962; Walker, 1955). Do disliked tasks actually take less time than liked tasks because homemakers have learned time- or work-saving methods, use more adequate equipment and supplies, or have quality–quantity standards that are comparatively lower than for liked tasks? Or do homemakers have greater unity within disliked tasks and, therefore, perceive time as less? Or is their motivation greater to complete a disliked task than a liked task so that their goal thus becomes dominant and provides unity of purpose? Or is their estimate of time an example of the Law of Central

Tendency * in action—is the time actually long and underestimated? These questions could provide a fascinating point of departure for an investigation of homemakers' reports of their use of time and any relationships to their ways of proceeding and their feelings about time.

TIME ALLOCATIONS

What is the significance of the amount of time used by homemakers for household work? Why does the time allocated to household work constitute a personal cost to the homemaker? Does it differ from a husband's time contribution for paid employment?

Time is a resource (Warren, 1957). Time used one way is not available for use in another way. The homemaker, like many other men and women, finds competition for her time. The extent of competition varies from one period to another during the family life cycle, from one season to another, from day to day. Choices for allocation of this resource are constantly needed.

The sources of competition for a homemaker's time are varied. Often a major contender for time is household work. Studies of the use of time by homemakers indicate that a full-time homemaker averages about 8 hours on a weekday for household work (Cowles and Dietz, 1956; Wiegand, 1953, 1954). (Refer to Chapter 11 for details.) Activities of the family also make demands for time. Entertainment and other events related to the husband's work plus community activities, such as the PTA, Scouts, and League of Women Voters, may seek time. Social activities generally vie for time—time for the bridge club, garden club, and neighborhood coffee session. Activities connected with the personal needs of the homemaker and each member of the family are not to be overlooked as competitors for the homemaker's time.

Time used for work is not available for other activities; some may be preferred rather than work. Work time for both husbands and wives is that time required to make a living or to keep a house. It is a necessary use of time for the survival of the family in an independent, dignified way. The four types of time use suggested by de Grazia (1962) are helpful in understanding the time contribution of the homemaker. Besides work time, de Grazia suggests these categories: work-related time, subsistence time, and free time. Work-related time includes the time for

* Stated simply, our estimates of time for a range of stimuli for a given situation tend toward an average value: we overestimate those that are below the average and underestimate those that are above it (Fraisse, 1963). However, attitude affects our perception of duration and the results may reverse the phenomenon. Further research is needed on this problem.

such activities as the journey to and from work and the grooming one does for work. Subsistence time (common to both husbands and wives) includes time needed to eat and sleep, and for personal care, medical care, and the like. In contrast, free time is that time that is not used for work, work-related activities, or subsistence time. Alternative uses are possible. Some of the free time may actually be for leisure—"a state of being free of everyday necessity . . . activities . . . one would engage in for their own sake" (de Grazia, p. 327).

The total number of hours contributed by the homemaker for the work of the home is logically considered a part of her nonphysical input. Another cost of the time contribution stems from the total time span during which the 8-hour input is made. It is not unusual to find the homemaker's work spread over 12 to 14 hours of the day. Such a long time span for household activities has several consequences. One consequence is that more constraints are placed on the free time of the homemaker. The time boundaries created by the somewhat inflexible household events mean that the homemaker has less choice in when she is free from work. Her off-duty time occurs in small "parcels of time." Evenings, meals, holidays, vacations, and, for some people, Sundays are parcels of free time (de Grazia). Homemakers report household activities before breakfast as well as throughout the day and after the evening meal (Steidl, 1963b; Nelson, 1963; and Walker, 1964). The length of the time span—about 12 hours for a full-time homemaker and about 14 hours for an employed one—has both its advantages and its disadvantages. On the plus side, rest pauses can be taken occasionally and some can be sizable; this is in contrast to employment work. On the minus side, the homemaker, especially one with young children, is not free of her work and its responsibilities and demands for very many of her waking hours.

Another consequence of the constraints on free time is that more timing of events for household work is needed. We have already identified timing as one cost of work. The household work must be coordinated with the needs of the family members and, as noted previously, the biologically based needs of family members for food and sleep create a relatively inflexible scheduling of the meals and consequently the work for them. The need for temporal coordination of activities may increase the stresses from living in time. The more often we must pace ourselves and our activities to meet deadlines, the greater the time stresses.

Special conditions also affect the work time of homemakers. Women who are employed either part time or full time in the labor force have not only the hours of paid employment and work-related time but also the homemaking time to be added together for their total work time. Women with children under six years of age are usually kept busy with homemaking work on a full-time basis. As the children grow older the homemaking time can be decreased to perhaps as little as 20 hours a week when necessary. For homemakers who have young children and are employed either full time or part time, it means an extra long day and it may mean also that someone else is helping with the work. The timing of activities under such circumstances may greatly increase the time stresses. The long work hours also mean that the homemaker has little discretionary use of time, for the time is fairly well filled with work, work-related, and subsistence time activities.

A third major cost of time allocation may stem from the relative proportion for liked and disliked tasks. As we saw in the affective component, a few homemakers disliked all homemaking tasks and a few disliked several tasks. Data giving amount of time or the proportion used for all disliked tasks have not been found, however.

Interpretation of Time Use

Time permits us to allocate a relative order to various events because time provides a measure; if we want to allocate a larger portion of our time to one event than to another, the amount of time that we spend makes it possible to emphasize the importance of a particular event, activity, or task. We can gain some clues as to the values that are held by an individual by watching his use of time (Warren, 1957). We must be careful, however, in our interpretation of the hierarchy of values in another's value system, because the importance of an activity cannot always be measured by the time it consumes (de Grazia, 1962).

Sociologists indicate that most people develop a characteristic life style—a characteristic way of distributing time, interest, and talent among their social roles such as worker, parent, spouse, homemaker, and so on (Havighurst, 1961) Each adult patterns his use of time, making adjustment in the context of the sets of social relationships in which he engages (Thompson and Streib, 1961). Variations will occur with the stage of the family life cycle.

Some information about the distribution of activities between homemaking and nonhomemaking activities is available from data collected in 1952. The pattern was fairly similar among three types of homemakers: about one-half of the blocks of activities reported were allocated to homemaking; the employed city homemakers had slightly fewer than the full-time farm and city homemakers (Steidl, 1963a) Interestingly, the proportion of blocks allocated to the broad areas of food,

Table 4-1. Percentage of Blocks for Activity Areas and Activities during One Day (93 Farm, 101 City, 54 Employed City Homemakers, New York, 1952)

Activity area and activities	Type of homemaker					
	Farm		City		Employed city	
	Number of blocks					
	1955		2142		892	
	Percent					
Activities reported singly for a block						
Food		25		24		24
Meal preparation	12		12		12	
Dishwashing	10		10		10	
Preliminary meal preparation	2		1		1	
Other food preparation	1		1		1	
Food preservation	[a]					
House		8		8		8
Regular care of house	7		7		7	
Special care of house	1		1		1	
Upkeep of house	[a]		[a]		[a]	
Clothing		6		6		5
Washing	3		3		3	
Ironing and other care of clothes	2		2		2	
Sewing	[a]		1			
Mending	1		[a]		[a]	
Family		6		9		4
Marketing		1		1		1
Personal		32		37		36
Sleeping and resting	2		2		1	
Personal care	19		21		25	
Other leisure activities	11		14		10	
Other work		8		3		10
Farm work	6				[a]	
Paid employment	[a]		[a]		7	
Other nonhomemaking work	1		2		2	
Community activities	1		1		1	
Activities reported together		14		12		12
2 activities	12		11		11	
3 activities	2		1		1	
4 activities	[a]		[a]		[a]	
5 activities	[a]					
6 activities	[a]					
No activity reported		[a]		[a]		[a]
Total		100		100		100

[a] Some, but less than 0.5 percent.

Source: Steidl (1963a:8).

housing, clothing, marketing, and personal activities were essentially the same among the groups of homemakers for a given homemaking area (Table 4-1). There was slightly more variation among the three groups of homemakers in the proportion of blocks of activity allocated to family and to other work, i.e., nonhomemaking work. Differences in stage of family life cycle probably account for much of the variation in proportion of blocks for care of family, but the high degree of similarity among other homemaking areas suggests a similar rate of occurrence. The proportion of homemaking time for a given activity area also followed a fairly similar pattern among the three groups of homemakers although the average time for each broad area of homemaking activities varied (Table 4-2).

Do homemaking activities express the individual's values? Although

Table 4-2. Homemakers' Use of Time for Homemaking on One Weekday (95 Farm, 102 City, 53 Employed City Homemakers, New York, 1952)

Homemaking activities	Type of homemaker			
	Farm	City	Employed city	All
	Hours used by homemakers			Hours
Food preparation	1.8	1.6	1.2	1.6
Food preservation	0.1	0.0	0.0	[a]
Dishwashing	1.1	1.0	0.7	0.9
Care of the house	1.4	1.6	0.8	1.4
Care of clothes	1.7	1.6	0.8	1.5
Care of family members	0.7	1.1	0.3	0.8
Marketing, records	0.8	0.5	0.3	0.6
All homemaking	7.6	7.4	4.1	6.8
	Percent of homemaking time			Percent
Food preparation	24	22	29	23
Food preservation	1	0	0	[a]
Dishwashing	15	13	17	13
Care of the house	18	22	20	21
Care of clothes	22	22	20	22
Care of family members	9	15	7	12
Marketing, records	11	6	7	9
All homemaking	100	100	100	100

[a] Less than 5 minutes, or 1 percent.

Source: Wiegand (1954:16).

comparatively few data are available, two studies suggest that the day-to-day activities performed by homemakers do express values. Ketchum (1961) asked homemakers with young children to identify values of importance to them and activities that they had performed the preceding day. Almost one-half of the homemakers' activities were classified as economic. Activities in two other categories, societal and physiological need, together accounted for about 40 percent of the activities. The values exemplified in the reasons included helpfulness, workmanship, freedom, family life, and orderliness, together accounting for 85 percent of the reasons. Ketchum concluded that there was some support for her hypothesis that values which homemakers ranked high in importance would be reflected in reasons given for use of time.

Dyer (1962) asked homemakers with preschool children to categorize the reasons that they had given for activities done the preceding day into nine selected value categories. They could classify almost all of the reasons. The top-ranking value according to the number of activities was health (45 percent of the activities), then aesthetics and centrality of family (together accounting for 34 percent). Interestingly, the same activity was not always classified with the same purpose; the situation varied or the task may have had more than one purpose. For example, putting the children to bed was classified as health and as freedom; the children needed the rest in some instances and in others the dominant reason was for peace and quiet. Dyer's data emphasize the importance of having the individual identify reasons for activities.

Interpretation of use of time is somewhat difficult and at best is a gross indicator of the relative importance of activities. We must be cautious in our assumptions that the greater the amount of time that is allocated to a given activity, the greater its importance to the individual. On occasion we must use time to attain a goal which may be in the future; i.e., the present use of time is a means of getting where our next goal can be worked on or where our time use will be more satisfying. It is important to realize that, with time, we can structure our lives so that we are carrying out those activities that are the more satisfying to us. Many young women need help to understand the commitments in time that they are making when they marry, and, subsequently, when they agree to the various activities which their children wish to undertake or which they themselves undertake as community activities or paid employment.

Some facets of the temporal component are subtle in their cost to the individual. The most easily understood cost is probably the amount of time used for work. No less important (but less measurable) are those costs that come from timing activities. The creative work specialist can help homemakers and their families appreciate the importance of developing techniques for controlling their use of time for more successful management of the home. Research that goes beyond the description of time allocations is urgently needed to gain greater understanding of the personal costs of timing events and the techniques used.

CHAPTER 5

Background for the Physical Component

The fields of human anatomy and physiology provide the background for understanding the physical component of the human costs of work. Selected information from these fields is given in this chapter when it appears to be relevant to the discussion in Chapter 6.

SKELETAL STRUCTURE

The muscles and bones constitute the team that provides the support and movement for the body in the performance of work. These parts of the body are under voluntary control, capable of change from training, subject to damage from poor work habits, and of direct concern in the design of equipment and work method.

Muscles and bones are bound into a working unit by ligaments and tendons. Ligaments are tough bands of connective tissue which bind bones at joints and support viscera; tendons are connective tissue which attach muscle to bone. Ligaments and tendons, unlike muscle, are not elastic. "They may be stretched if sufficient force is used, but they do not return to their original length after the force is removed" (Metheny, 1952:13). Working position that requires a segment of the body to be maintained out of natural alignment may put unnecessary pull on ligaments and tendons. If force is exerted by or in conjunction with this segment, both ligaments and tendons can be painfully stretched or torn, resulting in a sprain.

Major Body Weights

It is useful to consider the body as made up of three major weights which must be supported: the head, the chest, and the pelvis. As long as the balance of head over chest and chest over pelvis is maintained at work, sitting, standing, walking, and climbing stairs, a minimum of

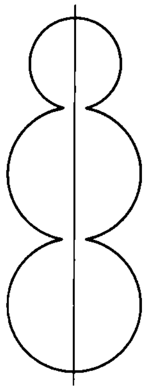


Figure 5-1. Diagram of three major body weights in natural alignment. (*Source.* Bratton, 1951b, p. 1.)

muscular effort and ligamentous strain is required to hold the body upright. The alignment permitting the benefits of natural balance may be represented diagramatically as in Figure 5-1. In standing, the three weights of the body are supported on two pillars, the legs.

The importance of this alignment of the body is not for static posture but as a means of handling the body during movement. The posture of work is the posture of movement. "If maximum efficiency of the body in movement is to be achieved, then movement must be performed within the framework of those laws which control stability" (Duvall, 1959:11).

The laws which control stability are stated by Metheny (1952:110).

"The balanced posture is like a stack of building blocks set squarely one on top of the other.

. . . .

"When the center of each part of the body lies directly over the base which supports it, gravity becomes a force which pulls the body together. When any part projects out of line and is totally or partially unsupported at its base, gravity becomes a force to pull the part farther out of line, and this pull must be combatted by the ligaments and muscles which hold the part to the body."

Effective control of the body weights during work can be improved by training. It is a matter of "Learning to balance the body segments one above the other and keeping them in line with the pull of gravity . . ." (Lee and Wagner, 1949:150).

This alignment of body weights without strain on muscles and ligaments is the basis of good posture; work-saving methods are built on a foundation of good posture. Ease and freedom of movement of the body and its parts during work are important for fatigue reduction and are promoted by an easy balance upon the base of support.

If working position requires the head or trunk to bend forward, ligaments and tendons undergo strain because natural balance is not functioning. In addition, such positions may require steadily maintained contractions in a localized group of muscles with resultant fatigue in the group of muscles so used. Metheny explains how the familiar "dowager's hump" results from habitually carrying the head in a forward position. A protective cushion of fat is built up because of excessive strain at the point where the muscles cross the large vertebra (seventh cervical) at the base of the neck. Schifferes (1960) makes the point that posture comes from within and is an ability to manage the body efficiently in a variety of circumstances.

The Spinal Column

The "backbone" is a most important unit in the physical component of work. Our heads are balanced on it and our arms are suspended from it, subjecting it to severe pulls and strains. The internal organs exert pull upon it. For all of these jobs it must be exceedingly strong and yet flexible enough to permit free movement. The spinal column encloses and protects a sensitive and vital part, the spinal cord, and provides for incoming and outgoing nerve roots all up and down its length.

The bony structure of the column is not "the backbone" but is made up of 26 separate bones, the vertebrae. The lower vertebrae are much heavier than the upper ones because of the greater weight carried at the base than at the top. Some have more secure devices for locking with the next vertebra than others and thus give extra protection to the cord where the stresses and strains are severe. Only slight movement is possible at each joint in the column, but the total effect is freedom of movement with strength great enough to withstand forces up to 300 pounds.

Compressible discs of cartilage act as cushions between vertebra. They account for the fact that we are taller in the morning than in the evening. After a night's rest in the horizontal position they are extended like pillows that have been fluffed up, but by the end of the day they are compressed. The discs are fluid-filled in the early years but begin to change during the teens and gradually become less flexible throughout adulthood and into old age. The discs may be seriously damaged by habitually working with the spinal column in a distorted position, by sudden heavy exertion with distorted body alignment or tense back muscles.

The pelvis is a complete girdle of bone at the lower end of the spinal column and serves as a bowl-shaped container for the organs above it. At the back, the pelvis is made up of the sacrum, formed by the lower vertebrae. The sacroiliac joints at the juncture of these vertebrae with the pelvic bones may be sprained by heavy lifting, by a fall, or by poor posture. Injury in this region causes pain in sitting or in rising from a sitting position. Since the pelvis supports the weight of the upper trunk and arms and is the place of attachment for the legs, it is subjected to severe pressure from above and pulls and pushes from below during heavy work.

The spinal column is shaped like an elongated S, thus acting as a natural spring. This spinal curvature allows space for the lungs and the abdominal organs, forms three arcs which divide the load of the masses supported, and absorbs the jars of walking better than would a straight column. Duvall (1959:12) says of the normal spinal curvature:

"The anterior-posterior curves of the normal adult spine are an excellent illustration of the adaptation of the human body to conform with the laws of balance. . . . If the spine were a straight, rod-like structure, then neither the rib cage nor the skull would be well-balanced one over the other or over the pelvis. . . . It is the normal anterior-posterior curves of the spine which bring the three weight masses of the body in line and thus give more stability to the upright body."

Few persons have the ideal spinal curvature. Deviations are frequent for a number of causes, among them are congenital weakness of the ligaments and habitual postural errors (Kahn, 1943).

MUSCLE ACTION

The nervous and muscular systems work together to produce motion of bones and to perform work. Work performance can be understood only as the operation of the neuromuscular system as a unit. Smith and Smith (1962:2) emphasize this point: "Here we are studying perception and motion not as two separate forms of adaptation, but as one mechanism, adapting the movements of the body to the gravitational and three-dimensional characteristics of space."

The Neuromuscular System

The system by which we make movements and so perform work is described by Morgan (1965:11):

"The physiological machinery of behavior is exceedingly complex. In principle, however, it is simple. It consists of receptors, a central nervous system made up of brain and spinal cord enclosed in the bony cases of the head and spinal column, motor nerves carrying impulses outward from the central nervous system, and finally the various effectors of the body such as muscles and glands. These are the essential parts involved in the adjustments of men and animals to their environments."

The muscle system with which we are concerned is made up of skeletal or striated muscles which move the bones and are under voluntary control. Other muscles of the body, such as the smooth muscles of the intestines and blood vessels, and the autonomic nervous system which controls them, are outside the scope of this discussion.

The nervous system is made up of units called neurons. The neuron has three parts, the dendrite, the cell body, and the axon. The dendrites are the receiving end and branch off the cell body like a tree. Each cell body usually has only one axon, the sending end. The structure called a nerve is a bundle of neurons; usually it is a bundle of axons with its cell bodies in the central nervous system.

The skeletal muscle is made up of bundles of thousands of muscle fibers bound together and controlled by neurons. Each axon from the central nervous system divides into a number of axon fibrils each ending in a separate muscle fiber. "Thus one motor neuron has complete control of a number of muscle fibers. A functional *motor unit,* therefore, is made up of one neuron and a number of muscle fibers" (Morgan, 1965:273).

The *motor units* vary in size according to the ratio of muscle fibers to a nerve axon; some axons may have as high as 150 muscle fibers, some as low as 3. An axon with a large number of muscle fibers will cause a relatively large contraction.

"Thus, in the large muscles of the body that are used in walking and in large, crude movements, the ratio is quite high. In the small muscles, like those of the eye or the fingers, which make very fine adjustments, the innervation ratio is rather small" (Morgan, 1965:273).

The functioning of neurons is essentially electrochemical. Best and Taylor discuss the physiology of the nerve fiber, explaining that it may be stimulated electrically, chemically, thermally, or mechanically. The nerve impulse "is a self-propagated disturbance. That is to say, the energy for the transmission of the impulse is derived from the nerve fiber over which it passes" (1961:1124). It is electrical in nature. Production of this electrical energy may decrease after a period of activity of the nerve fiber and may be one element of fatigue.

Reciprocal Action of Flexors and Extensors

The flexor and extensor muscles of the limbs, neck, and trunk occur in opposing pairs and are called antagonistic muscles. When flexors contract they lift limbs from the ground; the extensors pull limbs toward the ground. When flexors contract the extensors relax and vice versa. These groups of muscles of the limbs and trunk whose action is opposite are the chief agents in posture maintenance. Those muscles which activate the body in opposition to gravity are called antigravity muscles and are chiefly extensors (Best and Taylor, 1961).

The reciprocal action of the opposing flexors and extensors is the functioning mechanism in those well-coordinated activities of the body such as walking and the rhythmic use of the hands and arms. The functioning of this reciprocal action of the muscles is based on reciprocal innervation of the flexors and extensors; i.e., the nerve supply to the opposing sets of muscles is so arranged that when an extensor contracts its opposing flexor is automatically inhibited and relaxes. The inhibitory process is a reflex and takes place in the central nervous system. When there is reciprocal action of the antagonists, the alternate contraction and relaxation of a muscle provides a natural rest period, aids circulation, results in the carrying away of fatigue products, and postpones the onset of fatigue.

Co-contraction is the kind of motion produced when both flexors and extensors contract at once and it is under voluntary control. It is a t[illegible] kind of motion, sometimes needed for heavy work or for fine adjustments, but to be avoided when not needed. To work tensely at light work, using co-contraction, is a characteristic of the unskilled and produces unnecessary fatigue products. An example of both co-contraction and reciprocal action can be experienced in the use of the floating blade parer. The parer may be held and operated as one does a paring knife, using a fixed motion with co-contraction, or the parer may be operated with a free motion using reciprocal action. We can feel these contrasting types of motion by rotating the wrist smoothly back and forth, reciprocal action; making a tight fist and thrusting it forward, co-contraction.

Reciprocal action of flexors and extensors permits easy, graceful motions and is one goal in improving work methods.

Kinds of Muscle Action

Motions made by the human body have been classified in a number of ways and the different kinds of motion described are appropriate for different purposes. Training can help to recognize the different types and to select the type suitable for the job at hand.

Smith and Smith propose that motion involved in work is made up of three basic movement components: postural, transport, and manipulative. Postural movements are described as those which regulate body position in relation to the forces of gravity and acceleration. The transport component is that which moves members of the body through fluid space, either air or liquid. They point out that transport movements are integrated with postural movements which support and direct them and control their magnitude. The manipulative motion component is "fine manipulation of the terminal members of the body. . . ." These movements are "controlled according to the characteristics of hard space, i.e., the dimensions and position of objects" (Smith and Smith, 1962:7). This component is interrelated with the transport movements. They point out that developmentally the first movements to appear are the generalized postural, followed by transport movements and finally fine, manipulative movements.

Ballistic and Fixed Movements

Movement around any one joint between skeletal bones is usually made by a group of muscles. Different ways of combining the action of the muscles in a group produce different kinds of motion. The use of flexors and extensors, the muscles producing opposite action on a bone, often determines the type of motion produced. Chapanis, Garner, and Morgan (1949:266) describe two types of motion that are produced by differences in the use of these antagonistic muscles:

"In many movements, we use both sets of muscles at once; the two groups are balanced against each other: for example, when we hold a pencil in our hand, or drive an automobile, or make any slow tense movement. Such a movement is a *fixed* movement. On the other hand, we sometimes just contract one set of muscles and then relax them suddenly. When we do that, a muscle literally throws our bones and other muscles around. When we throw a ball, for example. . . . That kind of a movement is *ballistic.*

. . . .

". . . it looks as though people, when they learn all sorts of skills, gradually learn to reduce fixed movements to a minimum and develop good ballistic movement."

Rasch and Burke (1963) give a similar description for ballistic and for slow tension movements. The use of ballistic rather than fixed motion makes for ease of movement and can accomplish more at less cost to the body when it is appropriate. However, the purely ballistic movement is characterized by more vigorous contraction of muscles than is sometimes possible in housework. The homemaker cannot often go about her work as the athlete goes about a game. Many of the motions used in cleaning, bedmaking, dishwashing, and food preparation are of necessity more fixed than ballistic.

The substitution of rhythmic motion with its alternate use of flexors and extensors in place of co-contraction is a concept useful to improvement of work methods. This can apply whether the activity needs to be performed with great or with little vigor.

Static Contractions

Another kind of muscle action described by Rasch and Burke (1963: 71) is static contraction. "When a muscle develops tension which is insufficient to move a body part against a given resistance, it is said to be in *static contraction.* The length of the muscle remains unchanged. Examples occur when an attempt is made to lift an immovable object, or when an object is held stationary." This kind of muscle action has significance for the work of the homemaker and is the kind of muscle action involved in static work (Chapter 6).

CIRCULATION

The blood supplies the metabolic requirements for all activity; the method and severity of physical exertion have complex and profound effects upon the entire circulatory mechanism.

Basic Concepts

Karpovich (1965:149) gives this concise description of the operation of the circulatory system:

"The circulatory system exists for the sake of its capillaries, through the walls of which the exchanges of oxygen, carbon dioxide, acids and other materials take place between the blood and the tissues. The heart, in large part, supplies the necessary force to propel the blood; the arteries, by their elastic and muscular tissue, maintain an adequate pressure for the period between the heart beats and thus provide a steady flow through the capillaries; and the veins conduct the blood away from the capillaries.

"During physical activity there is an increase in blood circulation, which increases the rate of transportation of oxygen, carbon dioxide and the metabolites formed during muscular contraction. The increase in rate of blood flow is met through a combination of two factors: an increase in pulse rate and an increase in the blood volume output from the heart per beat (stroke volume)."

The concept of cardiac output is important in this discussion of circulation. The cardiovascular system is a closed one and blood volume in the body is constant under normal conditions. But the amount of blood that goes through the entire system or parts of it in a given amount of time can be varied greatly. These variations are brought about by wonderfully intricate adjustments in muscular, neural, and chemical processes in the body. For the purposes of this discussion, it is necessary to have in mind only two aspects of the complex changes: both the heart rate and the stroke volume (the amount discharged from the heart with each beat) change in response to changing needs of the body. Heart rate and stroke volume are interrelated and interacting. If the volume ejected per beat remains constant and the rate increases, cardiac output is increased. At very high levels of heart rate the stroke volume may decrease because of failure of the heart to empty after each beat. Many physiological mechanisms relate to changes in cardiac output, but the basic concept is that of the amount of blood put out by the heart in a unit of time under different combinations of circumstances.

The pulse rate for healthy persons varies with age, body position, time of day, emotions, and physical activity.

"In general, the rate of the heart bears an inverse relationship to the size of the animal, and a direct relationship to the metabolic rate. . . . The average rate in adult man is around 70 per minute, but there is a rather wide variation between individuals, a rate considerably below or above this average being not uncommon. Muscular training tends to reduce the cardiac rate; athletes not infrequently having a pulse rate between 50 and 60. On the other hand, a rate between 80 and 90 is sometimes seen in other healthy persons" (Best and Taylor, 1961:302).

Not only does the resting pulse rate tend to be slower for the physically fit than for the general population, it increases less for the physically fit on changing from the reclining position to standing. During exercise the pulse rate increases linearly with the amount of oxygen consumed. On cessation of exercise the pulse rate returns to normal in 1 to 4½ minutes for the well person. However, the more severe the exercise and the less physically fit the individual, the greater the length of time that is taken for the pulse rate to return to normal.

Blood pressure as well as pulse rate varies with age, posture, emotions, and exercise. The maximal or systolic pressure occurs with contraction or systole of the ventricle. The minimal or diastolic pressure occurs at the end of the resting phase or diastole of the heart cycle. The pulse pressure is the difference between the systolic and diastolic pressures.

The average systolic pressure for young male adults is 120 mm Hg and the average diastolic pressure is 80, making a pulse pressure of 40. The average pressures for age 60 are 140 systolic and 87 diastolic. For women up to the age of menopause the systolic pressure is 4 to 5 mm lower than for men. At menopause there is an abrupt rise and after that the average pressure for women remains higher than that for men (Best and Taylor, 1961).

In response to increased demands of the muscles during exercise the systolic pressure rises more than the diastolic, producing an increase in pulse pressure. In light exercise the systolic pressure rises several millimeters while the diastolic remains at normal level; in heavy exercise the diastolic pressure rises somewhat but less than the systolic.

The changes described in pulse rate and blood pressure are normal physiological responses to activity or other conditions and are not to be thought of as "bad" unless extreme or in need of being minimized. Physiological measures of the effects of work frequently include heart rate and blood pressure. These are significant costs of work only at high levels of muscular exertion or extremes of environmental conditions. Blood pressure changes, like heart rate changes, are not usually considered a significant cost of light or moderate work for the healthy person.

Increase in heart rate is proportional to energy expenditure for normar physical activity and like energy expenditure is a normal physiological function. Physical activity, whether work or play, which reasonably increases both is beneficial to the body of the well person.

An individual with a physical handicap may be required to reduce his physical activity. But physical handicaps vary widely and individuals vary in their response to the handicap, so that each case is an individual matter. No chart that is generally applicable can be given for levels of either energy expenditure or heart rate that can be safely tolerated with different degrees of limitation. Only levels of activity recommended by a physician for an individual have significance for working with handicapped persons.

Circulatory Effects from Standing

If we think of the blood vessels as liquid-filled tubes, it is easy to see that the heart has an easier job of getting blood through the vessels during recumbency than during standing. In recumbence the heart has only to force the blood through horizontal tubes at or near its own level. With the body in the erect position approximately one-fourth of the body is above the heart and three-fourths below it (Guyton). To return the blood to the heart from the lower extremities is more difficult than for the reclining body. According to Guyton (1963:326), "All investigators in the field of circulatory physiology recognize that when the body is in the erect position the weight of the blood in the circulation can cause very high hydrostatic pressures in the lower part of the body and result in 'pooling' of the blood and reduced cardiac output. . . ."

The term "pooling of the blood" used by Guyton is not meant literally. It is descriptive of the condition that results when the blood comes into the lower extremities through the arteries somewhat more rapidly than it can be returned to the heart through the veins. The pooling of the blood is affected by the degree of vascular distensibility. Obviously the more "give" or stretch there is in the vessels of the lower extremities the greater is the tendency of the blood to pool there. Guyton says, ". . . the greater the distensibility of the circulation, the greater will be the depressant effect of the erect position on cardiac output" (p. 328). Varicose veins increase circulatory problems in the erect position.

Compensating factors that help to prevent the pooling of blood in the lower extremities include, according to Rushmer (1961:175):

". . . (a) the balancing of intravascular pressures by extravascular or tissue pressure, (b) the reduction of the hydrostatic columns in veins by 'pumping' action and (c) the return of unabsorbed capillary filtrate to the circulation by way of the lymphatic system."

It is easy to understand why the athlete or the physically fit person is in a better position than the unfit regarding these compensating factors. The strengthening of muscles by exercise would tend to increase the effectiveness of muscular pressure upon the veins and aid the pumping action of the leg muscles.

The presence of valves in the veins of the legs provide the key to the pumping action. The contraction of the leg muscles against the veins forces the blood along and the closing of the valves between contractions prevents the venous blood from falling back. When the valves are closed the long columns of blood in the veins are broken into segments, thus reducing the hydrostatic pressure at the lower extremity and the resistance to the return of blood to the heart. The tensing of abdominal as well as the leg muscles aids in the return of blood to the heart even though there are no valves in the abdominal veins.

With these facts about circulation in mind, even though the description is oversimplified, one can better understand why walking or moving about during work is easier than quiet standing; why the physically fit individual functions better physiologically than the unfit during work; and why prolonged bed rest or inactivity for ill persons is avoided as much as possible.

CHAPTER 6

The Physical Component: Working Position and Movement

The physical costs of the work of the home are to be thought of in terms of effects on all the systems of the body that function during work. Energy expenditure is relatively light for many of the jobs in today's homes and is unlikely to be correlated with fatigue. The maintenance of working position is sometimes the most fatiguing aspect of the job. Movements made during work performance may constitute beneficial exercise or they can subject parts of the body to stresses that are fatiguing or detrimental to general well-being.

The worker's body constitutes her most important item of household equipment. The entire body involved in the work is the focus in work study for the homemaker; the effect of a method of work on the entire body should be understood.

FATIGUING POSITIONS

Three aspects of the movements of work as suggested by Smith and Smith (1962) and previously discussed (Chapter 5) were postural, transport, and manipulative. Those who have had practical experience both in maintaining a home and in sedentary work will probably agree that the postural aspect of both is a source of fatigue. The fatigue felt after a long period either on the feet or sitting is familiar to many. A familiar feeling of more localized fatigue also may follow a relatively short period of working with arms held high in order to search for and grasp an object from a high shelf. Two kinds of fatigue from postural movements are discussed in this section.

Static Work

Static work may be defined as work done by means of static muscle contractions required to hold the body or any segment of it in a fixed position without contributing directly to the work performance. Consider some possibilities for static work in bathing a baby in a low bathtub. As the mother kneels by the tub she must bend the trunk forward and support the baby with one hand. Even if she leans on the rim of the tub to support herself, there is still some static work involved in holding the head and trunk in position and the one arm that supports the baby. While muscles are holding they are not alternately contracting and relaxing with the movements natural to the task but maintain a relatively steady contraction in order to hold the position that permits the work performance by other muscle groups.

It is surprising that so little has been said about static work in relation to work methods in the home because the effects have long been known. Atzler (1927:486) warned against static work in a listing of general rules for body economy. The translation of one of the rules is: "Positively exclude static work . . . because in muscles at static work blood circulation is reduced." Snorrason (1955:361) repeats Atzler's warning against static work. He says that in order to have good work conditions, ". . . there must be an avoidance of static work with the attendant circulatory disturbances, and cases of degeneration in muscles, ligaments, and joints."

The harmful effects of static work on the circulation result basically from the maintained contraction as contrasted with the alternate contraction and relaxation of muscle. Muscular exercise augments cardiac output and so brings an increased flow of blood to the acting muscles. However, while the muscle is contracting, the blood vessels to that muscle are compressed and the blood supply to that muscle is reduced. Rushmer (1961:202) says of blood flow to muscles during exertion:

"At the beginning of exercise the flow of blood through the contracting muscles increases greatly to maintain and restore the supply of energy that is being released as work and wasted as heat. Barcroft and Dornhorst presented evidence that contraction of skeletal muscles actually hinders the flow of blood through them; thus, the vasodilati must be great enough to permit very large flows in the intervals betw contractions."

This mechanism works well for intermittent or rhythmic contracti ut not for sustained or tetanic contractions. Guyton (1963:391) f tetanic contractions,

"Occlusion of blood vessels during tetanic muscular contraction e a serious detriment to blood flow in the muscles. . . . For instan one can demonstrate this effect by simply closing the fists extremely tightly for 20 to 30 seconds. The lack of blood flow through the muscles causes both pain and muscle weakness."

Tuttle and Horvath (1957) reported experiments in which for dynamic work, only the systolic pressure rose; for static work the diastolic pressure rose appreciably also, thus effectively lowering the pulse pressure. This is another of the indications that static work interferes with normal circulatory processes which provide for muscle activity.

Fatigue from Static Work

The difference in feelings of fatigue after a period of active physical exercise compared to feelings after a period of working at a surface that is too low or too high may be due to the difference in the effect of dynamic and of static work. Maintaining the head in a position to see or raising the shoulders to position the hands above a work surface require a relatively steady contraction of muscles not directly involved in the work. The steady contractions of muscles for positioning could result in feelings similar to the "pain and weakness" mentioned by Guyton as a result of holding the fist tightly closed for 20 or 30 seconds. The winging out of the arms to operate a beater or to type is another example of static work not necessarily required for the job. If the height of the beater or the typewriter were adjusted to the dimensions of the worker, the job could be done with less fatigue and more comfort.

Static work is as much or perhaps more likely to be associated with the light work of the present-day homemaker as with the more strenuous work of an earlier day.

Smith and Smith (1962) refer to a study in which fatigue from static work was found to be three to six times as great as from lifting; they do not mention the method of determining fatigue. But whatever the definition of fatigue, the ill effects of static work are well known and the uses understood. The avoidance of static work for any part of the body ın important target for work improvement.

Fatigue from Standing

ıe term "fatigue of standing" might more properly be called "fatigue rect posture." Quiet standing and moving about on the feet while king are not, physiologically speaking, the same. In housework there relatively few cases of the quiet standing that is required of the subjects in physiological studies of standing. Yet there are in housework a number of jobs in which the working position could be characterized as intermediate between that of quiet standing and walking. Long periods of working at such jobs do result in feelings that are akin to the fatigue of quiet standing though possibly not so acute. Because of the intermittent moving about, the onset of fatigue is postponed longer than for the case of quiet standing. One or two hours of ironing or meal preparation on the feet can be tolerated but does give rise to fatigue; fifteen minutes of quiet standing may be severe even for some well persons.

The erect posture has several physiological effects, some of which are fairly well understood and add up to feelings of fatigue.

The difference in energy expenditure for lying and standing or sitting and standing has nothing to do with the fatigue that is felt. It has been shown that it is erroneous to say that we save energy by sitting to work (see Chapter 7). Moreover it is generally agreed that walking is less tiring than standing yet requires greater energy expenditure.

The activity of muscles, which of course would show up in energy expenditure, is also not related to the fatigue of standing. According to Basmajian (1962:87) "The fatigue of standing is emphatically not due to muscle fatigue and, generally, the muscular activity in standing is slight or moderate."

The two physiological bases for the fatigue of erect posture for which there is the most solid research support are:

1. Effects on the circulation.
2. Pain arising from pressure on ligaments, joint capsules, and tendons.

Basmajian has shown in his electromyographical studies that the muscles which were generally supposed to support the arches of the foot are inactive during quiet standing. He concludes that fatigue of the feet probably is caused largely by pain originating in the ligaments and tendons which bind the arches. This view was presented by Hicks (1954) who showed in anatomical studies of the skeleton, that one of the major tendons and the ligaments of the foot were the chief weight bearers in balanced standing. Basmajian (1962:88) sums it up, "most fatigue in the lower limbs caused by standing is more intimately associated with the inadequacies of the venous and arterial circulation and with the direct pressures and tensions upon inert structures."

It is assumed therefore, that the major causes of the fatigue of standing are found in the direct effects of the circulatory disturbances and in the pain arising from ligaments and tendons.

BODY MECHANICS

If mechanics is defined as the science dealing with force and motion, then body mechanics is, of course, a science dealing with body forces and motions. The term body mechanics is itself a popularization of kinesiology, "the scientific study of movements" of the human body (Duvall). Of kinesiology Duvall (1959:5) says:

"The teaching of fundamental movements, of motor skills, and the improvement in performance of these skills rests squarely on a knowledge of human motion and how it is accomplished. . . . Understanding of the causes of fatigue and inefficiency is based upon many things, of which kinesiology is one, and the principles of body movement are now being taught in many areas outside of education and medicine."

Body mechanics is of interest because of a desire to keep the homemaker's costs of work at a minimum. The physical costs of work can be too high in fatigue even for light work if the natural structure and functions of the body are disregarded during work performance. An untrained worker often will work against her body rather than let her body work for her. The physical cost of work can then be out of proportion to the amount of work accomplished, in the technical sense of foot-pounds, in energy expended, or in the discomfort and strain felt.

Mechanics of Movement

The laws of mechanics apply to moving the body and its segments just as they do to moving inanimate objects. Knowledge of the force of gravity, of momentum, and of leverage can contribute to the development of efficiency in body motions.

Gravity

Gravity is a force which is constantly acting upon the human body and one which the body is constantly combatting except when in the prone position. Elftman (1955:556) says, "The only way to profit from gravity is to keep on going down hill." How to maintain the upright posture economically during standing, sitting, walking, running, climbing, and lifting is a basic technique of work improvement. The worker's own body is not only her most important piece of equipment but also the greatest weight she normally transports and manipulates.

Walking, climbing stairs, lifting the arms, all involve the moving of weight through distance, constituting work in the technical sense. Lifting the body or parts of it may be a large share of the work in an activity, as for example, bending over to pick up a paper scrap from the floor. The method of bending over is important for this activity because of the stress on intervertebral discs from the weight of the body not the weight of the object lifted. When this action is performed with a knee-bend and with the back in good alignment, protection is maintained for intervertebral discs.

The center of gravity of the body in relation to the base of support is one of the keys to the economical handling of the body weight during work. The center of gravity is an imaginary point at which the entire weight of the body may be thought to be concentrated, the center of weight or mass. For women this point lies within the pelvic region at 55 percent of the standing height (Rasch and Burke, 1963). The center of gravity shifts when we walk, run, or assume a sitting position. The line of gravity is a vertical line from the center of gravity to the earth's surface. For the human body when standing, the base of support is in our two feet giving us a chance for variation in the breadth of support. When the feet are close together the base of support is narrow; when they are apart the base of support is broader.

For economical maintenance of stability, the line of gravity should pass through the base of support and the base of support should be broad. This is especially important when the work requires heavy exertion as in pushing, lifting, or carrying. But, as pointed out before, the body is always handling three weights, the pelvis, chest, and head; and so, even for light work sitting or standing, these weights need to be over the base of support. It is always desirable to maintain stability without sustained strain on ligaments and tendons and without holding a position by excessive muscular contraction, whether the work is heavy or light.

When the homemaker lifts a basket of clothes she has added an external mass to that of the body and thus has shifted the center of gravity. To safely preserve stability we must try to keep the line of gravity as nearly as possible over the base of support, i.e., hold the basket as close as possible to our own center of gravity. Otherwise there is a risk of accident or of damage from undue strain to arm and back muscles and ligaments.

The best way to avoid the strain of lifting a heavy object from a low level is not to place it on the floor. The basket of wet clothes (wet ones are twice as heavy as dry ones) or the heavy bag of groceries should be carried in close to your own center of gravity and set down on a chair, table, or cart to avoid lowering it to the floor and lifting it again.

To push near the top of the back of a heavy chair to move it is more effective for tipping it over than for moving it along the floor. If the force of the push is to be effective it must be applied at the level of the center of gravity of the object and in the direction the object is to move. To do this one should crouch before the effort and then apply the force for the push while coming out of the crouch. This will insure that the major part of the force will come from the large and strong muscles of the thighs and legs as they come out of the crouch. This will relieve and protect from injury the smaller and weaker muscles of the back.

Momentum

The housewife is constantly contending with Newton's first law, recognition of which is important to good body mechanics.

"... *A body remains at rest or in uniform motion until acted upon by an unbalanced set of forces.* This means that if a body is at rest, the forces acting on it must be completely balanced; the body is then said to be in equilibrium. If a body is moving it will continue to move at a uniform speed until some force causes it to stop moving or to change its rate or direction of motion ..." (Williams and Lissner, 1962:2).

This is known as the law of inertia. The body in motion has momentum equal to the product of its weight times its velocity.

Momentum is the force which the muscles must overcome when work is performed with sudden stops or sharp changes in direction. Circular motions, when they are practical, avoid the unnecessary use of muscular force to overcome momentum. Since speed is one component of momentum, slow circular motions require less muscular force than quick, jerky motions.

Swartz (1929) in an early study found that operating an electric vacuum cleaner required more energy at the faster rates of pushing than at the slower rates on the same rug. She speculated that at least part of this extra energy expenditure was due to the muscular work needed to overcome the greater momentum on reversal of direction when the sweeper was operated at the higher speeds.

Leverage

Children learn at an early age that to balance the seesaw, the heavier child must move toward the center and the lighter child nearer the end of the board. A tray carried close to the body is an application of the same principle, shortening the lever arm to minimize the effect of weight. Even so simple an application as carrying a rectangular tray or carton with the long side perpendicular to the body is giving the advantage to the load instead of the worker. If one picks up a loaded tray or even a book with the long side perpendicular to the body, then shifts the long side to parallel the body, the tray or book seems to become lighter, noticeably requiring less force to hold.

The leverage effects of the muscles on the bones are difficult to understand because of their complexity and the fact that they are hidden from sight. The arm is one example of a lever operated by muscles. It has been shown experimentally that the arm has its greatest strength when the forearm is perpendicular to the upper arm with a right-angled bend at the elbow (Miller, 1942). The explanation is in the length of the lever arm, the perpendicular distance from the point of attachment of the biceps muscle on the radius bone of the forearm to the axis of rotation of the elbow joint. When ". . . the elbow is straight the lever arm of the biceps muscle is short. The lever arm increases as the elbow bends, is maximal at about 90 degrees of flexion, and again decreases beyond this point . . ." (Williams and Lissner, 1962:38). (See Figure 6-1.)

This is one fact of anatomy which has a bearing on the mechanics of manipulating the hands at a work surface. When the relation between the height of the work surface and the height of the elbow is good, the arm can comfortably exert force from a right-angled bend at the elbow.

Body Mechanics of Working at a Counter

Homemakers frequently, and sometimes for long periods, perform tasks on work surfaces. The body mechanics of working in this position has had surprisingly little and only superficial attention in spite of its importance to the work of the home.

For active work with the hands and arms the comfortable position of the upper arm is vertical and in close to the body, not raised to the side or to the front. A desirable working position for either standing or sitting permits the arm to hang and to swing naturally from the shoulder joint without incurring the static work of lifted shoulders and upper arms.

The elbow joint is the point from which the lever of the arm is usually operated for manipulative motions with the hands.

Arm Position

The amount of adjustment made by the upper arms for work at counters was studied by Bratton (1959b) using motion pictures of three groups of women in different working positions performing two standardized tasks. For this study, Bratton devised a measure called "average angle of arm lift." For three groups of subjects, at each of the two tasks, the forward angle of upper-arm lift was lowest for standing; in this

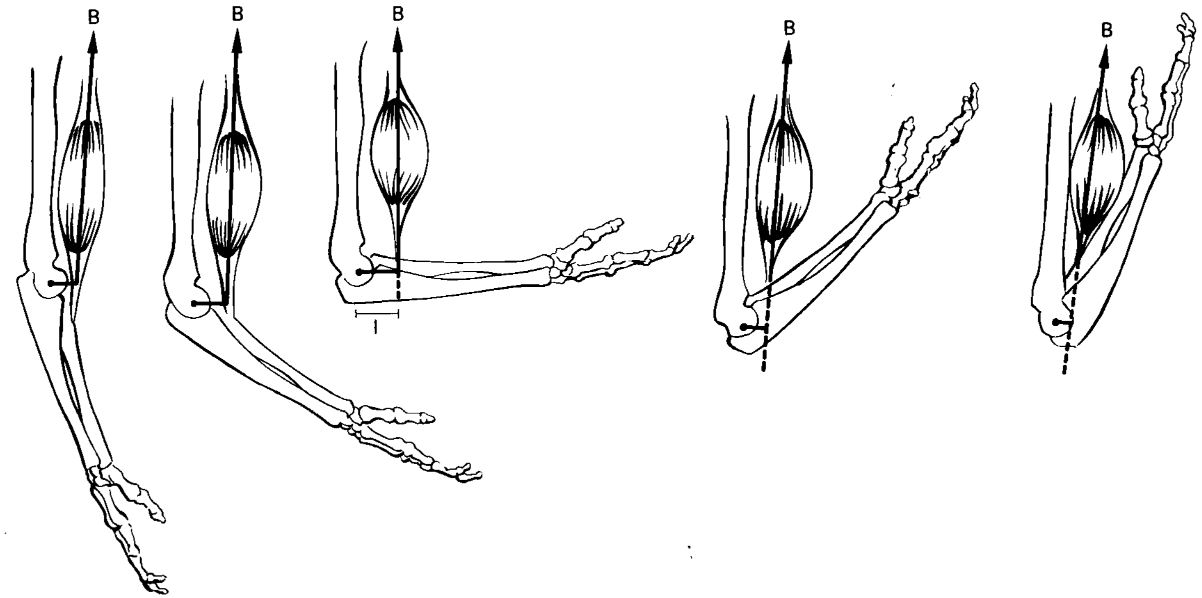


Figure 6-1. The leverage of the forearm. The biceps, B, at various points of elbow flexion, showing variations in the lever arm (perpendicular distance from action line of tendon to elbow axis). (*Source.* Williams and Lissner, 1962, p. 38.)

Table 6-1. Elbow Height and Angle of Upper-Arm Lift, Folding Towels on a Counter (12 Women of Average Stature)

Working position	Elbow height	Distance of elbow from counter	Average angle of arm lift
	Inches		Degrees
Standing at a 36-inch counter	41.0	5.0, above	20
Seated on 15-inch chair at a 23-inch counter	23.6	0.6, above	30
Seated on a 24-inch stool at a 36-inch counter	32.8	3.2, below	35

Source: Bratton (1959b), calculated from data given.

position the average elbow height of the women was 5 inches above the counter. When the workers were seated on a metal stool 24 inches in height the angle of arm lift was greatest; in this position the elbow height was 3 inches below the work surface (Table 6-1).

When the height of the elbow in the seated position was below that of the counter, the average angel of the upper arm lift was 75 percent greater than for the standing position with the average elbow height 5 inches above the counter.

Adjustments to the work-surface height other than arm lift were made by the subjects of the Bratton study, such as a backward bend of the trunk when the counter was too high. The problem of a counter that was too low did not occur because the subjects were of average stature. A counter height of 36 inches is not likely to be too low for such a group.

HEIGHTS OF WORK SURFACES

Work areas in which the height of the work surface is important to the worker include the sink, range, mix, and serving areas in the kitchen; sorting, folding, dampening, and ironing surfaces in the laundry; surfaces for infant care and bathing; surfaces for writing; surfaces for cutting garments and for machine sewing.

Surfaces for all of these work areas would contribute to ease and comfort in work if they could be adjusted to the individual worker. The right angle between forearm and upper arm has been shown to be the starting position of greatest strength and efficiency for exerting force with the hands. It follows, therefore, that the height of the work surface should be somewhat lower than the height of the elbow of the worker. This appears to be true even though work with the hands involves the shoulder as well as the elbow joint. Evidence to support this can be found in several studies.

Floyd and Roberts (1958) say that for table height the primary consideration is to bring the elbow into a satisfactory relation with the working surface.

Ellis (1951) reported a study of speed of performance and feelings of muscle strain in a standardized block-turning task at 6 different work-surface heights for 48 male subjects. The heights of the work surface were determined for each subject using a formula involving hand height and arm length. The greatest speed of performance and the lowest rating for muscle strain both occurred at a height that was 3 inches below the individual's elbow (the diameter of the block was 1.43 inches). When the subjects were asked to adjust the work surface to their preferred height for work, the average was almost the same as the height of optimal performance, 3 inches below the elbow. The second most favorable height was 8 inches below the elbow. For those work-surface heights which were greater than elbow height or farther below (13.5 and 18.9 inches below) the speed of performance was significantly less and the feelings of strain significantly greater.

Steidl (1954, 1955a) studied heights preferred by women for the separate electric oven. With an oven easily adjustable in height, over 50 women performed activities normal for the use of the oven. The height of the elbow showed more consistent relationship than any other body dimensions to the oven heights preferred. She therefore gave the recommendation for the installation height in terms of elbow height of the worker in relation to the height of the opened oven door.

Muse (1951), in her study of ironing, observed that at the ironing-board height chosen by the women, the iron handle was $1\frac{1}{4}$ inches to $3\frac{1}{2}$ inches below the elbow.

Apparently the recommendation for work surface below elbow height does not apply to the surface used for writing or studying. For writing, the arms are not held close to the body but lifted laterally and are in direct contact with the work surface. For studying, no downward force is exerted, and the elbows rest on the table. For these activities a table surface not appreciably lower or higher than elbow height would be comfortable. Such activities would require a higher work surface than for a task like ironing, as is true of the heights chosen by Ridder's (1959) subjects for writing and dining. Ridder did not report directly the height of elbow above the floor, but it can be roughly deduced from other dimensions given.

Special Requirements for Seated Work

Sitting for active work is not the same in its demands on the body as sitting quietly at rest or to write. For seated work there are special requirements for comfort. In addition to the need to have the elbow joint and the forearm above the work surface, just as when standing to work, there are other requirements. There is the need to maintain stability of the trunk and head without strain and to permit free movement of the feet and legs while actively using the hands and arms at a stationary surface.

There are three special requirements for work surfaces for seated work:

1. The elbow and the forearm are above the surface without static work to maintain them there.
2. The knees and thighs are under the counter with the feet solidly on the floor or on a footrest. There should be enough kneehole width for movement of the legs from side to side. When the knees cannot be under the counter, the trunk will be in a position of strain in order to manipulate the hands above the counter. When the feet are not solidly braced, tense and tiring contractions of muscles are needed to stabilize the body during the movements of the hands.
3. The counter with its supporting structure clears the top of the thighs. This freedom of movement for the legs is needed as well as the freedom to move from side to side. This is a particularly difficult requirement if the elbow height is to be greater than that of the work surface, as will be shown in the next section.

Dimensions of Women

Selected results from a number of studies of the dimensions of women are presented in this section. Even though most of the measurements were made a generation ago, the figures still seem valid for the purpose for which they are used. The average increase in height for Americans has been about ½ inch per generation (Morgan et al., 1963).

Seated at Work

The height of the elbow above the floor for women when seated for work was about 24 or 25 inches in the studies selected (Table 6-2). The height of the top of the thighs was 21 or 22 inches with knees under

Table 6-2. Certain Dimensions of Women When Sitting

Source	Number	Elbow height above seat	Thickness of thigh	Height above floor: Underknee	Top of thigh	Underforearm or elbow	Top of thigh to elbow
				Inches			
Bratton, 1959c	12		5.8[a]	15.8	21.6	23.9	2.3[a]
Floyd and Roberts, 1958	63	8.7		15.9			
Martin, 1955	131	9.2	6.0[a]		21.8	25.0	3.2[a]
Wilson, Roberts, Thayer, 1937	200			17.0[b]		24.3	3.3

[a] Calculated from other data given.
[b] 562 cooperators.

the counter and with a right-angled bend at the knees. The difference between the two dimensions is only about 2 or 3 inches.

The narrow margin available to the woman of average stature to permit the elbows above and the thighs below the counter is only about 3 inches and is shown in the scale drawing (Figure 6-2). The figure was drawn to scale from a composite of dimensions from a number of studies. Only the vertical dimensions and the thickness of the thigh are drawn to scale. This dimension of 3 inches for the average woman might be called the "sit-to-work margin." As the drawing indicates, for women of average build this small distance is barely enough to permit comfortable work on the surface with good body mechanics; it leaves little margin for intervening support structure and none for a drawer under the surface. Publications which advocate sitting to work for the homemaker have sometimes shown this kind of drawing not to scale. Then it was easy to show plenty of space between thigh and elbow.

In the study by Wilson, Roberts, and Thayer (1937) only the tallest 11 percent of the women had 5 inches or more in this crucial dimension. One arrangement that enlarges the sit-to-work margin is the use of a perch stool with a counter that is the height for standing work. When this was used with a group of 12 women of average stature, the distance from the top of the thigh to the elbow was 12 to 15 inches instead of 3 (Bratton, 1959c:40).

It may be that this largely unnoticed dimension of women accounts for much of the difficulty of getting a comfortable chair and work surface relationship for seated work. For many women, it may be the choice between using poor body mechanics or standing to work at a counter. The reality of this dimension of women suggests a possible need for desk design without a center drawer. It also suggests part of the difficulty with working from the seated position at any height of sink. For even the shallowest sink the depth of the bowl is greater than the average "sit-to-work margin"; upper arms will need to be lifted to position forearms over the sink and water is likely to run down from forearm to body. Recognition of this margin between elbow and thigh and its bearing on the relationship to the height of the chair and the work surface is needed to satisfactorily provide for sit-to-work jobs.

A jointed manikin based on the scale drawing in Figures 6-2 and 6-3 can be used to teach the relationships of women's dimensions to heights of chairs and work surfaces. The movable segments of the figure can be repositioned to demonstrate the relationship of top of thigh to under-table height, elbow to work-surface height, and the sit-to-work margin when the figure is seated on chairs or stools of different heights.

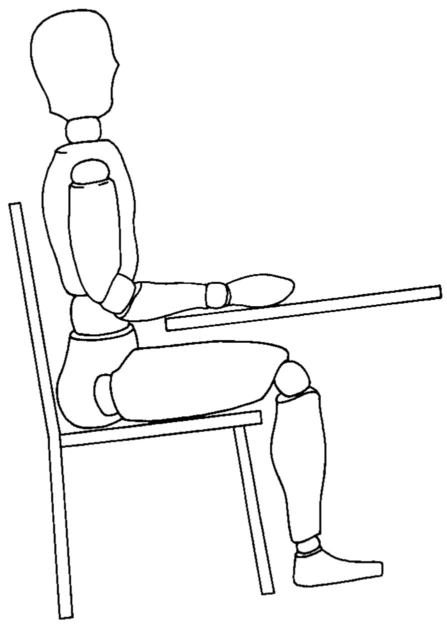


Figure 6-2. Relationship of seated worker to 24-inch work surface. Scale: ¾ inch equals 1 foot. (*Source.* Bratton, 1959c, p. 39; 1961, p. 10.)

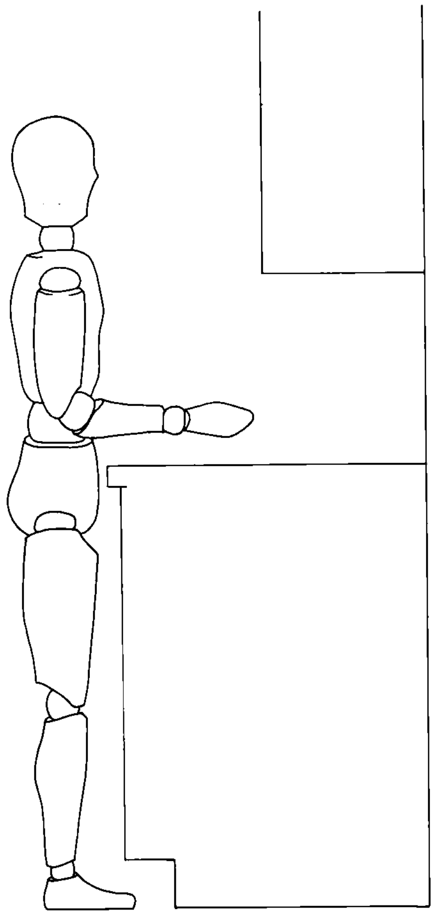


Figure 6-3. Relationship of standing worker to 36-inch work surface. Scale: ¾ inch equals 1 foot. (*Source.* Bratton, 1959c, p. 39a.)

Standing at Work

The average height of the women in the studies was 65 inches (Table 6-3). The average height of the elbow when standing for work was 40 to 41 inches in most cases. The average height reported by Wilson, Roberts, and Thayer, almost 42 inches, is appreciably greater than the others but the reason is not known. The average height of the elbow for women, 40 to 41 inches, appears to permit good body mechanics at the standard 36-inch counters so long as the work does not require the use of a high tool such as a beater or a deep pan or bowl.

The relation of the elbow and forearm to the standard 36-inch counter

Table 6-3. Certain Dimensions of Women When Standing

Source	Number of women	Stature	Shoulder height	Elbow height
			Inches	
Crew, 1948	36	65.3	—	40.7
Martin, 1955	131	65.0	53.0	40.6
Muse, 1951	25	65.0	—	40.1
Bratton, 1959c	500+	65.3	—	40.3
Steidl, 1954	55	65.5	54.1	40.2
Wilson, Roberts, and Thayer, 1937	562	65.2	53.8	41.9

for the woman of average height is shown in Figure 6-3. It is clear that, for women of this stature, work with a high tool or deep bowl would not permit the use of the good right-angled elbow bend for the start of the exertion of force downward. For individual women to test this relationship, it is probably more important to determine the height at which force would be exerted with the hand than to consider only the overall height of the bowl or tool.

The average heights of elbow for women of varying statures when standing in one study of over 550 women are given in Table 6-4. This

Table 6-4. Average Elbow Height for Women of Varying Statures (550 Women, New York State)

Stature	Number of women	Elbow height
Inches		Inches
61	33	37.7
62	35	38.3
63	79	39.2
64	78	39.6
65	103	40.2
66	80	40.9
67	53	41.9
68	47	42.2
69	30	42.5

Source: Bratton (1959c).

information suggests that for women in the short to medium groups the elbow height is high enough to permit good body mechanics for working directly on the 36-inch surface but not high enough to work comfortably when a tool or container of some height is involved.

The complete range of individual elbow heights for the 550 women in this study (Table 6-4) was from 35 to 44 inches. When the individual is planning for herself, she can consider her own elbow height and not an average for women in her stature group.

Preferred Work-Surface Heights

Several studies made a number of years ago were aimed at getting homemakers' preferences for work heights for several tasks when they were given the opportunity to try a variety of heights. The average heights chosen by the cooperators in some of these studies have been brought together in Table 6-5. The studies differed as to purpose and method. The Knowles, the Muse and the Wilson, Roberts, and Thayer measurements were all made in the course of a carefully done research project; the Knowles and the Muse measurements were made as a part of their comprehensive studies of ironing. The Bratton study of over 500 New York State women made use of homemakers who visited an exhibit, so the measurements were made under less than ideal conditions. The measurements reported from the class resulted from a laboratory exercise as carefully done as possible with students as cooperators. This study, then, was limited by the attitude of the students toward the

Table 6-5. Work-Surface Heights Preferred by Women for Standing Work

		Preferred working heights for:				
Source	Number	Dish-washing	Beating	Rolling or kneading	Cutting	Ironing
				Inches		
Knowles, 1946	4					34.3
Muse, 1951	25					33.5
Bratton, 1959c	510–544	33.2	31.9	34.7	36.4	34.2
Wilson, Roberts, Thayer, 1937	475–562	32.3	31.6	33.7	35.4	32.6
College students[a]	75	33.0	32.8			

[a] Bratton, unpublished data.

laboratory work and perhaps by the fact that (as in all of the other studies) they were not experienced homemakers.

The dates of the studies in Table 6-5 (1935 to 1954) may limit the value of the data somewhat because of the slight increase in stature of the American people, as explained previously. However, the amount of increase in preferred height of work surface with the increasing stature is small enough so that a ½-inch increase in average height of the worker would not be likely to increase the choice of work heights appreciably.

The heights chosen in the Wilson, Roberts, and Thayer study are consistently lower than comparable ones chosen in the other studies. For both the New York State and the class studies the data were collected in conjunction with the teaching of good working posture. This fact could have operated to give a higher preferred height because of the thought given to posture.

Elbow Height and Work-Surface Height

For the cooperators in the New York State study, the work-surface heights given as a distance below the elbow are shown in relation to the height of the elbow (Table 6-6). Elbow height shows a clearly consistent relationship to the height of the surface chosen by the women for the work.

Table 6-6. Distance below Elbow Height for Preferred Work-Surface Height (500 Homemakers, New York, 1938)

Elbow height	Dish-washing	Beating	Kneading and rolling	Ironing	Cutting
			Inches below elbow height		
36	5.0	6.0	3.5	3.5	1.5
37	5.5	6.0	3.5	4.0	2.0
38	6.0	7.0	4.5	5.0	2.5
39	6.5	8.0	5.0	5.5	3.5
40	7.0	8.5	5.5	6.2	4.0
41	8.0	9.0	6.5	7.0	4.5
42	8.5	9.5	6.5	7.5	5.0
43	9.0	10.5	7.5	8.0	6.0
Average[a]	7.0	8.5	5.5	6.0	4.0

[a] Averages include data for a few women with elbow heights of 35, 44, and 45 inches.

Source: Bratton (1959c).

Height of Palm and Work-Surface Height

The height of the flattened palm has often been suggested as a guide for determining work-surface height. In the study referred to above, the heights of work surfaces were not chosen at the height of the palm and were not consistently above or below it (Table 6-7).

If we are to design the kitchen to meet the needs of different sizes of workers performing a variety of operations, the result is likely to be a drastic change from the usual. Moreover, if one surface height is changed, we must be prepared to anticipate the effect on all of the other surface heights and the construction problems as well.

Other work areas outside the kitchen are less complex with fewer interrelationships among appliances and can be more easily adapted to the dimensions of an individual worker.

Table 6-7. Distance from Palm Height for Preferred Work-Surface Height (500 Homemakers, New York, 1938)

Height of palm above floor	Dishwashing		Beating		Kneading and rolling		Ironing	
	Above	Below	Above	Below	Above	Below	Above	Below
	Inches from palm height							
29	2.6		1.8		4.5		3.5	
30	2.2		1.6	0.9	3.7		3.4	
31	1.6	0.5	1.4	0.9	3.2		2.7	0.5
32	1.4	1.2	1.1	1.0	2.6		2.2	1.2
33	1.0	0.5	1.1	1.2	2.4	0.5	1.6	0.8
34	0.7	1.7	2.0	1.8	1.9	0.5	1.2	1.5
Average[a]	1.7	1.1	1.4	1.2	3.1	0.6	2.6	1.0

[a] Averages include data for a few women with palm heights of 28, 35, and 36 inches. The average palm height for all cooperators is 31.6 inches.

Source: Bratton (1959c).

CHAPTER 7

The Physical Component: Energy Expenditure

Objective measurement of the physical costs of work has long been a goal of industrial engineers and industrial psychologists, and the object of research for homemakers. One measurement, widely used because it is fairly simple, reliable, and objective, is that of energy expenditure.

The field of home management has from its beginning been concerned with economizing the use of resources and with providing information on which the individual can base choices between alternate resources. This concern has resulted in the widespread use of energy expenditure studies with the aim of helping women economize in the use of energy resource. Workers in home management have engaged in energy cost studies as well as using the results of research from other fields.

In some of the research as well as the popular literature there has at times appeared to be a failure to realize the significance of the energy cost measurement of human work. To understand the significance it is necessary to know what is being measured in energy cost studies and their value for assessing the human cost of work.

INTERPRETATION OF ENERGY COST STUDIES

The relation between the amount of work performed, muscular activity, and energy metabolism has long been recognized. Nutritionists have measured energy cost to determine human caloric requirements. Physiologists have used the method to determine human working capacity. Energy expenditure of industrial workers has been measured to compare environmental conditions, methods of work, and design of workplaces in terms of severity of cost to the body. Research workers in home management have applied these techniques to the work of the home.

The method of measuring energy expenditure was introduced in this country during the late nineteenth century by an American chemist, Wilbur O. Atwater,* who demonstrated that the law of conservation of energy applies to human metabolism. Atwater and his co-workers, Benedict and Rosa, developed a respiration calorimeter for measuring human energy expenditure.

The basis of the measurement is that any muscle activity requires the oxidation of food within the muscle. Therefore the total amount of the body's muscle activity can be indicated in two ways: first, by the measurement of heat given off by the body (as a result of oxidation within the body), and second, by the measurement of both oxygen used and carbon dioxide produced or by measuring only the amount of oxygen used. The first method, measuring the amount of heat produced, is called direct calorimetry and requires the use of extremely delicate instruments inside an expensive heat-proof chamber. The other method, indirect calorimetry, requires less expensive equipment and simpler laboratories. It can be used even in field studies. This latter is the most common method and was used in almost all of the studies quoted in this chapter.

Either direct or indirect calorimetry is a means of measuring a rate of oxidation in the body as a whole. Because energy expenditure represents a rate of oxidation which occurs as muscles are used, energy cannot be saved and accumulated to produce a large store to be drawn upon at a time of greater need. On the contrary, muscles that are used far below capacity most of the time may fail at the time of increased need. That muscles increase in size with use and atrophy with lack of use is an accepted physiological principle. Every muscle has latent or unused muscle fibers which will develop with exercise. Exercise will also increase capillarization in the muscles. Muscles that are insufficiently used will be less well developed, less well supplied with capillaries and therefore less able to meet emergency demands.

Studies Reported in a Wide Variety of Units

One of the problems in the use of energy expenditure data by people interested in the work of the home but untrained in energy metabolism studies is the wide variety of units in which such studies have been reported. The original data are usually in cubic centimeters or liters of oxygen used per minute from which caloric equivalents may be calculated, since the oxygen consumed is directly proportional to the heat

* Columbia Encyclopedia and Encyclopedia Americana.

produced. The caloric equivalents may be calculated in Calories per hour, Calories per minute, Calories per hour or per minute per unit of work done, Calories per single procedure or cycle of the activity, Calories per hour or per minute per kilogram or per pound of body weight, or per square meter of body surface.

The calorie is almost always the large or kilocalorie unit, written with a capital C, seldom the small calorie which is written with a small c. But sometimes in manuscripts for publication the capital C is put in lower case and not corrected in the proof reading. Then the text may appear to be discussing small calories when the data were given in large Calories, 1,000 times larger than the lower-case calorie. All of this can easily lead to confusion in the interpretation of energy cost studies.

Of this situation Passmore and Durnin (1955:803) say:

"We have decided to give all figures as kilocalories per minute (Cal/min.) of gross energy expenditure. Values expressed as Calories per hour are liable to misinterpretation, for very few activities are carried out at a steady rate over such a long period. Both work and play take place more commonly in periods of varying intensity lasting a few minutes only and interspersed with rest pauses."

Studies Reported as Total Energy Expenditure or Net above a Resting Base

Since the rate of oxidation must be measured for the body as a whole, it includes the oxygen required for the visceral muscles in body maintenance and for the skeletal muscles in posture maintenance as well as for the skeletal muscles performing the work in question. The energy expenditure of these separate muscle groups cannot be studied separately, so the energy for external work alone cannot be accurately reported but is found by arbitrarily subtracting out the energy value for resting in some position. In research reports the energy expenditure for certain activities may include this resting base; sometimes it has been subtracted. To make application of energy-cost figures we must be sure how the data were reported. The picture is further confused by the practice of varying the choice of resting position and conditions according to the activity being studied; the measurement of metabolism may be made during periods of lying, sitting, or standing at rest with or without the conditions for basal metabolism. All of this affects the value for resting metabolism significantly.

Of the practice of reporting energy expenditure as a net above a

Table 7-1. Variety of Units for Reporting Energy Expenditure

Activity	Source	Energy requirement
Folding towels, standing	Bratton, 1959b	1.4 Cal/min
Hand sewing	Langworthy and Barott, 1920	69.8 Cal/hr
Hand sewing, net above resting	Langworthy and Barott, 1920	9.4 Cal/hr
Hanging out wash	Passmore and Durnin, 1955	4.5 Cal/min
Ironing		
Study a	Swartz, 1933	57.4 Cal/hr/sq m body surface
Study b	Langworthy and Barott, 1920	85.8 Cal/hr
Study c	Knowles, 1946	1.6 Cal/min
Paring potatoes, sitting	Swartz, 1933	42.8 percent above resting
Simple work, sitting	Passmore and Durnin, 1955	1.7 Cal/min

resting base, Passmore and Durnin (1955) say that deduction of the value for the basal or the resting state seems an unnecessary procedure. Gross values are more useful for assessing the energy expenditure for an activity, providing allowance is made for the weight of the subjects.

The state of affairs with reference to the units of measure and the inclusion or exclusion of a resting base shows up in Table 7-1. Obviously reports from the different studies for similar activities cannot be compared in the units in which they are reported. Whether or not the value for ironing in studies a, b, and c, for example, represents a similar magnitude of expenditure cannot be determined from the table. (The values for studies of ironing a and c are very close, if you assume a person of average stature; the value for study b is slightly lower.)

Directions for converting from the various caloric units to Calories per minute are given in Figure 7-1.

Energy Expressed as a Percentage Increase over a Resting Base

Sometimes the results of energy cost studies are discussed and conclusions drawn mainly in terms of a percentage increase over the rate for resting. This practice tends to obscure the actual magnitude of the rate of energy expenditure. The results of the Swartz (1933) study are

1. From Calories per hour

$$\frac{\text{Calories per hour}}{60} = \text{Calories per minute}$$

2. From cubic centimeters of oxygen used per minute

$$\frac{\text{cubic centimeters of oxygen used per minute}}{1000\ (1\ \text{liter})} \times 4.86 = \text{Calories per minute}$$

[The thermal equivalent of 1 liter of oxygen used equals 4.86 Calories at a respiratory quotient of 0.85. (Best and Taylor, 1961:756.)]

3. From Calories per hour per kilogram of body weight

Calories per hour per kilogram of body weight $\times$ body weight in kilograms $\div$ 60 = Calories per minute

(The body weight of each subject is usually given. 2.2 kilograms = 1 lb)

4. From Calories per hour per square meter of body surface

Calories per hour per square meter of body surface $\times$ surface area of each subject $\div$ 60 = Calories per minute

(When research is reported in this unit, the area of body surface for each subject is usually given. For a person 65 inches in height and 120 lb in weight, the surface area of the body is around 1.60 sq m.)

Figure 7-1. Conversion of caloric values of energy expenditure from various units to Calories per minute.

frequently used in this way, partly because percentage increase is a term more meaningful to the lay person than Calories per hour per square meter of body surface.

The danger of misconceptions arising from the discussion of results in terms of percentage differences without giving the heat production values may be explained in this way. In one study the total energy cost of reaching with the arms to 56 inches above the floor was 1.36 Cal/min; reaching to 72 inches above the floor, 1.64 Cal/min. If these same data are given as percentage above a resting base, the first is 24 percent above that for standing at rest and the second, 50 percent above standing. On this basis the energy cost for the higher reach would be said to be double that for the lower reach, which sounds significant. But since both values are under 2 Cal/min, the energy expenditure is not likely to contribute to fatigue. The higher reach may involve muscle strain, poor visibility, or a difficult and unsafe grasp. These are valid reasons for preferring the lower reach but they are not related to energy expenditure (Bratton, 1959a).

General Levels of Energy Expenditure

A more serious result of this situation for the home management specialist (who is not a specialist in the studies of energy cost) is that she has had to operate with bits and pieces of information and has not been able to relate them and build up a body of organized knowledge about energy expenditure for household tasks. This has interfered with the development of a sound understanding of energy as a resource for accomplishing the work of the home.

In order to develop an understanding of energy expenditure as a measure of the physical cost of work, it is more important to have a general knowledge of probable levels of energy expenditure for different kinds of activities than to know the specific average values resulting from any one study. There is a wide variation in results for even a standardized task from one subject to another and for any one subject from trial to trial.

In a study made by one of the authors, for one subject working at a standardized task under controlled conditions, the values for energy expenditure ranged from 1.09 to 1.46 Cal/min with an average of 1.26 Cal/min. In the same study, for one task, one trial, the values for 9 subjects ranged from 1.09 to 1.58. It therefore seems more useful to know not a specific average value for that study but that the energy expended for such an activity is likely to be between 1 and 2 Cal/min if the individual is normal as to health and body build.

Accordingly, Table 7-2 has been compiled to promote this kind of understanding rather than to present specific results of specific studies. In some cases the studies from which the figures were obtained were reported in units other than gross Cal/min, but sufficient information was given in the research report to recalculate the results to a common unit of measure. This reference table is intended to give a general indication, not a precise measure, of the energy expenditure for common activities.

Skattebol and Johnston overcame the difficulty of differing units of measurement and unorganized information by collecting results from a variety of sources, organizing the information under categories of related activities in the homemaker's day and giving an estimate for each category based on the information available. This compilation by Skattebol and Johnston may be found in Gross and Crandall (1963:550). This has the advantage of giving a clearer picture of the energy costs of the homemaker's activities. The information is given in Calories per hour per pound of body weight. In this form the relative magnitude of the energy

Table 7-2. Approximate Energy Costs for Selected Activities [a]

1 Cal/min
- Resting

1–2 Cal/min
- Light, sedentary activities
  - Sewing
  - Knitting
  - Paring potatoes
  - Machine sewing
- Standing activities
  - Ironing
  - Beating with rotary beater
  - Dishwashing
  - Reaching to 22 inches above floor
  - Reaching to 72 inches above floor
- Operating a vacuum sweeper

2–3 Cal/min
- Walking
- Sweeping
- Dust mopping
- Applying floor wax, long-handled applicator
- Hanging clothes from basket on floor or table
- Playing piano

3–4 Cal/min
- Washing floor
- Waxing floor
- Bedmaking, when changing sheets
- Reaching to 3 inches above the floor
- Cleaning carpeted stairs

Over 4 Cal/min
- Going downstairs, upstairs
- Picking up items from floor
- Dancing
- Gardening, weeding

[a] The value given for an activity is not an accurate reporting of any one study or an averaging of values from a group of studies. Rather, these values represent a fair estimate of total energy expenditure not a net above a resting base.

cost of various activities is apparent. The figures can easily be multiplied by a common body weight, such as 120, to get a fair picture of energy cost for an individual.

Effects of Duration and Frequency of the Activity

Besides the need for having the results of energy-cost studies in a common unit there is a need also to understand the significance of the duration and frequency of the activity. Activities which occur once a week for 30 minutes or daily for only a few minutes will not have an appreciable effect on the total energy cost of housework. If a woman climbed stairs 20 times a day she would probably spend less than 5 minutes a day in this activity. If we estimate the rate of energy expenditure for the round trip going up and coming down as 5 Cal/min, then for this activity the total requirement for the day's stair climbing would be 25 Calories. This represents the caloric value of half an orange or a quarter of a cup of orange juice.

There is one danger inherent in the short bursts of high-energy expenditure such as stair climbing in spite of the low total of energy required. That is the physiological stress resulting when the person who normally operates at a low level of physical activity makes a sudden physical effort far beyond the normal. There can be danger for the woman who performs housework all week at relatively low levels of energy expenditure, then for 1 or 2 hours in the week does hard physical work in scrubbing or other special cleaning jobs. The danger is not great for the person who maintains herself in good physical condition by frequent exercise beyond 2 and 3 Cal/min of energy expenditure.

Energy-Producing Capacity of the Body

The natural capacity of the muscles to produce energy without fatigue is another factor that has often been overlooked and needs to be understood when evaluating the significance of energy-cost studies for the work of the home. Of the total rate of energy expenditure which represents the capacity of the body to work without accumulating fatigue products in muscles, Passmore and Durnin (1955:833) say:

> ". . . in order to prevent evidence of fatigue the intensity of the working rate and the length of the compensating rest pauses must be so adjusted as to give gross over-all rates of energy expenditure of not more than 5 Cal/min. This they call an 'endurance limit.' It represents approximately the upper limit of work that can be performed without an increasing accumulation of lactic acid and without a rise in body temperature."

The meaning here is that when there is a steady expenditure of energy of 5 Calories or more per minute in a working day, the circulatory system could not continuously carry away from the muscles the waste products of oxidation. At this rate of energy expenditure, moreover, the heat produced from oxidation in muscles would not be dissipated rapidly enough and the body temperature would rise. Both of these effects would result in decreasing the capacity to continue work.

If we assume that Passmore and Durnin may be suggesting 5 Cal/min as the "endurance limit" for men and that for women of smaller build it should be lower, then we might think of 4 Cal/min as the limit for women. That is, on the average, women would need to be working at 4 Cal/min or higher in order for energy expenditure to be a factor in fatigue. Rates of energy expenditure only a little lower than 4 Cal/min at frequent periods would help keep the body of a healthy person in good physiological condition. (See Chapter 5 for beneficial effects of exercise.)

Energy Expenditure as a Possible Indicator of Other Costs to the Body

Since some of the higher energy-cost activities are fatiguing for some people, it has been suggested that even though the level of oxidation is not enough in itself to cause fatigue in the muscles, increased energy cost may be an indicator of other factors which are related to fatigue. It is true that emotional, mental, and environmental factors can influence the rate of metabolism.

On this subject Bratton has written (1959a:103):

"Could even a slight increment in energy cost be related to, and thus be an indicator of, other body costs which bring on fatigue? To prove that energy-cost measurements are accepted as a reliable indicator would require an elaborate research program directed specifically to this end. We are not justified in assuming that measurements of the lower rates of energy expenditure reliably indicate costs to the body which contribute to fatigue."

The energy expenditure when seated to work with the knees forced to one side was 1.5 Cal/min, which is slightly greater than that for standing to work, 1.4 Cal/min (Bratton, 1959b). Both these values are well below 4 Cal/min, the fatigue-producing level. In the original report of this study the author mentions that the subjects complained more of fatigue after the short test period of sitting to work with the knees forced to one side than after the equally short test period of standing to work. But the very slight increase in energy expenditure cannot be assumed to be directly related to the fatigue complaints. The feelings of fatigue were almost certainly due to the discomfort from postural restriction and the static work in local muscle groups not to the slightly increased rate of oxidation for the entire body. What is needed to provide a significant measure of the results of such work is an indication of physiological activity in the special muscle groups involved in the static work. It would not be possible to use rate of oxidation in the entire body as an indicator of fatigue in local muscle groups.

CONCLUSIONS FROM ATYPICAL RESULTS

It is important to look closely at the source of the data to determine such matters as the experimental design, the number of trials, the number of subjects and characteristics of the subjects.

The reason heat units are sometimes divided by a factor of body build such as weight or body surface is to take out a cause of variation due to the individual subject and not related to the activity being studied. This practice is more important when results are obtained from too few repetitions and too few subjects. When the number of repetitions and the number of subjects is large enough for even elementary statistical treatment, subject variations can be averaged out or calculated.

Results from Studies of One or Only a Few Subjects

Biological studies are likely to be expensive and time-consuming and the number of subjects limited. Too often our knowledge of energy expenditure has been based on tests of one or two subjects and occasionally the subjects were most unusual in some way. In one important energy-cost reference, the data for laundry activities and cleaning the floor were obtained from one female subject who weighed 84 kilograms, almost 185 lb. Energy-cost results from such an atypical subject would have to be adjusted to apply to the woman of average weight.

The value for ironing given by Passmore and Durnin in Scotland was 4.2 Cal/min compared to under 2 Cal/min in all of the American studies. This is rather a large difference. One possibility is that Scottish irons are heavier than American ones. However, the information given by Passmore and Durnin also shows that the value is based on tests of one male whose age was 19 years. It seems possible that a 19-year-old male might affect the results by ironing with more speed and less skill than the women subjects of the American studies.

The Use of Studies from Other Countries

The practice of basing our knowledge of the energy cost of household activities on the results of studies made in other countries can lead to erroneous conclusions about the severity of the work in this country. The suggestion above about the weight of the iron is one example. Another example from the compilation of data by Passmore and Durnin is seen in the value reported for "putting the washing through the mangle," 8 Cal/min. What is a mangle? To the American woman, the mangle may be a rotary electric ironer. Eight Cal/min represents really heavy work and putting clothes through this kind of a mangle cannot be considered heavy work. This activity might require energy at a rate slightly higher than "simple work, sitting," but not on the order of 8 Cal/min. One of the authors once consulted with a native of Scotland who could explain what a mangle is in that country. It turns out to be large rollers used for extracting water from clothes after washing and is operated by hand power; according to the Scottish informant it is extremely hard work. Such a piece of equipment would be most unusual in American homes.

One American textbook on the physiology of muscular activity mentions the caloric requirement for a woman on a washday as over 4,300 Calories. This is equivalent to the daily requirement for a man performing fairly heavy work. The list of references indicates that this figure is from a study made in Germany. For methods typically used by American women for washing, 4,300 Calories is extremely high. To require a total energy expenditure of that amount the housewife would have to average over 3 Cal/min for all of her waking hours. To one who knows the nature of the laundry job in American homes, such a rate of expenditure hardly seems possible. Whether the washing job in the German study included carrying water, the use of a hand-operated washing machine, or other heavy work, it must be assumed that the studies were made of work methods that are not normal for American homes.

REVIEW OF LITERATURE: ENERGY COST OF HOUSEHOLD ACTIVITIES

Among the earliest and most widely used studies were those of Langworthy and Barott published in a series of reports from 1920 to 1922. They measured energy expenditure for a variety of household activities from hand sewing to floor scrubbing. They used one subject only in each series of tests, and because they used the method of direct calorimetry, requiring the small, sealed chamber, the activities were necessarily restricted and some of the conditions were artificial. A life-sized doll was dressed rather than a live baby, and no water was used in the dishwashing and floor-scrubbing experiments. The results reported by Langworthy and Barott have commonly been quoted in Cal/hr as an increase above the energy required for a state of rest. If the energy required for the resting state is included and the unit converted to Cal/min, the requirement for all activities studied was under 2 Cal/min.

Swartz in 1933 published the results of a series of energy-expenditure studies by indirect calorimetry, which are widely known. The subjects were mostly college students and faculty members. From 2 to 7 women were used in each test. Energy costs were reported for paring potatoes in both sitting and standing positions, mixing batters and doughs, and several laundry processes. For most of the activities the energy costs were on the order of 2 or less Cal/min; for only the most strenuous activity (hanging clothes from a basket on the floor) did the energy cost go beyond 3 Cal/min.

Swartz (1933:9) was careful to point out that energy cost was not related to fatigue. "It should be remembered that it is total body activity that is measured by this apparatus, and not fatigue. . . . It is possible for a very light task to be extremely fatiguing. The following data, therefore, do not justify any comparisons as to the tiring effect of the task studied."

Studies of energy expenditure for household tasks have continued sporadically since those of the 1920's and 1930's up to the present. Selected results from some of these studies, along with some from earlier studies for comparison, are presented in Tables 7-3, 7-4, 7-5, 7-6.

A quick inspection of Table 7-3, energy expended for laundry activities, leads to the conclusion that these activities add considerably to the

Table 7-3. Energy Expenditure for Some Household Laundry Activities

Activity description	Source	Body weight of subjects	Total energy cost
		Kg	Cal/min
Taking out and hanging wash	Passmore and Durnin, 1955	80.0	4.5
Hanging clothes, basket on floor	Swartz, 1933	62.5	2.7
Hanging clothes, basket on table	Swartz, 1933	62.5	2.1
Bringing in wash	Passmore and Durnin, 1955	84.0	3.3
Ironing	Passmore and Durnin, 1955	67.0	4.2
Ironing at preferred-height board	Knowles, 1946	62.8	1.6
Ironing at "very high" board	Swartz, 1933	62.7	1.6

energy requirements for the homemaker. Before drawing this conclusion for a specific individual, however, some questions must be answered.

What is the weight of the individual? Weight does have an effect on the results, especially for those activities in which a larger proportion of the body is lifted. The individual who was the subject for some of the Passmore and Durnin experiments weighed 84 kilograms, about 185 pounds. The energy requirement would be lower for a person of smaller build.

Is this activity a normal part of the individual's laundry task? Hanging separate pieces of clothing on a line is very different from putting a load of clothes into the dryer.

What is the normal duration of the activity on a washday or weekly? If the individual spends 1 hour per week hanging clothes, we would multiply 60 times the selected value, 60×2.7, to find the total Calories required for the job.

In Table 7-4, miscellaneous household activities, the energy expenditure for many of the common activities is under 2 Cal/min. The higher rates appear to be characteristic of only those activities that are not frequent or are of short duration and so do not add much to daily energy requirement. If, for example, the homemaker reaches to 3 inches above the floor by trunk bend as much as 100 times per day, the total time involved is not likely to be over 5 minutes. The total energy expended for 100 such bends would therefore be less than 15 Cal.

Of the activities in Table 7-4 for which the energy cost is relatively high, only walking at the subject's own stepping rate should be expected to occupy any large amount of the working day. Studies of meal pre' aration have shown that the worker does walk fairly great distances, but these same studies have indicated that the time is not great. The walking trips during approximately a 1-hour meal preparation period occupied only 5 percent of the total time, or 3 minutes at the most—less than 9 Cal total.

It is difficult to select one representative value for ascent of stairs for a table of this sort. The energy requirement for this activity is markedly affected by the weight of the subject and the speed of ascent. It is certain, though, that stair climbing has one of the highest energy requirements of activities that are common in housework. But at normal rates of ascent, only a long stairway would require as much as ¼ minute for climbing. For a person with certain physical handicaps, stair climbing has some hazards because of the sudden stepped-up demand on heart rate and energy consumption. But these are not hazards for the well person. If someone is looking for ways of using up excessive food intake,

Table 7-4. Energy Expenditure for Some Miscellaneous Household Activities

Activity description	Source	Body weight of subjects	Total energy cost
		Kg	Cal/min
Simple work, sitting	Passmore and Durnin, 1955	84.0	1.7
Sitting, writing	Passmore and Durnin, 1955	64.0	1.9
Hand sewing	Langworthy and Barott, 1920	50.0	1.2
Chopping, one hand	Richardson and McCracken, 1966	60.0	1.4
Rotary mixing			1.5
Spoon beating			1.4
Reaching	Bratton, 1951a	52.8	
To 46 inches above floor			1.2
To 56 inches above floor			1.4
To 3 inches above floor, bending trunk			2.7
Walking	Richardson and McCracken, 1960		
Subject's own stepping rate		64.2	2.7
Carrying 18-lb load		61.5	4.8
Pulling 18-lb load		61.5	4.5
Ascent of stairs	Benedict and Parmenter, 1928	60.0	5.8
Gardening and weeding	Passmore and Durnin, 1955	65.0	5.6

a normal amount of stair climbing does not offer much help, because of the very small time requirement.

One study (Elliott, Patton, and Singer, 1963) that included stair climbing, more recent than the one cited in Table 7-4, has been omitted because the experimental method gave results that are not comparable to other studies of this activity. The measurement of energy expenditure was made over a 5-minute test period, which is common, but of this time only 8 seconds was required for the climb. For the remainder of the test time the subjects stood quietly at the top of the stairs. This produced a value much lower than those from other studies.

From the evidence presented in Table 7-5, it appears that many of the activities of higher energy cost in homemaking occur in care of the house.

Table 7-5. Energy Expenditure for Activities in Care of the House

Activity description	Source	Body weight of subjects	Total energy cost
		Kg	Cal/min
Cleaning windows	Passmore and Durnin, 1955	61.0	3.7
Scrubbing, kneeling	Passmore and Durnin, 1955	48.0	3.4
Clearing the floor, kneeling and bending	Passmore and Durnin, 1955	84.0	5.9
Floor care	Hoopes and Patton, 1963		
Sweeping w/broom		61.0	2.9
Dust mopping			2.7
Washing floor			
On hands and knees			3.7
W/sponge mop			3.1
Waxing floor			
On hands and knees			3.3
W/applier			2.6
Vacuuming			
1 ft/sec, upright sweeper	Swartz, 1929		1.6
1.2 ft/sec, upright sweeper	Richardson, 1966	56.9	1.6
1.2 ft/sec, tank and canister sweeper			1.7
Cleaning carpeted stairs w/tank-type sweeper	Elliot, Patton, Singer, 1963	60.9	3.1
Bed making, bed 20 inches high (includes changing sheets)	Elliot, Patton, Singer, 1963		3.4

The value given by Passmore and Durnin for scrubbing, in a kneeling position (3.4 Cal/min) is similar to that for washing the floor on hands and knees (3.7 Cal/min) given by Hoopes and Patton, even though there is quite a difference in the weight of the subjects. This difficulty in knowing all variables that may affect results is one bit of evidence as to why it is more meaningful to have in mind general levels of energy cost than results of specific studies.

It is interesting that the value given for vacuuming in the 1929 study is the same as the one for the 1966 study on the same rug type and at a similar speed of operation. There was one subject for the 1929 study, there were 5 for the 1966 study.

For many years, the claim was made that sitting to work would save energy to the extent of 8 percent compared to that used for standing to work. This misinformation may have arisen from the fact that the body does use less energy for sitting quietly than for standing at rest, and some studies have shown the difference to be 8 percent. That this claim was not true for working was evident from the result of the Swartz study of 1933 (Table 7-6). The first report of the Bratton study, with results similar to those of Swartz, came out in mimeograph in 1957 and was published 1 year later (Bratton, 1958). Similar information was published in *Agricultural Research* (October 1961) from a study done at the USDA. In 1966 Richardson and McCracken again confirmed the relationship of the energy costs for sitting and standing to work.

A representative sampling of the results from the 1933, 1959, and 1966 reports is shown in Table 7-6. The dough-rolling task for the Richardson and McCracken study was probably more strenuous than the potato-paring and towel-folding tasks of the other studies, giving a higher total energy cost but with the same relationships and the same minute differences between costs for sitting and standing. The implications of all three studies are similar. After all these years and this number of confirmations, no longer should we tell homemakers to "sit to save energy." Whether or not the energy cost for sitting to work is even slightly less than for standing to work seems to depend on how you sit. In any case, the differences are so slight and the total energy cost for tasks that can be done sitting is so low that in a practical way there is no difference. Sitting to work will undoubtedly save the feet but not enough energy to matter, whether the need is to save energy or to use more to counter-

Table 7-6. Energy Expenditure for Household Activities Performed While Sitting and Standing

Activity description	Source	Body weight of subjects	Total energy cost
		Kg	Cal/min
Paring potatoes	Swartz, 1933	58.6	
Sitting on chair			1.2
Sitting on stool, knees forced aside			1.3
Standing			1.3
Folding towels	Bratton, 1959b	53.0	
Sitting, knees under counter			1.4
Sitting, knees forced aside			1.5
Standing			1.4
Rolling dough	Richardson and McCracken, 1966	63.4	
Sitting on chair			2.3
Sitting on adjustable stool			2.2
Standing			2.0

act too many food calories. There may be valid reasons why a homemaker should provide opportunities to sit as she works, but saving energy isn't one of them. After more than 30 years of similar research results, that should be settled.

The claim that housework is heavy work is not true for most homemakers who have the modern equipment usual in this country. Mothers with young children needing to be picked up and carried and needing to have everything done for them are probably the chief energy users of today's homemakers. That the energy requirement for most women using present-day methods of household work is low can be checked by a study of some of the reference tables in this chapter along with information about the use of time in homemaking tasks.

Refer to Table 7-2, then try to estimate, or ask some homemakers to estimate, how many minutes per week or per day is likely to be spent in those activities that use energy at a rate of more than 3 Cal/min. For help in making an estimate, refer to reports of the duration of homemaking activities in Tables 10-8 and 10-9. Would the homemakers of your acquaintance spend more than 2 hours a week washing and waxing floors? If 2 hours per week is an acceptable estimate, then at 3.5 Cal/min she would use 420 Cal for that job for the week, not equal to the number of Calories in two servings of cake or pie. This rate is still below the limit of endurance for work continued for long periods of time.

We could start with information from the studies of the homemakers' use of time. The average time used for a weekday for homemakers is given in Table 4-2. In which of these activities in Table 4-2 are there likely to be tasks that require over 3 Cal/min and for what proportion of the time? From the information in Table 7-2, probably only the tasks related to care of the house and laundering with the nonautomatic machine and no dryer would require that rate of energy expenditure. Much of the heavier household work is done weekly, so that the proportion of time in the homemaker's week that goes into these heavy tasks is small. Observation will show also that many activities which require the higher rates of energy expenditure seldom continue uninterrupted for long periods. The strenuous activity is usually intermittent with less strenuous activities, minute by minute. This seems to justify the claim that the present caloric requirement for household work in the United States is low.

The rationale of energy-expenditure studies in the field of work simplification implies that the information resulting will provide a valid basis for design of equipment, workplace, or choice of work method. Before accepting this point of view we must be very clear as to what has been measured and what is the significance of the measure for the worker. What has been measured is the rate of oxidation of food in muscles of the entire body. This is the normal physiological function of the body and its reduction by minute amounts is not a useful goal of work-saving methods. For the well person and for a sedentary population, an increase in energy expenditure would be more to the point. Unfortunately the most time-consuming aspects of housework do not offer much opportunity along this line.

To see the need for reducing time or effort that goes into housework and to offer energy-cost information to further this aim is to show a lack of understanding of all three—time, effort, and energy expenditure. It is important to understand the functioning of all systems of the body involved in work performance. More help for those who need it, whether the physically handicapped, the elderly, the wife with outside paid or volunteer employment, will be available from the field of home management if we can break out of the narrow limits of the concepts of saving energy and saving steps.

In the following chapter some of the other physical costs of work, hopefully measurable, are discussed in order to strengthen this broader view of easing work.

CHAPTER 8

Other Measures of the Physical Cost of Work

There are possibilities for measuring some aspects of the physical costs of work other than energy. Some of the research aimed at measuring those other indicators of fatigue and reduced capacity for work are discussed in this chapter.

THE LOCUS OF MUSCULAR FATIGUE

It has often been assumed that the locus of fatigue effects from physical work is in the muscles, and that the locus of fatigue effects from mental work is in the brain or central nervous system. A broader view is desirable. Remembering the postural aspect of work, we can see that the feelings of tiredness resulting from a long period of mental work at a desk may be the physiological result of static muscular work as well as some unexplained stress on the nervous system. Remembering that the motor unit is neuromuscular and that the nervous system is a physiological one, operating by electrical and chemical changes, it is possible that the seat of fatigue from the use of muscles may be in the nervous system as well as in the muscles themselves. To go a step further, it is evident that feelings of fatigue from anger or frustration can give rise to physiological changes in the nervous system, probably the central nervous system, and so affect the functioning of muscles.

At one time there was hope that chemical changes in the active muscle might provide a reliable measure of fatigue. Chemical changes do occur in the working muscle but have not proved to be a general indicator of fatigue. First, the chemical changes in an active muscle with normal circulation represent normal physiological functioning and not necessarily fatigue products. Measurements that indicate an increase in the amount of lactic acid in a muscle after its contraction are not now considered to be a reliable indicator of muscle fatigue. Second, muscle fatigue can be shown to be related to failure at some point in its nerve connections, not always in the muscle itself. Ryan and Smith (1954:293) say:

"For some years it was thought the muscular fatigue could be explained in terms of chemical changes taking place in the muscles as they contracted. While these chemical changes undoubtedly are present and have something to do with the total effect which we call fatigue, it is now clear that they are by no means the most important factors. The most important factors are some, as yet unknown, changes in the central nervous system."

The question as to whether muscular fatigue is due to chemical changes in the muscle itself, neuromuscular block, or central nervous system fatigue is not yet entirely settled. In an important study, Merton (1954) showed that, in single muscle experiments, blood supply is the significant factor and that the fatigue is in the muscle itself. This finding seems to reemphasize the importance of chemical changes in the muscle as a cause of fatigue. The significance of Merton's finding for the practical working situation is not conclusive, however, for as Merton (1954: 563–564) points out:

"This conclusion may be artificial . . . because the experiments lasted only a few minutes and the movement investigated involved little skill. Most small movements that are of practical interest as regards fatigue are skilful [*sic*] and repetitive for long periods, so that deterioration in performance may well be central in origin, but if the short-term strength of the muscles themselves is important, then the conclusions of this paper are relevant."

It seems that we should continue to allow, as many authors agree, that an important aspect of muscular fatigue is in the central nervous system.

INDICATIONS OF CHANGE IN THE CENTRAL NERVOUS SYSTEM

Feelings of tiredness, so well known to everyone, are so difficult to measure objectively that they are often considered to be unreliable indicators of fatigue. Perhaps they are for research purposes, but for most of us they are *the* indicator of fatigue. If we *feel* tired we *are* tired. The fact that they are hard to measure for purposes of objective comparison does not weaken their importance. It merely indicates the weakness in our measuring devices. It seems evident that a phenomenon so widely observed is real and not imagined. Whether the feelings of tiredness result from a long period of work or from poor morale and inertia, they are likely to arise from some actual physiological changes in the body, probably in the nervous system.

Ryan and Smith (1954:290) comment that "feelings of tiredness must . . . depend ultimately upon specific physiological phenomena."

Efforts to analyze, to localize, and to measure changes in the central nervous system that may accompany work performance are therefore of interest to us and have shown some promise as significant indicators of the costs of work under differing conditions.

Muscle Tension as an Indicator of Effort

Effort expended is commonly accepted as a cost of work. If work is hard, greater effort is required to perform it. Effort can properly be considered as part of the cognitive component of work but because of its tendency to be expressed in muscle tension, it is included here in a study of the physical measurement of the costs of work.

Effort is a phenomenon of the central nervous system and is often expressed outwardly in increased tension in various muscle groups. The idea of "trying hard" seems to be accompanied naturally by the idea of tensed muscles and thus lends itself to objective measurement. The child who is learning to write must expend more effort in writing than the skilled writer. He therefore grasps the pencil more tightly and presses harder against the paper. The tense muscles do not contribute to the writing but are an indication of the extra effort he needs in order to write.

Since the amount of force exerted is thought to be a clue to the amount of effort required for an activity, and the amount of effort is likely to change with the increase of fatigue, this measure has been used in studying work method and equipment design.

In an early study of metal polishing in a cutlery factory in Great Britain (Farmer, 1921) 2 workers were studied as they performed 1 operation in polishing metal spoons. Tests were made at 4 periods throughout a workday which ran from 8:00 A.M. to 5:30 P.M. There was a consistent increase throughout the day in the time required to polish the bowls of 4 spoons and in the amount of pressure exerted as the spoons were held against the wheel. The authors assumed that the increase in total time required and in pressure exerted resulted from fatigue.

One skilled worker worked rhythmically, removed a small amount of metal in the polishing, and did excellent quality work. She increased the pressure somewhat during the day. The increase in pressure was much greater for the less-skilled worker whose body movements were jerky, who removed an excessive amount of metal, and who used more time for 4 spoons.

The results of this study of 2 workers for a few tests are not conclusive, but the study gives some evidence that the amount of pressure exerted did increase from the beginning to the end of the day.

There is a study by Knowles (1944) on the effects of the height of the ironing surface on the worker. The data from this study on the amount of force exerted on the ironing board were examined in the light of this theory of effort. There were only 4 subjects in the Knowles study but it is a landmark, for it is one of the few studies that attempted to assess several of the physiological costs of a household task.

(Knowles was comparing the effects on the worker of the use of two heights of ironing surface. The one she called the standard was 31 inches in height. (The adjustable-height ironing board was not widely available at the time.) The other, the preferred height, was adjusted to each subject's preference on the basis of testing. All of the preferred heights were higher than the standard ironing board; three were 34 inches and one 35 inches.)

With 5 tests for each of the 4 subjects both at the standard-height and preferred-height ironing board, 20 comparisons between the two heights of ironing board are possible. Of these 20 comparisons, 15 showed a greater exertion of force (hence effort) at the standard-height board. Of the 5 comparisons which did not show an increase, one was the same and one was so much lower (on the order of one-half) than all other values for that subject that it appears to be open to question (compiled from Knowles, 1944:157, 167, 179, 189). Since a major objective of the study was to compare the physiological effects from the use of the standard- and the preferred-height board, the amount of force exerted appears to have been a reliable indicator of difference in the amount of effort required for the use of the two boards.

If we assume that fatigue from ironing would be gross and not localized in small muscle groups, we might assume that a relatively long period might be required to induce fatigue or noticeable changes in the effort required to continue working. Data were available for a relatively long ironing period (about 3 hours) at the preferred-height ironing board. The values for amount of force exerted for ironing both flat work and shirts at the beginning and at the end of this long ironing period appear in Table 8-1.

Table 8-1. Force Exerted on the Ironing Board at the Beginning and at the End of a 3-Hour Ironing Period (Average of 3 Days for Each Subject)

Subject	Pillowslips and napkins: Beginning	Pillowslips and napkins: End	Shirts: Beginning	Shirts: End
	Pounds per second			
A	7.3	7.9	7.9	8.4
B	6.7	8.7	9.4	8.1
C	5.1	5.7	5.8	6.2
D	5.3	9.6	6.8	9.6
Average	6.1	8.0	7.5	8.1

Source: Knowles (1944:159, 171, 182, 193).

For ironing flat work, all subjects increased the force exerted from the beginning to the end of the long ironing period. For ironing shirts, 3 subjects increased the amount of force exerted but Subject B did not. In her recorded comments about the work elsewhere in her thesis, Knowles says that Subject B let the quality of the shirt ironing go down at the end. Of Subject D, who had the highest increase in force exerted from beginning to end, Knowles commented that she complained bitterly of fatigue near the end of the test but did not let the quality of the ironing go down. These two bits of evidence provide an interesting clue that the affective component may have influenced the results. It would be interesting to test the hypothesis that some subjects, when they get tired, give up and expend less effort and others try on to the end even at greater cost to themselves. When results from these two personality types are put together in a study of force exerted, they tend to average each other out and make the results appear insignificant. Perhaps some kinds of personality tests need to be used in conjunction with this measure of effort in order to separate those who give up after becoming fatigued from those who do not.

The measurement of force exerted as an indicator of effort should suggest some interesting possibilities for the study of household work. Additional studies of this kind would, of course, be needed before conclusions are warranted. If the number of subjects were sufficiently large and tests could be devised to sort out those who give up and those who try doggedly to the end, it might be possible to test some hypotheses about work method and equipment design.

Finger Tremor

Finger tremor is another measurable phenomenon thought to result from changes in the central nervous system brought about by fatigue. Morgan (1965:302) points out: "Probably the most important of all factors in coordinated movement is restraint or inhibition." Tremor can result from interference with these mechanisms.

A more detailed explanation of what happens when the "restraining mechanisms" are interfered with is given by Basmajian (1962:10–11):

"Now, it is apparent that even the larger bundles of muscle fibers are quite small and that a strong contraction of a skeletal muscle must require the contraction of many such motor units. A fundamental principle governing such contraction is that there must be a complete asynchrony of the motor unit contractions imposed by asynchronous volleys of impulses coming down the many axons. All the motor units are contracting and relaxing with twitch-like action at differing rates up to 50 per second. The result of a continuous shower of twitches with different frequencies within a muscle is a smooth pull. In certain disturbances, however, the contractions become synchronized, resulting in a visible tremor."

On the theory that fatigue effects in the central nervous system would be likely to interfere with the restraining impulses that help to produce coordination of motor units, attempts have been made to relate tremor quantitatively to fatigue. Results of some of these studies have been disappointing in that the relationship has not been consistent between tremor measurements and factors that might be assumed to influence fatigue.

One study of household work using finger tremor as a measure did not give significant results in relation to the variables being studied. Mize et al. (1956:18), studying space requirements for baking centers, used finger tremor as one means of evaluating 3 sizes of work surfaces. They report, "No significant differences were found between these three sizes of surfaces for differences in finger tremor. . . . There was slight evidence that some differences in finger tremor were accounted for by the order in which the different surfaces were used. . . ."

This may point to a problem that was taken care of by the long ironing period in the Knowles study. The total test period for the study of surfaces for baking centers was about 2 hours, but the test periods for the variables in working surface were under 25 minutes. Duration of the working period is probably of great importance for work involving many groups of large muscles; short work periods, such as are used for localized groups of small muscles (as in finger-tapping tests), do not in practice induce fatigue. If the working period is too short to induce fatigue for the type of activity being studied, no fatigue indicator will show significant differences among the variables of working conditions.

MEASUREMENTS OF POSTURAL ALIGNMENT DURING WORK

Since working posture was known to affect the physical costs of work, photographic techniques were developed for objectively measuring the amount of postural deviation during work. Knowles (1946) used motion pictures and made frame-by-frame measurements of the angle of trunk bend. The impetus for developing the technique came from her preliminary observations of women ironing in their homes. Knowles (1946:14) explains:

"While watching the women ironing in their homes, the investigator was impressed by their poor body positions as they worked. Much of the time they stood with shoulders stooped, head far forward, hips protruding, and abdomen sagging, at a board which was obviously too low. Throughout the period the subject would occasionally raise the trunk of the body to a good vertical position, stretch, draw a deep breath, then assume the slumped position and resume work."

Knowles reports that the average angle of bend for the subjects in the laboratory study of ironing increased progressively as the ironing board was lowered. When the ironing board was at its lowest height, the subjects tended to remain in the bent position. When the board was at the intermediate heights they attempted to assume an upright position after each reach across the board.

Knowles concluded, on the basis of these postural and of the physiological measurements, that the standard, 31-inch ironing board is not a good height for everyone and showed that the heights chosen by the subjects when a choice was offered were less costly to the body. Immediately after the publication of the Knowles study, an adjustable-height ironing board came on the market; since then the adjustable board has become commonly available.

Later the photographic technique was adapted and used by Steidl (1955a) to study the effects on trunk bend of the use of ovens at different heights.

An improved method of measuring postural attitudes in three dimensions during work was developed by Agan et al. (1965).

Keiser and Weaver (1962) made adaptations of the technique of postural measurements from films, one of which was angle of knee bend. They also determined correlations between the postural measurements and energy expenditure, both for bedmaking and stair climbing. They concluded, "Correlations between angles of body movements and energy expenditure in stairclimbing indicated that there was a positive relationship. Angle of knee bend correlated more closely with energy expenditure than any other measurement made for this activity" (p. 482).

Measurement of Upper-Arm Lift

The photographic technique was adapted to measure the amount of upper-arm lift in order to provide an indirect assessment of the amount of static work for the arms in certain working positions. The effects on the arm lift of the worker from standing and sitting at counters of varying heights and on different chairs or stools, was studied in this way during a standardized towel-folding activity (Bratton, 1959b). The results were reported as mean angle of arm lift and as a percentage of all film frames that were above a somewhat arbitrarily chosen comfort level. For a group of 10 subjects, all of average stature, in 3 working positions the results are given in Table 8-2. Since working with lifted arms does involve unnecessary cost from static work, then the difference in proportion of time the arms are lifted above 35 degrees for sitting and for standing to work, is great enough to account for some of the discomfort associated with work in the seated position.

For these measurements of the angle of arm lift, the movements of the subjects during work were not all in one plane. Therefore, the angle readings do not give a complete and accurate picture. But since the

Table 8-2. Percentage of Film Frames with Underarm Angle of Lift 35 Degrees or More (10 Women of Average Stature)

Working position	Underarm angle, 35 degrees or more
	Percent
Sitting, 36-inch counter on 24-inch stool, knees under counter	84
Sitting, 36-inch counter on 24-inch stool, knees to side	85
Standing, 36-inch counter	35

Source: Bratton (1959b)

method of the research specified a uniform placement of the camera in relation to the subjects during photographing and a uniform placement of the projector for the angle readings, the same error was operating for all subjects. The technique does appear to give some measure of the effects of the work on body alignment.

ELECTROMYOGRAPHY

Biologists have known for one and a half centuries of the electrical properties of muscle. Galvani, the Italian anatomist, discovered that skeletal muscles contract if they are stimulated electrically and that they will produce electrical voltage when they contract from any cause. Karpovich (1965:17) explains that "Activity in a muscle, as in any living tissue, is accompanied by the production of an electric current," usually called the action potential. He says further, ". . . whenever a muscle is stimulated, the activated part becomes negatively charged with respect to the inactive parts; and the resulting difference in potentials gives rise to an electric current" (p. 18).

Electromyography is the measurement of electric phenomena occurring in muscle during contraction and can be used to determine if certain muscles are acting or not acting in different positions or movements of the body. As a research method, it has become widely used in England, the Scandinavian countries, Canada, and the United States and promises to contribute to our understanding of how the body performs work. Over the past decade or more the improvement in method and refinements in the equipment have produced information which may supersede some long-held concepts of the working of the muscular and skeletal systems. The equipment is similar to that used in making electrocardiograms; the electrodes used may be placed on the surface of the skin as for electrocardiograms or a needle electrode may be inserted into the muscle.

The research can be done only by persons with a high degree of specialization in anatomy because of the necessity for highly refined techniques for identifying muscles at different depths and for interpreting the facts provided by electromyography. The significance of results can be interpreted only by one who has a good understanding of complex interrelations among the muscular, skeletal, circulatory, and nervous systems.

Basmajian (1962) provides an introduction to electromyography and reviews the studies of his own group and of others, giving information that was not heretofore available on postural mechanisms and the fatigue of muscles. Electromyography as a research technique may change some of our long-held ideas about the contributions of specific parts of the muscular-skeletal system to the functioning of the body in its environment.

Basmajian and his co-workers have come to the conclusion that ligaments "play a much greater part in supporting loads than is generally thought . . ." (p. 72). By way of introduction he says: "Hardly any informed person would doubt that when gravity acts on the upper limb, and certainly when the limb carries a heavy load, muscles are the chief agents in preventing the distraction of the joints. Yet, recently, we have concluded that this is a false belief."

In one of his series of studies of the shoulder and elbow region, the subject was seated with his arm hanging in the relaxed neutral position. The arm was subjected both to a load of 16 lb held in the hand and to a sudden heavy sustained downward pull by an observer.

"Contrary to expectation, the vertically running muscles that cross the shoulder joint and the elbow joint are not active to prevent distraction of these joints by gravity. . . . Much more surprising is the fact that they do not spring into action when light, moderate, or even heavy loads are added unless the subject voluntarily decides to flex his shoulder or his elbow and thus to support the weight in bent positions of these joints. Quite often, he may do this intermittently or, when uninstructed from the very onset. But it must be clear that such muscular action is a voluntary action and not a reflex one" (Basmajian, 1962:75).

Of the fatigue from such load-bearing, Basmajian says: ". . . our experience has shown that the fatigue experienced in heavily loaded upper limbs is not accompanied by any significant muscular activity. Yet 'fatigue' becomes unbearable. This particular type is apparently due to the painful strain on the ligaments and capsules" (p. 48).

We mentioned earlier the finding of Basmajian's group that for quiet standing the arches of the foot are maintained by ligaments rather than by muscles and that the discomfort of the fatigue of standing is due to pressure upon the connective tissues.

Electromyographical research has strengthened some of our concepts of body mechanics that were formerly based partly on speculation. Several studies reviewed by Basmajian have shown that during forward flexion of the trunk a major back muscle (sacrospinalis) is active at the beginning and during partial flexion but is inactive at extreme forward flexion. This would mean that in the early stages of heavy weight lifting from the floor the load is borne by ligaments only. "This observation appears to confirm strongly the dangers to the vertebral ligaments and joints of lifting 'with the back' rather than with the muscles of the lower limb . . ." (Basmajian, p. 93). The same situation holds for full trunk flexion in the sitting position. Floyd and Silver (1955) showed that this position (considered bad posture) may be maintained comfortably for a long time by some people and that the large back muscle remains completely relaxed. This position is not recommended, however, by them or by Basmajian, because the relaxation of the sacrospinalis muscle and dependence on the ligaments including the intervertebral discs has dangers, especially to the discs.

These studies showing the activity and inactivity of certain muscles in various positions and when body and other weights are borne by ligaments provide information about methods of work performance in the home. Work performance with relaxed muscles across joints, allowing ligaments to carry the load, has inherent danger of injury to the body.

The effects of wearing high heels, studied by means of electromyography, include increase in the activity of calf muscle due to the shifting forward of the center of gravity. Basmajian remarks that, "One would have expected that in women wearing high heels the well-known compensatory spinal lordosis would be a sufficient adjustment. Apparently it is not" (p. 89).

Electromyographical studies show some promise of contributing to our understanding of fatigue. Lippold, Redfearn, and Vučo (1960) explain that some authors say there is no change in action potentials in the muscles with fatigue, but their studies indicate there is. They believe that, with continued use of the technique, they have learned to recognize changes in the recording that could indicate fatigue. Concluding their discussion, Lippold et al. (p. 130) say: "Looking at the variety of changes which occur during muscular fatigue it is clear that fatigue effects take place at all levels of neuromuscular organization. The relative importance of the changes is determined largely by the strength, duration and nature of the contraction."

It is possible that electromyography may in the future contribute further to our understanding of how the body performs physical work.

PART II

The Work

CHAPTER 9

Description and Analysis of Work

Work is examined for various purposes and by various methods. Although the work of the home differs from employment work in many ways, analysis of the methods of studying work in other fields can be useful, for we can relate the approach and the results to our purposes. It is often through contrasts in situations that clarity is obtained. Ideas for developing a different approach may also be found.

The terms job and task are used with differing definitions. When we refer to job we mean the position or the total array of responsibilities. A job may comprise a few or many responsibilities and activities or tasks. Tasks, then, are subunits of job. For the homemaker, the sum of her responsibilities is her job; the job comprises many tasks, such as dishwashing, meal preparation, bathing children, marketing, or shopping. Tasks, of course, can be further divided into smaller units, and psychologically each unit may constitute a task. Grocery shopping may logically be the task as well as selecting the meat, fresh vegetables, or other items. The size of the task is variable.

TRADITIONAL APPROACHES

The traditional approach to the study of work encompasses job description, job analysis, and job evaluation. Each has a different purpose. The "job aspects" and the "man aspects" receive different emphasis because the ultimate use of the information varies. The information may be used to describe the job rather specifically (with respect to duties, qualifications, and requirements) in order to inform the worker what is expected of him; to analyze the job to determine training content and personal specifications, and improve efficiency; or to evaluate the job from the standpoint of wages. These techniques provide a broad analysis of the work. This is in contrast to the more specific analyses that we obtain through motion and time study of work.

Job Description

A job description provides the basis for job analysis and job evaluation. A job description is quite detailed in order to provide essential information for further analysis. Ryan and Smith (1954:35) point out that a job description for selection and placement should include "what the worker does and how often, how his work is initiated, the degree and closeness of the supervision he receives, the extent to which his work is checked by others, the nature and consequences of errors, the place of the job in the organizational structure of the company, and numerous other observations, ratings, and data. . . ." This content differs somewhat from the description of household work because the working situation differs. The questions of supervision by others, errors, and the place of the job in the organizational structure of the company are not a part of the content of a job description of household work. The ultimate use of the information also differs. The description of homemaking by Gilbreth (1927:vii) had the stated purpose of making homemaking "as interesting and satisfying as it is important." We, too, have this broad purpose.

In industry, sources of information for a job description include records and reports, interviews with workers and supervisors, observation of the job, direct experience on the job, and examination of characteristics of present workers. Sources of information for describing the work of the home include the various research studies based on observation, film analysis, interviews, mailed questionnaires, and diaries kept by homemakers. The researcher's personal experience on the job is another source of information just as in industry.

Job Analysis

In industry, job analysis provides the basis for selection and placement of workers. This use of job analysis serves four main functions: it establishes a priority system for selection and placement on the jobs; it establishes criteria of job success; it furnishes a preliminary estimation of the traits which may be evaluated in selecting persons for the job; it estimates traits which may differentiate success on one job from success on another (Ryan and Smith).

One approach used by industrial psychologists is to identify criteria of success on the job and then identify traits that will predict the criteria of success. Traits, relatively independent characteristics, may be personality, social, or physical characteristics; interests; abilities; and aptitudes. More specifically, we might examine sensory abilities, perceptual abilities, speed, manipulative and psychomotor abilities, verbal abilities, rote memory, numerical ability, reasoning abilities, and skills (Ryan and Smith).

The U.S. Employment Service has also tackled the problem of identifying worker traits for use in referring workers to a company in the absence of exact specifications. Basic trait requirements were grouped into six components: training time, aptitudes, temperaments, interests, physical capacities, and working conditions (Fine, 1958).

In another approach to the problem of matching training, abilities, and experience to job requirements, "worker functions" were identified (Fine, 1955). "What the worker does on the job" was studied rather than "What gets done on the job." The idea was that knowledge of the worker functions across occupations would point out the relationships among occupations and common requirements, thus permitting better placement and utilization of manpower.

A job analysis of household work by Smith (1962) provides an example of another purpose, that of providing a basis for house arrangement. Smith obtained a description of the person or persons performing the activity in the home, the time and location involved, the equipment and furnishings used, the frequency with which the activity was performed, and the specific components of the activity. She studied also the changes that the homemaker made from one activity to another. Analysis of this descriptive information provided the basis for recommendations for arranging rooms in homes.

Comprehensive analyses of homemaking work permit us to identify common requirements among the tasks as well as the variables. Such information can help us plan work for a preferred level of input and output, accomplishment, and variety.

Job Evaluation

Job evaluation provides information to compare the relative worth of jobs within an organization. Lanham (1955:28) explains: "Job evaluation determines the relative order of importance of a series of jobs, based on the duties, responsibilities, and requirements for performance, by analysis, description, and evaluation of those factors in an orderly and systematic way." The job description provides the basis for the rating of the various characteristics set up for the job evaluation plan.

Elliott Jaques (1961:99) believes that equitable payment for employment work should take into consideration the "time-span of discretion." He defines this as "the period of time during which marginally sub-standard discretion could be exercised in a role before information about the

Perhaps the writer isn't fooling as much as it might appear in this job description "perpetrated by a job analyst in an idle moment while his *frau* exercised considerable initiative, ingenuity and judgment in the semi-routine performance of a normal 18-hour day." Obviously the job is "frightfully out of line in any wage or salary structure."

Job Title: Housewife

By Harold W. Jacobson, Job Analyst
National Company, Inc., Malden, Massachusetts

Grade: *HIGH*

Description:

Functions in several capacities and offices performing a wide variety of duties semi-routine in nature but where the exercise of independent judgment is required in the application of practices and policies to situations not previously covered:

Effects the purchase of a wide variety of organic materials for processing, giving special consideration to costs, market conditions, and state of material. Plan, layout, and schedule processing operations, maintaining strict control of flow and inventory to meet schedules. Conduct necessary chemical operations, using various heat treatments as required to transform basic organic materials into completed form for distribution to consumer;

Maintains budgeting, cost control, and cost accounting systems, operating within a limited financial framework. Strike semi-monthly trial balances to determine relationship between accounts-payable and accounts-receivable and, as required, perform necessary magic to bring accounts into balance;

Operates and maintains a variety of manually and electrically powered equipment for heating, cooling, stitching, suctioning, cleansing, etc.;

Performs other miscellaneous duties of a routine nature not specifically mentioned, but where such duties are a normal outgrowth of the job.

Figure 9-1. A job description. (*Source.* Jacobson, 1953: 32: 145–146.)

SUBSTANTIATING DATA

EDUCATION:

This factor appraises the minimum amount of theoretical education required, however attained.

Broad general knowledge of several specialized fields such as chemistry, mechanical and electrical engineering, marketing, accounting, and fundamentals of human relations.

COMPLEXITY OF DUTIES:

This factor appraises the need for initiative, ingenuity, and independent judgment.

Perform a wide variety of semi-routine duties directed toward the attainment of a general objective: the physiological and psychic welfare of a small social group. Performance requires the use of judgment in devising new methods and modifying or adapting standard practice to meet new conditions.

RESPONSIBILITY:

This factor appraises the responsibility for equipment, material, process, and health, safety, and work of others.

Complete responsibility in terms of costs, methods, and personnel for equipment, material, process, etc. Supervise and direct one inept male in the performance of a limited number of routine duties such as: rub, scrub, sweep, brush, mop, polish, etc.

EFFORT:

This factor appraises the mental and/or visual demand required.

High degree of concentration where the volume and nature of work require unusual coordination of hand and eye.

WORKING CONDITIONS:

This factor appraises the surroundings or physical conditions under which the job must be performed. It includes health and accident hazards.

Somewhat disagreeable working conditions due to exposure to dust, dirt, heat, etc. Exposure to accidents where results will probably be minor in nature: cuts, bruises, burns, etc., which, although painful, are not incapacitating in nature. Health hazards negligible. Fatigue factor high.

Figure 9-1. (*continued*)

SUBSTANTIATING DATA

EDUCATION:

This factor appraises the minimum amount of theoretical education required, however attained.

Broad general knowledge of several specialized fields such as chemistry, mechanical and electrical engineering, marketing, accounting, and fundamentals of human relations.

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Figure 9-1. (*continued*)

accumulating sub-standard work would become available to the manager in charge of the role." If the time span of discretion is especially important in "multiple-task roles" as Jaques believes it to be, then the work of the housewife, which demands that a number of different tasks be carried through concurrently, qualifies for having this characteristic. Research is needed to identify the effects of homemakers' use of discretion with reference to the time span. In a brief analysis, half in seriousness and half in fun, an industrial analyst (Jacobson, 1953) identified the range of responsibilities of a housewife and concluded that it was quite demanding. He recognized the importance of discretion or judgment used by homemakers. (See Figure 9-1.)

Job evaluation per se has not been applied to the occupation of housewife and for good reason. One of the peculiarities of this occupation is that a woman with no experience can enter this occupation. The fact that she is a wife makes her eligible to be a housewife. In fact, she must enter it. The learning period for the job could be studied particularly with reference to the variation in the job with changes in the family life cycle.

Determination of the value of the homemaker's work is in some respects a type of job evaluation. The problem of valuing the homemaker's work and identifying her total workload is discussed in Chapter 11.

JOB DESIGN

The study of work in industry has focused also on the content of the job with particular reference to the level of satisfaction and to the division of work between men and machines. The idea of designing jobs to match worker requirements—including preferences—reverses the approach of identifying worker requirements for a job and matching the person to them. It does not eliminate the need to eventually match people to jobs. Attention to job design has become increasingly important with the division of work into small units for mass production of items and with the automation of many processes. This specialization of work dehumanizes it and emphasizes the need to examine the design of jobs; the probable effects on productivity are also of concern. (Data concerning the effects on productivity are meager.)

Job design is described briefly by Miller (1962:189) as "the best organization of human tasks into the job requirements of individuals." He also notes that "Task descriptions provide input information for patterning tasks into job design." Our study of homemaking work should be directed toward providing information of use to homemakers in determining optimal content and pattern of tasks. The homemaker is in a unique position to determine many of the specifications for her job, and it is reasonable to help her identify the specifications and means of achieving those that she prefers.

Some of Miller's (1962:191–192) points concerning design are provocative:

> "Design is not a rigorous process except at certain stages. It is true that each design decision puts constraints on what further decisions can and must be made for a workable and economically feasible system or system component.
>
> . . . .
>
> "Implicit in the concept of design is innovation. Innovation may extend to the perception and organization of patterns of functional 'requirements' for a system or component, to devices and to operational procedures. The fundamental value consideration in choosing a design option is some ratio of performance to cost of the mechanism chosen."

Miller indicates further that performance and costs may have to be measured by a variety of criteria. This is true in the home as well as in industry.

Miller's points are valuable for our study of the homemaker's job; some of his concern centers around the division of work between men and machines in industry and the subsequent effect on the task content. We should identify design decisions that have a direct effect on further decisions and on the design of the job. The goal would be to have guidelines for determining desired behavior and the settings that would permit and facilitate it.

L. E. Davis (1957) provides additional ideas for us to consider. He explains that job design specifies the content of each job and determines the distribution of work within the organization, and that there are many choices open to the job designer in specifying the content of a particular job. He indicates (p. 420) that:

> ". . the job design process can be divided into three phases:
>
> 1. The specification of individual tasks.
> 2. The specification of the method of performing each task.
> 3. The combination of individual tasks into specific jobs to be assigned to individuals.
>
> The first and third determine the content of a job while the second indicates how the job is to be performed."

Davis suggests that the content of a job comprises four aspects: work content, methods content, organization content, and personal content.

He defines (p. 430) the work content as the "assigned series of tasks which arise from the requirements of the technical process or the equipment used or from traditionally established needs," and the methods content as the "specification of the ways in which the work activities are to be performed, including tools, equipment, and location."

In our analyses of work, we should be careful to identify technical factors that contribute to differences in tasks since equipment and supplies used in homes can be varied. The "specification of methods" in the home was judged impractical many years ago by Kneeland (1928a): the diversity of equipment, supplies, and arrangements used for doing the work plus the variation in quantity and quality of product precluded the use of standardized work methods. This continues to be true. Instead, we need to know the methods specified by the choice of equipment, supplies, or materials.

Vroom (1964) indicates that research on the effects of job content has been neglected. The psychological consequences of the variety of functions in a particular job and the nature of the functions has received little attention in the world of employment—as well as in the world of the homemaker.

THE STUDY OF HOMEMAKING WORK

The occupation of homemaking entails a variety of tasks, duties, and responsibilities. Most homemakers are both managers and workers. They are responsible for both mental and physical activity. They plan and carry out the plans, facilitating and evaluating them as action progresses. If they do not actually do the task, they delegate and see to it that it is done. In many respects, the homemaker's managerial situation is similar to that of small farms and other small businesses. All the time of one person is not needed for the mental activity of managing; the size of the operation will not support the separation of this function from that of doing the physical work. In most homes, the additional problem of the continuing need to evaluate and take new information into account as action progresses limits the separation of the mental and physical work. The variable work conditions, materials, and standards for the outcome contribute to the amount of mental work.

The study of homemaking work is almost an entirely neglected area of study, yet the job of homemaking encompasses a core of activities essential to our existence. Ironically, household work and workers have traditionally had low status. This stems partly from a lack of appreciation of the contribution made to the family and society and partly from the lack of attention paid to improving the work situation and the content of the work. The low pay of most domestic workers illustrates these points.

Homemakers bring to employment work their experience of managing their household—a job that includes a variety of tasks and requires control of a complex situation. The value of this experience is often not recognized by either the homemaker or the employer, for little effort is made to take advantage of managerial abilities.

Changes in social conditions and patterns of living also emphasize the need to know more about work and how to minimize the human costs of doing it. More and more, women are joining the labor force with the result that they have less time to allocate to household work.

Employed women in all types of work—professional, clerical, semiskilled, or domestic—carry the dual responsibility of managing a home and a paid job. This is a heavy workload. Demands of homemaking and employment work can impose substantial limitations on the amount left for personal enjoyment, relaxation, and family. The heavy workload of the employed homemaker, as well as those with very young children, emphasizes the importance of identifying ways which will expedite the accomplishment of household tasks with the least amount of attention.

The goal of accomplishing household work is primarily a means to other ends, one of which is the development and socialization of the children. Work in homes is a child's first acquaintance with work—how satisfying or dissatisfying it is, how difficult or easy, how essential to his existence, how important to accept responsibility and to control and time events. Homemaking work can be the vehicle for his experimentation with task accomplishment. Failures may be less costly when they occur within the shelter of the individual's own family.

Effective work methods, well learned, become standing rules that can be used to advantage to decrease attention during task planning and performance; standing rules also decrease the amount of planning that is needed. A routine sequence of steps, set in motion after a quick check for appropriateness to the present situation, permits a smooth flow of work that only a skilled person can achieve. The security the homemaker derives from being in control of a situation and taking justifiable pride in it is reflected in the children's impressions and motivation to emulate the situation. The opposite—dissatisfaction, tenseness, and resentment—can be taught also.

Not only for these reasons but also for others is the analysis and improvement of execution of household work desperately needed. Employers of domestic workers can benefit from knowledge of the content of the work and the costs to the worker. Application of this knowledge could improve the supply of domestic employees. Better quality of work and greater output could be achieved at lower cost to both the employer and the employee.

The increasing number of special care centers and homes for the aged and handicapped emphasizes the urgent need not only for skilled employees to perform the housekeeping tasks but also for persons knowledgeable in the scope of the problem to direct their work. Rehabilitation of some handicapped, chronically ill, and aging persons can also be effected through analysis of work and its costs. The goal of helping them to become independent can be attained more readily.

The study of homemaking work has other important ramifications, for when the focus is on work, the implications need not be limited to workers in a given situation. In industry, both management and labor are concerned with the problem of human input. The study of household work and the study of employment work are complementary. They provide insights into each other. Knowledge of the personal costs of working in one situation may parallel those in the other. Some of the costs may stem from different working conditions, others from differences in the content of the job. Knowledge of factors associated with lower personal costs for household work supplements information for researchers concerned with employment work. Such knowledge will be of help in designing the total job and the content of each task within the total job so that they are commensurate with reasonable personal costs. The study of employment work and household work identifies the demands placed on the worker from the task and contributes toward the equitable payment of the employed worker. In the home, where there is greater freedom of choice of which jobs are done, which are delegated, and which supplies are used, the homemaker has the option of designing many characteristics of her work. We need to identify consequences of alternatives.

Specific Purposes

Our first purpose of studying work is to identify the demands made on the person. Household tasks are necessarily part of the problem of studying the use of the human resource in accomplishing work, for tasks are an output—the result of using the human resource in conjunction with other resources. The nature of the action is one determinant of the various human costs.

Our second purpose is to identify the requirements needed in the workplace for the task and the person. Identification of such requirements is a prerequisite to functional design. Such knowledge will permit the manufacturer, builder, and work specialist to build into the design of equipment and workplaces those characteristics that will automatically minimize worker input. Equipment and workplaces, as well as the work, are part of the problem of studying the use of the human resource for work since they help or hinder the implementation of the action.

Our third purpose is to obtain the background to guide the functional placement and arrangement of workplaces and of supplies and small equipment within workplaces. The placement of the objects used in work, as well as their design and quality, determines the human costs of using them. Knowledge of work provides an important basis for determining guides for placement and arrangement of workplaces.

To achieve these purposes, a work management specialist must know how to analyze homemaking work. This will help equip her to assess work under changing conditions.

CHAPTER 10

The Content of the Job

Variety is the keynote of what the homemaker does. The content of her job varies from day to day and from task to task. The significance of variety in the content of the homemaker's job is that it makes it semiroutine. Not all of it can be mechanized or automated; thinking is required so that appropriate adjustments are made to take care of changing situations. From the standpoint of the requirements made of the person, the variability in the work requires a constant adjustment in type and amount of personal inputs.

Some of the variety stems from the situation. This is important in that it influences the basic content of the work itself. Various factors may influence the content of the job and task—the composition of the family, employment, values, goals, standards, and the time period under consideration. Such factors may vary from family to family but also within a given family from one occasion to another.

Some of the variety may be within the control of the homemaker: quality and quantity of work; her preferences for the content of the task; or the choice of the work situation and content—such as the supplies that are used or the materials that are worked on. Other sources of variety (but not within the control of the homemaker) include the season of the year, the weather, and certain environmental conditions, such as wind, humidity, and temperature. For a given residence, dirt from factories and traffic is beyond her control. The place of work within the home may be varied also for some tasks. The quality of the shelter may be improved in some instances. The family members' preferences and interests also reflect changes in the content of the work. The changes in the age of the children may bring important changes in tasks.

Besides the situation, the diversified character of the work is a major source of variety in the homemaker's job. Our major emphasis in this chapter is the study of the content of the homemaker's job from several points of view for an exposition of the nature of the job.

WHAT IS DONE AND WHY? WHAT IS USED?

Homemakers' work can be analyzed in several ways so that the demands made of the worker can be identified. The work analyst will then be in a strong position to use various approaches to eliminate or reduce work through the design of the work itself or of the workplace.

Task Functions

The functions of tasks comprise one source of variety in the content of the homemaker's job. Some tasks are primarily productive, others mostly supportive in nature. Marketing and shopping facilitate the performance of many tasks; so do the maintenance operations of cleaning and conditioning after cleaning. Production and maintenance operations pervade tasks in the food, clothing, and house areas.

Broadly speaking, the functions of homemaking tasks are for subsistence and cultural development: to maintain the family with food, clothing, and shelter; to socialize and develop the individual; and to provide an atmosphere that helps each family member achieve his goals. Most tasks serve the dual functions of subsistence and cultural development although the emphasis varies with the task and from time to time.

Since a homemaker may expect to accomplish more than one purpose with her performance of a household task, there is no one best way to do a task. The work analyst will want to respect a homemaker's rational preferences and be accepting of less than optimal solutions from the standpoint of work reduction.

Number of Activities

To achieve the functions of a home, a wide variety of tasks are done. The broad scope of the job imposes an ebb and flow on what is done, for not all tasks can be done every day and they do not need to be. An overview of what a homemaker does can be obtained by considering the day's succession of activities. The number of activities also grossly describes the amount of shifting from one task to another.

The number of changes of activity during a day suggests a substantial amount of shifting from one activity to another (Table 10-1). (Some variation in number of changes is related to method of data collection.)

The number of shifts among activities per hour is substantial: an average of 13 per hour of observation for mothers having preschool children, 10 per hour for those with only school-age children, and 8 for

Table 10-1. Number of Homemaking and Nonhomemaking Activities during a Homemaker's Day

Source[a]	Number of activities: Average	Range	Characteristics of homemakers	Notes
(88)	20.0	5–42	248, New York	Recall of use of time yesterday; about one-half of blocks of activity were homemaking
	21.0		Full-time farm	
	21.0		Full-time city	
	16.5		Employed city	
(44)	25.8	14–43	50, Michigan; about three-fourths full-time	Recall of use of time yesterday; all had a child under 10 years of age
(16)	49.0	30–75	50, Michigan; full-time	Recall of activities for successive intervals for yesterday
(93)	62–68	33–124	7 case studies	Homemakers recorded activities, a weekend day and weekday
(66)	194–292		30 to 76 homemakers per group	4 to 8 observations/family, 2 to 3 hours/observation

[a] Sources are identified at the end of Chapter 11.

homemakers of all-adult families (Smith, Gerhold, and Kivlin, 1961). If each change involves a shifting of attention from one situation to another, these data suggest how frequently homemakers shift attention from one task to another but do not identify the amount of variation in content of task from one block of activity to the next.

The shifting among activities suggests that a variety of tasks are done, some to achieve the functions of a home, some to achieve the homemaker's personal goals. A closer examination of data is necessary to identify the content of the job of homemaking.

The traditional categories of household tasks provide a logical frame of reference for describing job content. In a given day, homemakers in one study (Steidl, 1963a, b) often did tasks in 3 or 4 of 5 grossly identified activity areas; a task in the food area was always reported and, almost always, one in the house area. The most frequent combinations of homemaking activity areas were: food + house + clothing; and food + house + clothing + family (Table 10-2).

Further insight into what a homemaker does may be obtained by examining the content of blocks of activity. Of 14 fairly specific tasks in Steidl's study, 6 was the median number of different homemaking activities in a day reported by full-time homemakers and 5 was the median

Table 10-2. Homemaking Activity Areas Reported by Each Homemaker during a Day (93 Farm, 101 City, 54 Employed City Homemakers, New York, 1952)

Homemaking activity areas	Type of homemaker					
	Farm	City	Employed city	All	All	
	Number				Percent	
Food	2	1	4	7	3	
						3
Food + house	12	8	9	29	12	
Food + clothing	2		1	3	1	
Food + family			2	2	1	
Food + marketing			1	1	[a]	
						14
Food + house + clothing	23	20	12	55	22	
Food + house + family	8	10	3	21	9	
Food + house + marketing	1	3	4	8	3	
Food + clothing + family		1		1	[a]	
Food + clothing + marketing		1		1	[a]	
Food + family + marketing			1	1	[a]	
						34
Food + house + clothing + family	19	27	10	56	23	
Food + house + clothing + marketing	7	6	4	17	7	
Food + house + family + marketing	3	5	1	9	4	
Food + clothing + family + marketing	1	2	1	4	2	
						36
Food + house + clothing + family + marketing	15	17	1	33	13	13
Food + house (with or without other activity areas)	88	96	44	228	92	

[a] Some, but less than 0.5 percent.
Source: Steidl (1963a:16).

number for employed women. Some of these tasks were repeated, for the median number of blocks for all homemaking activities was 11 for the full-time farm homemakers, 12 for the full-time city homemakers, and 8 for the employed city homemakers.

Repetition of Tasks

Our review of homemaking practices indicates that the repetition of tasks varies with the task and may be associated with one or more factors (Tables 10-3, 10-4, 10-5). The type of equipment, the age and number of children, and employment of homemaker were identified in some studies as relevant to frequency of performance for some tasks. Less studied are a number of other factors and whether they are operative together: the total quantity of work to be done; the proportion done during a given work period; the quality of output; the supply of ma-

Table 10-3. Repetition of Care of House Tasks

Task	Source[a]	Repetition by homemakers
Cleaning living room	(76)	Weekly for 4/5; seasonal cleaning for 4/5.
	(28)	Straightened up daily by 9/10; dusting 2 times/week or weekly; floor care 2 times/week by 1/2.
Cleaning bathroom	(13)	Every day for 2/3; thorough cleaning 1 time/week for 1/2 and 2 to 3 times/week for 1/10; areas cleaned daily varied.
	(50)	1 time/day for 2/3.
	(65)	1 to 3 times/week, average for 3 groups of women.
	(28)	Straightened daily by 1/2; cleaning daily, 2 times/week, weekly, each about 2/5.
Cleaning Venetian blinds	(107)	Weekly for 2/5; every 2 weeks for 1/3; 1 time/month for 1/4; major cleaning job 2 times/year for 1/3 and 1 time/year for 1/4.
Wet-mopping floors	(117)	Influenced by (a) presence of children: 1 or more floors washed daily or several times/week for 1/2 if children and 3/10 if all-adult households; and (b) size of household: several times/week for almost 3/5 if 6 or more, 2/5 if 4 or 5, and 3/10 if 2 or 3 in household.
	(28)	Weekly for 1/2 in kitchen.
Making beds	(50)	1 time/day for 2/3 or more.
	(65)	6 to 8 times/week, average for 3 groups of women.
	(28)	Daily for almost all; changing linens weekly for 9/10.
Day-to-day cleaning tasks	(50)	1 time/day for 2/3; 2 to 3 times/week for 1/5; employment made no difference in number of tasks reported; highest number—7, 3 or 4 for 1/3, 5 to 7 for 1/3.
Cleaning tasks	(65)	Nonfarm full-time homemakers made beds, dusted, and cleaned the bathroom more often than employed homemakers and farm full-time homemakers. Some differences with employment of homemaker and younger children.
Other	(72)	Frequency of use of cleaning equipment: broom—every day for 4/5; vacuum cleaner—1 time/week for 4/5; 2 times/week for 1/2; 3 times/week for 1/3.

[a] Sources are identified at the end of Chapter 11.

Table 10-4. Repetition of Care of Clothing Tasks

Task	Source[a]	Repetition by homemakers: Automatic washer	Repetition by homemakers: Nonautomatic washer
Washing	(117)	4 days/week, almost 1/2 more often	1 or 2 days/week—almost 1/2 once and 1/3 twice a week
	(43)	2 to 3 times/week for almost 1/2; weekly for 1/4	2/3 washed weekly; 2 to 3 times/week for 1/5
	(29)	1 time/week for 1/10	1 time/week for 2/5
	(82)	1 time/week for 3/10	1 time/week for 7/10
	(98)	6 to 7 days/week for 1/4; 3 or more days/week for 2/3	
	(96)	7 days/week for 1/3; 2 times/week for 1/3.	
	(41)	Significant differences in frequency of washing with type of machine; average: 2 or more times/week for almost 1/2	
	(26)	Owners of automatic washers washed more often than owners of nonautomatics	
	(73)	3 days/week, average; differences with family size: 1.8 days/week—4.6 days/week for 2 vs. 7 to 10 in family	
Hand laundering	(117)	4 out of 5 families; averaged 2 times/week; not related to type of machine	
	(26)	Almost all; 1 time/week for 1/2	
	(73)	2/3 during 1 week	
	(13)	1 or more times/week for 3/5; 1 time/day for 3/10; 2 to 3 times/week for 2/10	
Ironing	(53)	2 periods/week for 1/3; ranged to 7 but clustered at 1, 2, 3 periods	
Dry cleaning	(3)	1 or more time/month for 2/5; occasionally for 2/5; first time for 3/10	

[a] Sources are identified at the end of Chapter 11.

terials on which the work is done; the homemaker's preferences for quality and total quantity, the amount done each time, the duration of the work period and preferences for getting the task out of the way; the family members' preferences for what is done, how much, and how well; and the homemaker's need to coordinate household and nonhousehold activities.

One consequence of possible interplay among such a large number

Table 10-5. Repetition of Marketing, Dishwashing, and Child Care Tasks

Task	Source[a]	Repetition by homemakers
Marketing	(52)	1 time/week for ¾ if full-time homemakers and for almost all if employed.
	(91)	1 time/week for major trip for ⅘ of homemakers; families averaged 3 trips/week
	(97)	1 time/week or less for ⅗ if full-time farm homemakers, for ⅖ if employed and nonfarm full-time homemakers
	(2)	3 to 6 trips/week
	(55)	1 time/week for ⅔
Meat shopping	(70)	1 time/week for ½, a few times/week for ⅓
Dishwashing with dishwasher	(21)	1 or 2 times/day for 9/10
	(117)	0 to 3 times/day
Dishwashing by hand	(117)	3 to 4 times/day for ⅘; similar for households of various sizes
	(97)	3 times/day for ¾ of full-time and ⅔ of nonfarm and ⅓ of employed homemakers; 1 time/day for ⅕ of employed homemakers
Cleaning up	(66)	15 to 22 activities/12 to 14 hours of intermittent observation
Child care work periods	(102)	0.2 to 6.2 work periods/household on a weekday with lowest average in households with only 1 older school-age child, highest average if both a toddler and baby
Communication with child	(66)	34 times/12 to 14 hours of intermittent observation in families with preschool children

[a] Sources are identified at the end of Chapter 11.

of variables includes increased opportunity for variation in what is done and how often. A homemaker may be able to exercise considerable choice in structuring the frequency of doing some tasks. In exercising control over this aspect of task performance, choices among possible ways of proceeding will be made. The importance of identifying restraints on freedom of choice is imperative. For example, when young children quickly outgrow their clothes, the number of garments may be kept low so that more return on the investment is realized. The effects on the work are related: the task of washing the children's clothes may have to be done more often than when the supply is larger; the amount of work that can be done at a given time is limited by the total supply; and the task keeps recurring—the homemaker never gets it out of the way for very long.

The repetition of tasks is also important in other respects. A plan must be made for when the task will be done. Timing of the work for the task is also involved. For tasks with a nonpermanent workplace, getting ready to do the task and putting away after it may become important sources of personal input when the task is repeated often rather than when a larger amount of the task is done at one time. Of course, the unit size of the task for a particular time period may be related to the worker's preferences: some homemakers may prefer to do a disliked task for a shorter duration during a given work period; for others, advantages may accrue from doing more at one time so that the homemaker does not have to repeat the task so soon. The desired amount of physical work during a given time period may be another consideration in repetition of tasks.

Our review of repetition of tasks also suggests that some of the variation is related to the time span for which the data were collected, for some tasks are done less frequently than every day (Table 10-6). Less clear is the influence of the individual's way of looking at tasks. Some people report in more detail than others. This point of view would naturally affect the number of activities recalled for the preceding day. Nelson (1963), following her analysis of observation and recall data of 19 Costa Rican homemakers, concluded that their time-use goal appeared to be to work in relatively long, uninterrupted periods. They tended not to report repeated participation in the same activity within a time span although the observation data established it. The importance of continuity for an activity may, therefore, influence the reports of repetition of an activity.

The level of specificity of task definition raises a problem in establishing the proportion of repetitive work. Some data from a study of most liked and least liked tasks suggest a relationship between more specificity of task definition and higher frequency of performance (Steidl, 1965). Further study is needed.

Cycles of Action

Repetition of cycles of action within a specific task is another aspect to consider because it is related to the attention that the worker must provide and the possibilities for rhythm in work. Homemaking tasks differ widely in whether any segments of action or cycles are repeated. Of course, one factor is how specifically we define a cycle. The repetition of cycles in the task of folding clothes would be quite different when determined by the number of identically shaped and sized items compared to merely the total number of items folded. In the latter situation, the characteristics of the cycles would vary somewhat in requiring the

Table 10-6. Frequency of Each of Six Activities During Preceding Day for Each Homemaker (93 Farm, 101 City, 54 Employed City Homemakers, New York, 1952)

Activity	Type of homemaker	Total number of times reported by each homemaker				
		0	1	2	3	4 or over
		Percent of homemakers				
Meal preparation [a]	Farm	0	1	3	54	42
	City	0	0	19	39	42
	Employed city	4	10	24	31	31
	All homemakers	1	2	14	43	40
Dishwashing	Farm	2	2	24	59	13
	City	1	15	38	41	5
	Employed city	4	28	44	22	2
	All homemakers	2	13	34	44	7
Regular care of house	Farm	7	30	30	17	16
	City	12	35	27	14	12
	Employed city	20	35	28	13	4
	All homemakers	12	33	28	15	12
Washing	Farm	51	18	13	12	6
	City	53	20	14	7	6
	Employed city	68	17	9	0	6
	All homemakers	56	19	12	7	6
Ironing and other care of clothes	Farm	68	20	10	0	2
	City	56	30	10	3	1
	Employed city	69	22	9	0	0
	All homemakers	63	25	10	1	1
Care of family members	Farm	51	14	5	4	26
	City	38	13	11	6	32
	Employed city	65	14	13	4	4
	All homemakers	49	14	9	5	23

[a] Includes preliminary meal preparation.
Source: Steidl (1963a:17).

homemaker to take new information into account whenever a change in item occurred. In the former, the same pattern of motions might be used. The general type of information might be fairly similar.

In contrast to the task of folding clothes, much of the action for many menu items is clearly not repetitive, but within other menu items, parts of the action comprise repeated cycles, such as paring potatoes, chopping nuts, stirring sauces, and beating the batter for a cake. The variation in cycles of household work is in contrast to much industrial work and points up one limitation in directly applying some of the industrial recommendations for work methods. Formal study of the cycle characteristics and amount in household work remains to be done.

Type of Action

With such opportunity for variation in the content of any one task, we need to analyze the type of activity to identify the diversified character of the activities and the subsequent requirements in skills, aptitudes, and knowledge.

Get Ready, Do, and Put Away

A general description of the type of action can be obtained with the traditional steps of get ready, do, and put away. For many years the importance of looking at the three main steps of most operations has been emphasized by Barnes (1944, 1958, 1963) and Gilbreth, Thomas, and Clymer (1954, 1959). In teaching, these steps help us to recognize that often some preparation is necessary before performance and that performance may be followed by cleanup and put away. The importance of functional storage facilities and organization of supplies, materials, and tools to lighten the work can be emphasized through identification of these pretask and posttask activities. The evaluation of work methods and conditions is aided by knowledge of the relative amount of time and work involved in each step.

How much of a homemaker's work is allocated to each step—preparation, performance, and putting away? Logically, a homemaker might hope to keep to a minimum the supporting actions of get ready and put away so that she would be freer to use her homemaking time more directly on productive activity and possibly reduce the amount of homemaking time. Formal analysis of the total job of homemaking to determine the proportion of each type of action has not been done. Homemakers' descriptions of their most liked and least liked tasks provide some information:

"For both the most and least liked tasks, almost every homemaker reported a part of a task classified as 'doing'; about 60 percent reported 'getting ready'; and about 30 percent reported 'putting away.' One could speculate that homemakers do not consider 'putting away' as part of a task, but as a separate task, or that the homemaker may dovetail into another task the 'putting away'" (Maloch, 1963b:7).

Getting ready to do a task may involve several types of activities. We may need to gather together and get out items needed to do particular task processes. Before clothes are washed we may need supplies, such as detergent or bleach, or a tool, such as a brush, to treat spots. We may also need to collect those items on which work will be done, such as the clothes that are to be washed or pressed, or the items to take out for repair or cleaning.

In contrast to the preparation for a task, the putting away or cleaning up represents some of the opposite actions. Items are replaced after use and stored after they have been worked on. Storing clean, folded clothes illustrates the latter. Some items may have to be put aside until they are ready to be put away, such as the iron that has to cool. Equipment that has been set up needs to be pushed back into place or taken down. In some instances, washing small tools and wiping up comprise the final stages of the task. In other cases, the care of the equipment represents the final finishing up; examples include emptying the lint trap or filter on the washer or dryer. The disposal of the supplies that have been used, such as mop water, may also be part of finishing up. At other times, an area may have to be cleaned so that it is usable for another purpose, e.g., the dining table and floor after sewing.

For the performance of the task, the action can be described in fairly general terms in some instances, but in others the action is closely associated with one or two tasks. Such general terms as fix, make, do, or sort could apply to the action in a number of tasks. In other cases, the action is more specific such as iron, dust, polish, run vacuum cleaner, change water, serve food. These actions, whether in general or more specific terms, describe the substance of the task and represent the main content. The preactions and postactions, in contrast, might be termed facilitative or supportive actions.

Much of the content of the three main steps of a task may depend on how specifically or how broadly it is defined. With grosser definition, more parts may occur. Some examples from homemakers' descriptions of what they did for a particular task, along with the researchers' classifications, are given in Table 10-7 to illustrate the range of actions and the relationship to the way the task is defined. Note that the classification of the activity may depend also upon the task identification. Compare the activities when the task was sprinkle clothes (No. 1) with the descriptions of ironing (Nos. 2 and 3).

Analysis of some observations of work indicate that the three separable parts of task action may actually be interwoven rather than performed separately. In some cases, there are advantages in proceed-

Table 10-7. Examples of Actions for Get Ready, Do, and Put Away in Homemakers' Task Descriptions

Task definition	Get ready	Do	Put away
1. Sprinkle clothes	Find place to sprinkle; separate clothes	Sprinkle	Put in dampen bag
2. Ironing	Sort clothes and decide what is needed most; sprinkle these clothes	Iron these	
3. Ironing	Sort into steam and dampen, then sprinkle	Iron	Put away
4. Ironing	Plug in iron	Iron dresses, hardest things first	Unplug the iron
5. Folding clothes	Take out of dryer	Fold	Put away
6. Scrubbing the kitchen floor	Move everything out of kitchen; vacuum or dust mop	Use floor scrubber and polisher, liquid detergent and ammonia, rinse twice and wax and polish	Move everything back
7. Cooking Sunday dinner	Shop once a week and plan for the week	Bake first; then peel potatoes; meat; set table; salad last	Eat

Source: Unpublished data, Steidl and Maloch, State Research Project 45, Cornell University.

ing so that all the preparatory work takes place before the doing and, subsequently, all the doing of the task takes place before any of the putting away.

There are logical reasons, however, for the preactions and postactions to be interwoven with performance. One of the requirements of getting ready for a task is to anticipate what is needed or how the materials will be used. In some instances, this is not possible due to the changing situation as the task progresses. In other cases, it is not practical to get out or keep out all items that are used to do a task until the task is completed; the work surface may not be sufficiently ample to provide holding space for all items, they may become disorganized, or they may get in the worker's way.

Relatively few studies of the amount of getting ready, doing, and putting away in isolated tasks rather than across tasks can be cited to provide further understanding of the content of the homemaker's work. For the task of cleaning the living room, preparatory operations were performed by 7 homemakers, straightening by 80, and one homemaker did both (Roberts, 1956). Recall data provide less detail than observation data, but these data suggest that few homemakers did preparatory actions early and many did them concurrently with the performance.

In a detailed film analysis of meal preparation and cleanup, Steidl (1957, 1960) identified the type of activity at each kitchen center. Six categories were used: prepare and serve; clean up; cleanup get ready; get out; put away; and care of hands. During the work for 8 dinners having the same menu, 2,780 changes in activity occurred, averaging 347 per meal. Of these, 31 percent were classified as get out and put away.

Data were collected also in two homes (Steidl, 1961a) during the preparation and cleanup of a meal comparable to that used in the laboratory study just cited. Uses of storage areas totaled 123 and 193 after storage devices were added. The proportion of storage uses during preparation varied in the two homes, 37 and 63 percent, in contrast to the 59 percent for one dinner in the laboratory study. Some of the variation in work procedures may have come from more limited work surface in the homes, concentration of stored items, distractions from food preparation work, and more than one worker.

Analysis of work with respect to the amount of getting ready, doing, and putting away is important in connection with the affective, cognitive, and temporal components of the worker's input as well as the physical component. In getting ready for a task, thinking and planning are necessary to identify what is to be done, as well as the variety of movements, such as carrying, reaching, and placing items. The homemaker may have to determine the time sequence for the getting ready. She may dislike the delay in getting started. She may find there is little chance for rhythm because the action is made up of a number of short and unrepeated actions. The work may be done in more than one place and have diverse activities. During the putting away, there may be decisions about where to place items or how to fit them into space, particularly if the storage is disorganized or if items are recently purchased and have not been used before. Knowledge of the amount of facilitative action provides one basis for evaluating work conditions and methods.

Physical Action

The type of physical action varies among the tasks but components of activities can be identified, such as climbing and descending stairs, carrying, squatting, and manipulative motions. The importance of identifying the type of physical work is to determine the personal costs from working position and movement. The choice of equipment and supplies may be planned for a desired amount and type of physical work. The design of the workplace can be planned to facilitate physical work so that strain from working at the workplace is minimized or eliminated. Knowledge of the type of physical work is also important in planning for the desired amount of effort for a given time span. It may be desirable to divide a task and do it on two or more occasions. We may also need to consider whether a particular combination of tasks is desirable in terms of the type and amount of physical work.

Processes

The type of processing done is of help in examining the job content. The processing term may have some commonality among tasks but is task related in a specific sense. Cleaning is done during food preparation, dishwashing, washing, and care of the house, yet the exact method of cleaning and way of proceeding varies somewhat among these tasks. A brief analysis of two task areas follows.

In food preparation, processing is done by heat, refrigeration, freezing, mechanical means, and the various cleaning processes. Variety within the food preparation task is illustrated from Heiner and McCullough (1948): 20 common cooking methods; 57 common operations of food preparations; 175 packaged supplies for active kitchen storage for 1 week for an urban family of 4 members; and 108 utensils plus 24 optional utensils.

Care of house includes several groups of processes. The first group—to clean—includes both chemical and physical processes; supplies include solvents, abrasives, and absorbents. A second group of processes provides a protective covering on a surface. A third group includes straightening operations: picking up, organizing, and rearranging.

The variety of processes used and the effect of the variety of supplies on the process used indicate that the homemaker needs to have knowledge of what supplies and processes might be used, the general approach used to accomplish a task, and specific procedures with supplies, tools, or equipment. She needs to know what quantity and quality of supplies are needed to get the desired results. The mechanization of work through household equipment has also brought about, and should continue to bring about, changes in the type and amount of input contributed by the worker. The work specialist will continue to be challenged to be aware of new products and their potential help or hindrance in the work of the home.

Mental Action

Throughout our discussion of the various types of activity, the use of the cognitive component was either indicated or implied. Since much of household work cannot be completely routine, information must be obtained and thought about (processed) and decisions made about how to proceed, how much to do, when to do the work, and how to control the activities for the chosen outcome. At least partial attention is needed to receive information and identify pertinent facts. Changes in the usual situation must be taken into account, such as supplies that have not been used before, variable quality of supplies, a new recipe, a new appliance, or a new, small tool. Even in the performance of skilled activities, a certain amount of attention and thinking are required so that new information is anticipated and adjustments made in the skilled actions.

Discretion is required on the part of the homemaker. We agree with Jaques (1961) that the time span of discretion is an indicator of responsibility. The homemaker's judgment has far-reaching consequences. Her style of managing a home, including the way she does household tasks, has short-range effects as well as many long-range consequences. Essentially the latter has not been established, but we can raise the questions about the positive effects on the development of individuals in the family and on relationships among family members from work performance that is compatible with the goals of the individual and of the family as a group and is subordinate to the family rather than to the individual. Of course, a homemaker has the responsibility to get the work done as a function of her job, but she may also choose to teach her children how to cope with household tasks. In this event, the work may not be done so effectively, for the goal of effective work performance is subordinate to that of teaching.

Other mental activities may concern the adjustments to changes in the family situation and the work situation. Judgment is needed with respect to when it is desirable to change and when not. A very simple example is when to learn how to use new supplies. In deciding the practicality of changing, a homemaker ideally identifies the consequences and whether the advantages outweigh the disadvantages of changing or continuing with the status quo.

HOW AND WHEN IS THE WORK DONE?

We now turn our attention from some of the broader aspects of job content to more specific ones: the manner of working and the timing of the task.

Continuity of Action

The general manner of proceeding with household tasks is determined by the continuity of action. Managing a home requires coordination of a variety of activities and the parts of each activity. The division of activities or tasks into parts may be inherent in the nature of the task or may be due to external factors.

Continuity of work is concerned with the intermittency or continuousness of action on a given task from the time action is initiated until it is completed. Factors controlling the continuity of household work appear to be the task or activity itself, factors external to the activity, the homemaker, and changes in the place of work.

1. How continuously a homemaker can work varies with the household task. Intermittency of action is inherent in the nature of some tasks. Machine washing of laundry illustrates this. A natural division of action occurs after the machine is loaded. Washing time must elapse before the next part of the task can be done. Much of the work in meal preparation may also be intermittent; baked potatoes cannot be produced by one continuous action; work is necessarily interrupted while the potatoes bake. In such cases, the nature of the processes of the work itself is such that the homemaker does not need to be present, for action continues without her; the processes require intermittent work or discontinuous action on the part of the worker; active and inactive work periods result. In contrast, some processes require the constant presence of the worker if action is to proceed; ironing and dishwashing by hand illustrate this situation. In some instances, mechanization has made it possible for the processing to continue without the worker being present for all of the time. The automatic washer permits the worker to be away from the machine for longer intervals than does the nonautomatic washer. The effect of equipment and supplies on the continuity of the processing has important implications for the design of work.

2. Interruptions in the action may occur that are not necessary for task completion. Factors external to the task cause them. We are all familiar with the complaints of homemakers about the number of interruptions from the doorbell, telephone, and children. Interruptions of

this type may be less predictable than other interruptions external to the task, such as the need to attend to another task. The latter may be within the control of the homemaker and expected. Emergencies such as equipment breakdown or spillage also cause interruptions. Not all of these are postponable in receiving attention. The effect of interruptions from factors external to the work is variable. A homemaker can use some techniques to eliminate some interruptions. Homemakers often send children on errands or have them take care of their younger siblings so that they can continue a task.

3. Another source of continuity or discontinuity in action may be the homemaker herself. In some instances, her desire for completion of a task will extend the duration of the activity; in other cases, her desire to terminate a task may cause an interruption.

4. A fourth source of discontinuity in work comes from the need to change the place of work. Every time a trip must be made from one location to another, a break in the rhythm of the work occurs. During meal preparation when 5 or 6 work and storage centers might be used for the work, action is interrupted each time the worker moves from one center to another. Attention must be shifted from the work that is being done when a trip is made; each trip represents a stop and a start in work. The break in the continuity of action when a trip is made would seem to be of a smaller magnitude than when the continuity is interrupted so that processing can continue or so that some other event can receive the worker's attention. Although most trips may take only 2 or 3 seconds in a well organized and arranged kitchen, they are a factor in work accomplishment (Steidl, 1958a). Trips to other rooms during the work for a given task also break the continuity of action.

Continuity of action and timing of tasks are affected by the variety of homemaking and nonhomemaking tasks. The tasks chosen for a given day and their sequential order may necessitate stopping one task to begin or resume another. The preference for a particular amount of continuity may, indeed, be a factor influencing the organization of a homemaker's day. The organization of the parts of the task and of where each part is done may directly influence the amount of stopping and starting.

Knowledge of the continuity of household work is necessary in studying the requirements made by the work on the worker. Both the amount of shifting from one task to another and the number of tasks being carried on at any given time may be closely related to fatigue. Continuity of action may be related to preferences for homemaking tasks. Identifying the causes of starts and stops and the homemakers' views toward them is necessary to relate input and output factors. Thus, the intermittency of the action on a job, the duration of action in the various work periods, the tasks done together, and the order of doing them are important considerations.

Characteristics of the task that may be directly related to the continuity of work include the repetitiveness of parts of the activity, frequency of doing the job, total time required, and necessary elapsed time between some phases. Personal factors related to continuity of work may include the effort required, fatigue, task acceptance, desire to complete it, physical movements involved, skill, need for frequent decisions, ease of doing the work, age of the homemaker, and the preference for the job. Composition of the family, employment of homemaker, and the number and ages of people either participating in or present during an activity may also be related to continuity of work.

Some of the factors associated with continuity of action have been selected for further consideration.

Blocks of Activity

The number of blocks of activity and the repetition of tasks provide some information about the continuity of work. As explained earlier in this chapter, one unit or block of activity occurred with each successive activity reported by homemakers as they described their preceding day. Those homemakers with fewer blocks of activity may have had greater continuity of action.

Further description of continuity of action can be obtained by examining the duration of the blocks of activity. We can assume that the greater the duration, the greater the extent of continuity of action; of course, less detailed reporting could be a factor. In Steidl's (1963a) study of activities reported by homemakers, almost three-fourths of all blocks of activity for the preceding day continued for less than 60 minutes, and two-fifths were under 30 minutes (Table 10-8). Apparently the nature and number of household activities together with a variety of other activities necessitated many short periods of time but did not preclude longer ones.

These homemakers' days varied not only in number of different tasks but also in the duration of work on them. Those tasks (associated with blocks of short duration) may be ones that were discontinuous in nature or ones that could be completed in a short time span.

Duration of Tasks

A number of studies, some based on homemakers' estimates, some on observations in laboratory or home studies, provide information about duration of more specific tasks and parts of tasks (Table 10-9). A num-

Table 10-8. Duration of Work for Each Activity Each Time Separately Done During a Day (93 Farm, 101 City, 54 Employed City Homemakers, New York, 1952

Activity	Times reported	Duration of work (minutes)[a]			Actual size of time period (minutes)						
		Under 30	30–59	60 or over	5–10	15	20–25	30–35	40–59	60–119	120 or over
	Number	Percent			Percent						
All activities	4,989	41	31	23	13	16	12	22	9	13	10
Homemaking[b]											
Meal preparation	589	55	35	9	15	26	14	24	11	8	1
Dishwashing	475	59	33	5	19	22	18	26	7	5	
Preliminary meal preparation	68	57	24	12	10	22	25	13	10	12	
Other food preparation	64	80	12	3	44	25	11	9	3	2	2
Regular care of house	335	48	28	17	20	16	11	20	8	15	2
Special care of house	56	16	25	54	2	11	4	11	14	21	32
Washing	157	34	29	31	13	14	7	21	8	15	16
Ironing and other care of clothes	101	20	21	58	11	6	3	8	13	39	19
Care of family members	352	59	29	7	20	24	15	20	9	6	1
Marketing and records	65	35	17	46	8	20	8	12	5	21	25
Nonhomemaking											
Sleeping and resting	81	11	30	57	4	5	2	11	19	38	19
Personal care	1,052	46	38	6	15	17	15	28	9	6	
Other leisure activities	590	26	26	44	8	11	7	19	7	18	26
Farm work	109	38	31	27	16	14	8	21	10	18	9
Paid employment	67	1	3	95		1		1	1	6	90
Other nonhomemaking work	80	26	20	51	11	11	4	14	6	32	19
Community activities	40	12	20	68	2	8	2	8	12	28	40
Activities reported together											
2 activities	562	23	38	36	4	8	11	24	14	21	15
3 activities	63	6	24	60		3	3	14	10	41	19

[a] No data column omitted. All activities except community activities had 1 to 10 percent no data on time for an activity reported.

[b] Excludes 4 activities, each of which was reported 18 times or fewer by all homemakers.

Source: Steidl (1963a:12).

Table 10-9. Duration of Selected Homemaking Tasks

Task	Source[a]	Duration
Cleaning		
Living room	(76)	15 to 480 minutes; 30, 45, 60 minutes most often
Daily care	(83)	Generally 15 to 30 minutes
Special weekly care	(83)	30 to 180 minutes
Stairs—carpeted; Vinyl tread	(19)	2 to 10 minutes, depending on worker, method and equipment, type of stair covering
Master bedroom	(28)	Average time 29 minutes; average of 5 minutes or less for each of 11 elements of cleaning activity
Bathroom, regular cleaning	(13)	Average under 7 minutes/task, 39 minutes for bathroom, 10 homemakers' records
Collect cleaning equipment		2.5 minutes
Put away cleaning equipment		4.0 minutes
Clean tub		4.9 minutes
Clean lavatory		3.4 minutes
Clean stool		4.2 minutes
Wash floor		6.2 minutes
	(13)	Cleaned in piecemeal fashion, due partly to interruptions, partly to combining with other cleaning jobs
Day-to-day cleaning tasks	(50)	Average 6 to 24 minutes for all workers
Sweep floors		6 minutes
Clean bathroom		12 minutes
Clean rugs and carpets		12 minutes
Make beds; dust furniture; floors		18 minutes each
Put house in order		24 minutes
Wet-mop floors		24 minutes
Washing clothes		
Sorting 2 standard loads	(64)	Less than 3 minutes
Drying an 8-lb load	(23)	
Hanging on lines		Average under 9 minutes
Placing in dryer		Average under 1 minute
Removing and folding		Average 5 minutes or less
Handwashing nylon shirts	(37)	3 minutes/shirt to wash and hang
Child care	(102)	Most common work periods: ½ hour and 1 hour or longer if 1 child and it was a baby; ¼ and ½ hour as child became older or 2 or more children

Table 10-9. Duration of Selected Homemaking Tasks (*Continued*)

Task	Source[a]	Duration
Marketing		
Not in store (planning and preparation; time for transit; storage of food purchases)	(91)	1½ hours, each about ½ hour
Making out shopping list		12 minutes
In store		
Major shopper	(91)	1 hour 15 minutes
Other shopper	(91)	About ½ hour
All shoppers	(91)	1 hour 50 minutes
	(22)	About 1 minute/item, average of 12 items/basket
All shopping	(91)	3 hours 25 minutes/week
Tasks at sink center	(56)	5 minutes—wash cooking and mixing utensils; 10 minutes—washing, paring, rinsing potatoes; 20 minutes—dishwashing
	(84)	2 to 6 minutes—salad; 5 to 7 minutes—potatoes
Tasks at range center	(84)	2 to 10-minute work periods with shorter periods for final food preparation
Tasks at mix center	(56)	5-minutes during mixing of cake
	(84)	2 to 5-minute stopovers to prepare dessert from packaged mix

[a] Sources are identified at the end of Chapter 11.

ber of tasks were done in a short period and apparently can be done as separate tasks but do not have to be. Of other tasks that were reported as requiring a longer time, some might be subdivided. Such variability in task duration and potential for separate performance permit dovetailing of some of these tasks with others that require the homemaker's intermittent action.

Meal preparation includes a number of menu items or subtasks, and the subtasks must be coordinated for completion at the same time. Description of duration of work for specific menu items is complicated by the fact that the nature of much of the work is discontinuous. The duration of active work periods rather than time span for menu items becomes more meaningful when continuity of action is being considered.

The duration of the work at centers between trips, or "center-uses," identifies further the extent of continuity since center-uses of shorter duration would represent more discontinuity of action than center-uses of longer duration. In the studies summarized in Table 10-10, many very short uses of a center were characteristic of the work. Work surface and storage space were available with each appliance so that the number of special trips for work surface or stored items would be kept to a minimum. The intermittency of action during meal preparation and cleanup was identified also by Bennion et al. (1956). They found many brief stopovers at centers.

The continuity of action on menu items can be partially described by the number of centers used since trips between centers represent one dimension of discontinuity—change in place of work. Over 100 center-uses can be expected during the work for one dinner.

The pattern of frequent shiftings of place of work during meal preparation in well-organized kitchens emphasizes the demands placed on the worker's attention and ability to coordinate plans. Proficiency in performing each subtask is particularly essential to successful accomplishment of the total task of meal preparation since the work is discontinuous and considerable control must be exercised.

Table 10-10. Duration of Center-Uses [a] During Meal Preparation and Cleanup

Time during one center-use	Heiner and Steidl	Mize	Steidl
	Simple breakfast and complex breakfast	Complex dinner	Complex dinner
Seconds	Total number of center-uses, all trials		
	1,271	122	932
	Percent of all center-uses		
1 to 59	80	75	80
60 to 119	10	9	12
120 and longer	7	16	8
No information	3	—	—
Total	100	100	100
	Percent of all center-uses		
1	11	10	12
1 to 9	35	32	44
1 to 14	44	42	55
1 to 29	62	61	68

[a] Center-use: all of the work done at a center as the result of one trip to a center.

Source: Steidl (1958a:449).

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The work for cleanup also comprises a number of different parts or segments of activity. The 7 steps in the dishwashing process identified by Weaver, Bloom, and Feldmiller (1956) varied in the time required—from less than 1 minute to 13 minutes. The combination of some short, some long parts of cleanup again characterizes the work. The timing of the parts of cleanup is not critical as it is in meal preparation, but this is not to say that the segments of activity are not coordinated. Sequencing is necessary and interweaving of parts is optional rather than required.

Type of Activity

Another method of examining the continuity of action is to look at the changes among types of activity. Change from one type of activity to another requires a shift in attention and thinking about the task, probably using another plan. Different manipulative actions may be required. Other tools or equipment may be needed. The change in type of action in some cases is a relief to the worker because it adds interest and variety to the task; in others, it is a break in the rhythm of work and may interrupt the pull or traction to complete work.

Changes among types of activity can be illustrated by studies of cleaning and meal preparation and cleanup. Reports of procedures used in cleaning the living room were analyzed for continuity by Roberts (1956). Her categories were: completed cleaning operations, interrupted cleaning operations, and continued cleaning operations. The focus was on each cleaning operation, such as dusting or using the vacuum cleaner, and whether the homemaker completed it before doing another in the living room or another room. A majority of the cleaning operations were completed. The homemakers generally used a combination of systems rather than only one.

The extent of continuity of action during meal preparation and cleanup was described by changes in 6 types of action across all menu items and other jobs (Steidl, 1957, 1960). The average number of changes varied: prepare and serve—100 times; cleanup—67; cleanup get ready—51; get out —53; put away—55; and care of hands—21 times. The average duration of each phase of activity was 14 seconds.

Changes in type of activity during each center-use during the meal preparation and cleanup further describes continuity of action. Over three-fourths of the center-uses involved 3 or fewer shifts of activity. These data indicate that the worker went to a center and did comparatively few types of activity most of the time (Steidl, 1957).

The distribution of the type of activity throughout a given work period also identifies continuity. The spacing of storage work throughout meal preparation and cleanup (Steidl, 1961a) emphasizes the intermittency of this type of action and the need for functionally designed and placed storage facilities so that discontinuity of action is not increased.

In some cases, the homemaker will have an option about manner of proceeding and thus be able to design more or less continuity of type of action into a given task. Critical timing of processes, a variety of processes, and the need to interweave them may preclude a high degree of continuity. For a given time span, such as a morning or a day, homemakers may then favor a combination of tasks that differ in amount of change of activity. This system of organization would help control the design of the total job to match preferences.

Type of Food Supplies

The proportion of active and inactive work time and the total time span can be controlled during meal preparation by choice of supplies. Data comparing various market forms of foods (fresh, frozen, dehydrated, and canned) with varying degrees of preparation provide a basis for choice (Table 10-11). With some food forms, comparatively little "active preparation time" is required, but the brief work time may be within a short or long "total preparation time." In the studies reviewed, active preparation time generally included activities that required the full attention of the homemaker; total preparation time included the active preparation time and other time such as for thawing or baking that did not require the full attention of the homemaker.

The trend in time requirements was similar for fruits and vegetables: fresh ones required the longest active preparation time and frozen ones required the longest total preparation time. Within each market form, of course, we can find fruits and vegetables that are lower than others in active and total preparation time.

A comparison of data for 4 vegetables in each market form indicated the following generalizations about the worker's active preparation time: for fresh vegetables between one-third to one-half of the total time; for frozen vegetables—about one-third of the total time; and the worker's active time for canned vegetables was only a small fraction of the total time. Modern homemakers have an opportunity to regulate the proportion of their time needed to serve a cooked vegetable.

In general, the frozen potato products saved more worker time than did dehydrated potato products. As was true with other foods, a homemaker has a choice about where she wants to save time—in the active preparation time or in the total preparation time and in some instances in both.

Commercial forms of baked products saved active preparation time

Table 10-11. Active and Total Preparation Time for Various Types of Food Supplies

		Preparation time (minutes)	
Food supplies	Source[a]	Active	Total
Fruits	(8)	Fresh—16 or less Canned, frozen—1 or less	Frozen—less than 85 but as much as 181 Canned—1 to 9, most 1
Vegetables	(92)	Fresh—6 to 31, most 10 to 18 Canned—5 or less, most ½ to 1½ Frozen—1 to 6	Fresh—22 to 80, most under 60 Canned—4 to 28, most 7 to 13 Frozen—12 to 100, most under 22
Potatoes	(45)	Fresh—longest except for frozen whole boiled potatoes	Fresh—longest
Baked products	(54)	Cake, pie, yeast rolls, biscuits, waffles: 16 to 57; 44 to 80 percent saved with mixes, 90 percent if frozen	Yeast rolls: homemade—over 3 hours; mixes and frozen products—over 2 hours Homemade cakes—1 to 2 hours
Meat, fish, poultry, cheese	(27)	Home-prepared: 1 to 54 minutes Commercial: under 10	

[a] Sources are identified at the end of Chapter 11.

and, except for some frozen products and a few mixes, saved total time for preparation. Mixes saved less active preparation time than other commercial forms of baked products.

Active preparation time for plain meats and fish, dinners and main courses, sandwiches, pies, fried breaded foods, and combination dishes such as chow mein and beef stew was often as long or longer than total time for the commercial forms studied–canned, chilled, frozen, and packaged combinations. Using frozen foods that required thawing before use in home-prepared foods increased the total preparation time for these products thus widening the difference in total time between the home-prepared and commercial forms.

In contrast to studies of time costs for individual menu items, the effects of using convenience foods in meals rather than home-prepared foods were determined. Meals usinơ frozen foods rather than freshly prepared foods required one-third to one-half less of the worker's time

(Snow, 1956). However, the longer total time for the frozen item to be heated was a problem: casseroles required approximately 2 hours to thaw and bake in a preheated oven.

Martin's (1964) data indicated that the total elapsed time for 7 meals was always less with convenience foods. Some convenience products required about equal time for preparation and for cleanup. The time for shopping and storage was more for the home-prepared meals than for the convenience meals. For those who wish to cut down on the proportion of supportive actions, the convenience foods are an asset.

In a lecture demonstration (Snow and Armbruster, 1961), a menu was prepared, once from highly serviced foods and again from foods as unserviced as the market afforded. Time costs were lower for the meal from serviced foods. Timing was critical during the preparation of the meal with serviced foods and there were many short waits, too short to start anything else. Work during the meal with unserviced foods permitted time for planning as the baking progressed. These data again demonstrate the potential for designing into work the characteristics we prefer.

Our review of the active and total preparation time for the various convenience foods illustrates the potential effects of choice of supply on the continuity of work. Of course, the time input and the intermittent attention are not the only resources to be considered. Monetary costs are often an important aspect and the family's preferences for flavor and variation in menu items cannot be overlooked. With respect to continuity of work, however, the data clearly indicate that the food supplies affect the proportion and duration of active and inactive time and the total time span for the task. These dimensions of work have an important impact on the work that the homemaker does and how she goes about it as well as the manner in which she combines tasks with meal preparation.

Interruptions External to the Task

Some breaks in the continuity of work come from factors external to the work itself. Often these are the children, telephone, or visitors (Gaudin, 1960; Maloch, 1962; McCandless, 1959; Wiegand and Gross, 1958). Occasionally, equipment for another task breaks down and requires attention. Most of these interruptions are beyond the control of the homemaker. The reaction of the homemaker to the interruption and the number of interruptions are of concern.

Homemakers' reasons for liking a particular homemaking task included accomplishment or lack of interruption, and for disliking a task, the opposite—lack of accomplishment or interruption (Maloch, 1962). Over one-third of the reasons given for doing their most liked and least liked tasks at the time reported were to avoid interruption. The timing of the task with respect to other activities or people was apparently important.

One-half of Gaudin's (1960) homemakers said that they were generally interrupted while washing clothes. Interruptions averaged 1.5. Some homemakers expected interruptions from the children and others planned to do their washing at a time when they would not be interrupted by them. Some of Seaman's (1962:75) cooperating homemakers felt that their time records "failed completely to give a real picture of the constant interruptions" from the children. McCandless (1959), however, reported that there were not interruptions for nearly three-fifths of all the day-to-day cleaning tasks—tasks of short duration.

From a time-use standpoint, interruptions can be costly. Homemakers in two socioeconomic groups averaged about 3 hours per week for interruptions such as answering telephone and doorbell (Van Bortel and Gross, 1954). In 3 out of 4 groupings of least liked tasks, the mean hours spent for interrupted tasks were longer than for uninterrupted tasks (Steidl, 1965). Small bits of time may seem unimportant when considered by themselves but taken together help to explain the concern or bother expressed by homemakers. The time itself as well as the break in the rhythm of work and extension of the task are parts of the problem.

Implications for Working Position

The variable degree of continuity of action during performance of many household tasks indicates that we should give careful consideration to the flat recommendation to sit to work. The short duration of many blocks of activity and tasks, the number of places where the work must be carried on, the short duration of work at some workplaces, and the interruptions external to the task are sources of discontinuity of action that limit the practicality of sitting to work. Of course, the importance to the individual of being able to work in the seated position and the functional design of the workplace to permit a comfortable working position will determine the importance and practicality of sitting to work, but the degree of continuity will be a major determinant of the practicality. Little satisfaction can be gained with working in the seated position when the duration of the seated position is severely limited by the nature of the work.

A small investigation (Bratton, 1961) of 102 homemakers' experience with and opinion of sitting to work indicated that sitting to work was not widely practiced. Ironing, folding clothes, preparing vegetables, preparing ingredients for baking, polishing silver, and preparing vegetables and fruits for canning and freezing were done "sometimes" or "frequently" by about one-half of the women. Objections expressed to sitting for household tasks fell into 3 categories: working in the midst of the family, especially when children are small; the nature of the work, especially routine kitchen work; and difficulty with equipment, usually the chair—work-surface relationship. (See Chapter 6.)

Informal interviews with selected homemakers revealed several determinants of sitting to work: the volume of work, state of health, use of fresh vegetables, habit, and duration of the job.

Careful analysis of the nature of the work for a task is needed to determine whether it is appropriate for the seated position. Sitting to work is not appropriate when the worker must frequently move from place to place or get up and down because of interruptions. Choice of supplies and planning ahead may help redesign some tasks so that work can be continued at one place for longer periods of time, but the number and kinds of tasks in the home that permit sufficient continuity of action for seated work are comparatively few.

Tasks rank high in continuity of action when they require the continued presence of the worker for action to proceed and contain few changes in type of process. Both continuity and discontinuity of action require that the worker plan carefully for task accomplishment and personal satisfaction with the content of the work.

Organization of Tasks

A description of the organization of tasks is actually a description of the outcome of one or more plans or the lack of a plan. Planning may be done with respect to what to do, when to do it, how to do it, what resources to use, where to do it, who to do it. By the same token, organization must be in some terms or another, for when we organize, we make a plan for proceeding, arranging, coordinating, grouping, delegating.

The scheduling for programing of the tasks describes organization. A broad view of the programming concerns the day of the week, month, season, or year. Somewhat more specific is the spacing by part of day—morning, afternoon, evening. Even more specific is the order: first, second, third and so on, or merely what came before and/or after an activity. Another important aspect of the organization of tasks is the style or general method of carrying out the plan.

Day of Week and Time of Day

Some insight into the problem of the general organization of household activities is found in a study (M. J. Davis, 1957) of decision mak-

Table 10-12. Spacing of Homemaking Tasks by Day of Week and Time of Day

Tasks	Source[a]	Spacing of tasks
All tasks	(110)	No evidence of a universal work pattern for a week.
	(15)	Activities saved for weekend: cleaning—½ of urban and rural white employed, ⅓ of rural Negro employed homemakers; washing—⅔ of latter group. ¼ saved no homemaking task for weekend.
Set time for task	(14)	Start dinner preparation: more than 15 minutes variation for 9/10 of homemakers; cleaning house: more often a set time than dinner preparation.
Meals	(55)	⅕ served meals regularly; ⅖ semiregularly; ⅖ irregular time pattern.
Dishwashing	(21)	Usually ran dishwasher after evening meal.
	(117)	½ operated dishwasher at a particular time of day.
Washing	(117)	7/10 indicated a regular day, a particular time of day, or both; more routinization of day and time of day if nonautomatic washer.
	(41)	⅔ had a special day.
	(119)	Most had regular times.
	(97)	A regular day or days for ½ of employed and full-time farm and ⅔ of full-time homemakers.
	(29)	7/10 washed on Monday, 3/10 on Tuesday, ½ on Saturday.
	(26)	⅔ started between breakfast and noon meal, 1/10 after noon meal.
	(88)	½ of blocks of time in morning, ⅖ in afternoon.
	(82)	⅗ at beginning of week.
Ironing	(82)	⅗ at beginning of week, 3/10 no special day.
	(119)	⅔ had no regular time.
	(88)	Most often in afternoon, then morning, then evening.
	(49)	Almost all after 10 A.M.
Food marketing	(91)	Generally a regular day and time of day.
		Reasons for regular day: time available; pay check comes then; market is less congested; market has specials; transportation available.
		Reasons for choice of hour: wife's or husband's schedule; availability of transportation; avoid crowds; dovetail activities of children.
Food shopping day	(91)	Friday or Thursday.
	(52)	Friday if full-time homemaker; Friday then Thursday or Saturday if employed.
	(70)	Friday then Saturday; 1/10 no special day.
Food shopping hour	(91)	Morning, afternoon, evening.
	(70)	Morning and afternoon more often than evening.
	(52)	Full-time homemakers—spaced throughout; employed—afternoon or evening.

Table 10-12. Spacing of Homemaking Tasks by Day of Week and Time of Day (*Continued*)

Tasks	Source[a]	Spacing of tasks
Care of house	(76)	Friday or Saturday for cleaning living room.
	(83)	Friday for general cleaning.
	(119)	Some regularity for tasks not done daily.
	(50)	Day-to-day cleaning tasks: ½ between 9 A.M. and noon.
	(88)	⅔ in morning, ⅕ in afternoon.
Care of family members	(88)	Spaced throughout day but fewest before breakfast.
	(102)	Evenly spaced if a baby; concentrated 6 to 8 A.M. and 6 to 8 P.M. if young school-age children and 6 to 8 A.M. if older school-age children.

[a] Sources are identified at the end of Chapter 11.

ing in relation to household activities. Out of 410 decisions recorded by 59 homemakers during a week, 36 percent centered around when to perform an activity and involved 51 homemakers. The problem of whether to do an activity entered into 30 percent of the decisions. Which of two or more activities to do also posed a problem in 23 percent of the decisions. Dominant factors reported in the household decisions were first time, then people, material goods, and standards.

Homemakers in Kelsey's (1965) study indicated need for organizational changes in household tasks during the preceding 5 months, especially in the time of the day and the time of the week when they worked and the order of doing tasks; almost all had some need to postpone work. The most organizational changes were needed in care of the house.

We obtained a partial description of the "calendar when" when we looked at how often the tasks were repeated. Some tasks, of course, are done regularly more than once a day or every day. Other tasks are such that there can be an ebb and flow in rate of repetition so that the homemaker can choose which tasks might be scheduled for a particular day of the week or time of the day.

The particular day of week or time of day when tasks are done help describe homemakers' patterns of work. The regularity of doing a task helps identify their standing plans for programming their work. These matters have been included in a number of studies (Table 10-12).

Although certain trends in the spacing of tasks by day of week and time of day can be noted, it is not difficult to understand why variable work patterns exist. A variety of factors determine the rhythm of spacing tasks during a week and during a day. The interplay among these factors is worked out within each household. Many permutations and combinations of patterns are possible.

Sequence When

The order in which tasks are done during a day (with respect to being first, second, third, and so on or with respect to what activity precedes and follows a given activity) shows even greater diversity in scheduling than the scheduling by day of week and time of day. A few studies provide information about the sequencing of activities (Northeastern Farm Housing Technical Committee, 1959a, b; Nelson, 1963; Smith, Gerhold, and Kivlin, 1961; Steidl, 1963a, b; Gaudin, 1960).

From these studies, we conclude that diversity of sequencing of activities is characteristic of homemaking work. The variable order in which tasks were done seems to indicate homemakers use discretion as they carry out a plan or develop a plan for their work.

Methods of Combining Tasks

Basically there are two methods of proceeding with tasks: separately or together—one at a time or more than one at a time. The nature of household work is such that some tasks can be done one way, some the other.

Several terms are found in home-management literature to describe the general method of proceeding with household tasks that are done together. Tasks have been classified as "overlapped" (Tasker and Stouffer), "active" and "passive" (Tasker), and "primary" and "secondary" (Seaman). These terms have a similar connotation, e.g., that tasks are sharing time or are being done concurrently. "Overlapped" referred to situations in which a homemaker was performing activities simultaneously and was actively engaged in one activity and passively engaged in another. The definitions for the preceding terms include the concept of one task receiving more attention or more active work by the homemaker. For another term, "combined" (Steidl), no assumption was made with respect to the manner in which time was shared since the report of the homemaker did not provide sufficient information—merely the fact that she did two or more tasks during a given time period.

What does it mean when we say that some tasks are done together? If a homemaker has more than one task going, how is she doing them? When tasks are "done together," is there more than one way of proceeding? We believe that when tasks are being done concurrently there are three basic ways in which the tasks might be kept going: alternate active and inactive work times on two tasks; overlap active work times; and interrupt and interweave active work on "independent" tasks—tasks that have only active work times. Certain characteristics of work are partly responsible for the general way of proceeding.

1. *Alternate active and inactive work times on two tasks.* This way of proceeding comes from the continuity–discontinuity of household work. Active and inactive work times occur during some tasks and intermittent action is therefore necessary. Active work time is that period when the worker's presence or attention is needed to keep a task going—the process must be attended. Inactive work time is that period when the task process continues without help from the worker—the process is unattended. The consequences of the active-inactive work times are that they both permit and require the dovetailing of two or more tasks or parts of them if household tasks are to be accomplished.

The fitting together of active work time on one task while the inactive or unattended work time continues for another means that tasks are done in parallel. They share time in the sense that they are going on at the same time although the homemaker is actively engaged in only one. The sum of the active work times of both tasks would equal the total time span; the sum of the active and inactive times for both tasks would be double the actual time span.

When active work times are fitted together, short-term memory is often required. A homemaker must remember to go back and take care of the task that she has left; it may be after a given period of time or when she hears a particular cue. Short-term memory commonly occurs in the work for meal preparation. Meal preparation comprises a number of menu items or tasks, many of which have active and inactive work times. The homemaker must return to food cooking on the range so that she can regulate the rate or duration of cooking. Sometimes only a few moments elapse between trips to the range.

With other tasks having active and inactive work times, long-term memory may be required because a fairly long period of time elapses between the active work times for a given task. An example is the active times associated with hanging and taking down clothes from a drying line. The inactive work period during drying may extend for several hours. The homemaker must remember to return to the task, although the timing may not be critical.

2. *Overlap active work times.* A second way of doing tasks concurrently is to actually do them simultaneously. To be able to do tasks simultaneously, in the strict sense of the word, physical action must generally be required by only one of the tasks, and the worker must be able to think—to process information intermittently for the two tasks. When information for the tasks is received by different senses, such as visual

and auditory, and different responses are required such as speech and manipulative motions, two or more tasks can be carried along simultaneously. Ironing requires the continued presence of the homemaker; when she is talking with a child or supervising him, she can carry the child care and ironing tasks along concurrently, working simultaneously on both.

3. *Interrupt and interweave active work times on tasks that have only active work times.* With this technique, a homemaker works back and forth among tasks that do not have to be sequenced; such tasks are independent, separate tasks, often of short duration, and if the action is interrupted, it is at the worker's option rather than imposed by the nature of the work. Sometimes it is more expedient to proceed in this manner even though action is interrupted, for it may reduce the amount of planning.

Some task areas are made up of a number of tasks which may be done in a variable sequence because they do not build on one another, i.e., one part of a task or one task can be done before another on one occasion and no problems arise. The daily care of the house may include a number of related but independent tasks, such as making beds, picking up clothes, hanging them up, emptying ash trays and wastepaper baskets, putting away games, straightening furniture and magazines. Because they are independent and do not require intermittent action, they can be done in almost any order. Advantages of the independence or separateness of certain tasks are that they can be taken care of during the inactive work periods for other tasks and often can be interrupted without damaging the product.

When action on the independent tasks is interwoven, the task system falls into the third category of tasks done together. However, when action on one independent task is completed before action on another is initiated, the tasks are in the other major category of being done separately or one at a time. Observation data rather than recall data may be needed to identify which system was used.

The preceding techniques for doing household work represent basic ways of proceeding. Combinations of these systems may be made, of course. For example, the second or third system of doing tasks together may be used during the inactive work time of another task. The effects of voluntary interruption by the homemaker have been dealt with only partially. The effects of interruptions external to the task have been purposely excluded. Our purpose was to explain that the rationale for proceeding in various ways is determined partly by the nature of the work.

Other characteristics of work or the work situation are also important in determining the general method of proceeding. These include: the degree of flexibility for task completion; the need to coordinate the completion of two or more tasks or events; the total time span needed for completing a task; the duration of active and inactive work periods; the impact of nonhousehold activities of the homemaker and/or other family members; and the availability of services outside the home.

An important question is, "How many tasks can a homemaker keep going at one time?" What characteristics of tasks permit a homemaker

Table 10-13. Homemakers' Methods of Proceeding with Tasks

Source[a]	Description and feelings
(89)	Blocks of time with 2 or more activities: about 1/10 of all blocks; 2 to 6 activities/block, generally 2; an average of 3 blocks with multiple activities for full-time, 2 for employed city homemakers; personal activities most often combined with other activities, followed by food activities
(105)	Combining tasks a method of saving time for some, not for others
(61)	Saved time on meal preparation by combining with other tasks
(119)	1/3 of homemakers regularly combined meal preparation and care of house; 1/5 combined washing and care of house; combining tasks a method of saving time
(91)	1/2 combined major food shopping trip with other activities, especially when market was over 1/2 mile from home
(78, 93)	Interweaving of child care and other activities
(93)	Meal preparation a passive activity in 3/5 and child care an active activity in 1/2 of overlapping activities
(50)	1/2 of day-to-day cleaning tasks combined with other day-to-day cleaning tasks
(26)	Regularly combined various tasks with washing; reasons: not required to be at machine and just works out
(93)	Quality of management: satisfied, "good" managers may have more clustered activities and more premeditated overlap
(90)	Satisfied and dissatisfied managers similar in overlapped activities but only former had large number of clustered activities
(24)	1/3 reported following no system for household work, 1/3 weekly, 1/6 daily, 1/10 a combination
(40)	3/5 blocked time for big jobs
(53)	Tasks done at particular time to avoid interruptions; also related to another part of a task, best time or feel more like doing it, time needed to complete task, and presence or absence of family members
(28)	Standing plans for regular care of house for 4/5, specific plans made evening before or in morning; routines used

[a] Sources are identified at the end of Chapter 11.

to do them "concurrently"? Do homemakers differ in their ability to dovetail tasks and to do tasks which share time and attention? Of help in considering these questions is Gilmer's (1961) idea that we should be careful of piling up simultaneous activities which are nonroutinized. If we as work specialists suggest the concurrent performance and dovetailing of tasks, we must be careful that we provide guidelines to avoid engaging in too many activities together that require judgment and decisions about how to proceed. Research is needed to provide these guidelines.

A number of studies provide information which describes how homemakers have proceeded with their tasks (Table 10-13). The researchers' terminology has been retained.

The variety of tasks and the low level of continuity of action for many tasks make constant demands on attention. Interweaving of tasks and parts of tasks entails planning and timing of action. Changing situations call for judgment to determine the most appropriate manner of proceeding.

Variability in repetition of some tasks provides the worker in the home with some choice in the content of a day's activity in terms of amount of physical activity, place of work, number of tasks, types of action, duration of various types of action, the amount of getting ready and putting away, amount of precision work including careful timing, and the extent of intricate interweaving of tasks. Taking advantage of such options as these, as well as options in supplies and equipment, can add interest and variety to our job.

CHAPTER 11

The Amount of Work

How much work does a homemaker do? Our approach to this question is to consider who does the work, where it is done, and how much is done. Answers to such questions will develop our appreciation of the homemaker's job and facilitate analysis of families' situations for better control of the amount of work.

Fortunately, families have a variety of ways in which they can proceed to control the quantity of work they accomplish as well as the personal costs of doing it. Awareness of sources of help available and conditions for reducing physical work contributes to realistic appraisals. Future research should broaden the base for evaluating the costs of work by contributing measures of the affective and cognitive costs of work.

Although our major focus is from the homemaker's point of view—what affects the amount of work *she* does—we do not intend to imply that the personal physical and temporal inputs accrue for only the homemaker; other workers make similar contributions and may be just as interested in controlling their input. Most of our source material identified only the homemaker's input and output, for she is often the principal worker. The major exception was found in the study of time used for homemaking.

WHO DOES THE WORK? WHERE IS IT DONE?

The amount of work is influenced by the help received and by the place of work.

The Help Received

Help can be obtained from a variety of sources—other persons within the family, paid help, paid services, and help received through the equipment, supplies, or materials.

Family

The traditional pattern of the homemaker as the main worker seems to be shifting in recent years, yet it is difficult to identify the situation since a complex of factors is involved. The entrance of married women into the paid labor force outside the home and the decrease in number of adult females in the household have been major factors in the shift toward a greater involvement of husbands in household-task performance.

Work that is delegated to and done by another family member reduces a homemaker's input in various ways. Less time is among the more easily identifiable changes. Physical costs of working are also eliminated. Less thinking is involved before and during the activity if the planning is transferred to the helper and supervision is not needed.

Work supervised by the homemaker may reduce some of her inputs but in some instances it may increase others. The unskilled helper, and especially the inexperienced young child, may require increased attention from the homemaker to see that the activity is proceeding correctly so that help can be given at the appropriate moment. The homemaker may also need to develop her plan or help the child develop the plan step by step and in more detail than if she were doing the work herself. However, the physical input is decreased during supervision rather than performance of work, and the close attention and precision in motions may be reduced. The time span for the task performance may be increased because the helper is unskilled. The responsibility that the homemaker assumes in teaching her children to perform household tasks and their gain in experience can affect the amount of work on the part of the homemaker.

Nichols (1964) proposes that the most complex of three levels of task organization based on number of tasks and persons involved is that in which one person, the manager, arranges the efforts of others for the performance of one or more tasks. She suggests six components of this organizational process: assign, authorize, actuate, supervise, coordinate, and evaluate. This conceptualization agrees with our ideas of the potential for homemakers' greater mental input with helpers.

The amount of help received is described rather generally in terms of proportion of homemakers receiving help, proportion of children and husbands who helped, and more specifically in terms of proportion of responsibility assumed and proportion and amount of time contributed. The proportion of total output contributed by helpers would be more definitive. A review of the literature indicates participation of family members in the work of the home but variation with age, sex and num-

Table 11-1. Family Members' Help with Homemaking Tasks

Task	Source[a]	Help received and helpers
All tasks	(46, 47, 113, 104, 61, 9)	1926 to 1953: 80 percent of homemakers; 13 to 22 percent or 7.7 to 18 hours/week, lowest most recently
	(14)	1943: 80 percent of white homemakers, 17 to 18 hours/week; 95 percent of Negro homemakers, 11 to 13 hours/week
	(109, 110)	1952: 44 to 57 percent of homemakers, highest for employed homemakers; 5 to 13 percent of time, average 0.6 hour/day
	(103)	1964: 20 to 30 percent of time/day, highest for employed homemakers; 70 to 80 percent of husbands and 70 percent of children helped; teenage girls helped most
	(36)	Teenage girls averaged 67 minutes, boys 25 minutes/day
	(94)	More teenage girls than boys helped
	(71)	Number of tasks and time increased with age; girls more than boys
	(1)	8th-grade girls had more numerous and more extensive home responsibilities if mothers employed than if full-time homemakers
	(24)	80 percent received help in 6 task areas; homemakers averaged 88 percent of total daily workload
	(63)	Employed homemakers: more received help when 3 or more adults, 3 or more children, husbands with 12 years or more schooling, and homemaker herself had worked outside home 10 to 12 years
	(68)	Responsibility for tasks varied with task, substantial proportion by wife only
	(95)	Town husbands helped wives more than farm husbands in food preparation and cleanup
	(65)	Husbands of full-time farm homemakers averaged 1 task compared to 2 or 4 for husbands of full-time nonfarm and employed homemakers
	(48)	Women with part-time jobs took greater responsibility for work within home than full-time employed and full-time homemakers
Day-to-day care of house	(50)	Averaged 0.1 hour on day before interview; ½ employed, ⅕ full-time homemakers received help; ¼ of homemakers received help with bedmaking; help given in ⅛ of households with children under 6, ⅔ with teenagers; 85 percent of tasks done without help
Cleaning living room	(76)	3/10 of homemakers had helpers for last general cleaning; helpers averaged 1 hour for in-between cleaning

Table 11-1. Family Members' Help with Homemaking Tasks (*Continued*)

Task	Source[a]	Help received and helpers
Regular care of house	(35)	3/5 of families with children received help; averaging 2 hours/week; 1/2 of rural and 1/2 of urban families had helpers; 1/4 of total time for care of house, rural, 1/5 for urban
Washing	(73)	1/5 of 444 weekly records showed help; averaged 43 minutes/week; helpers' time 4 percent of total time for washing
	(7)	15 percent of homemakers shared responsibility
Dishwashing	(11)	Averaged 2 hours/week, about 30 percent of total dishwashing time; help on 70 percent of days, with or without dishwasher; related to number and age of children
	(15)	1/2 to 3/4 of families received help with food preparation or dishwashing; averaged 39 to 52 minutes
Food marketing	(15)	Wife shopped alone, 62 to 75 percent; husband and wife, 11 to 14 percent; husband alone, 7 to 23 percent, especially in rural Negro families
	(70)	Husband and wife, 15 percent; husband alone, 15 percent
	(55)	Husband and wife, 24 percent; husband alone, 7 percent; wives, 66 percent
	(22)	In 46 percent of shopping groups, a woman was alone; a man alone in 28 percent of groups and a member of a group in 40 percent
	(91)	Homemaker only shopper in 38 percent of families if full-time homemaker, 17 percent if employed
	(52)	More husbands and wives shopped together when homemaker was in labor force

[a] Sources are identified at the end of this chapter.

ber of children, geographic and residential location, race, employment of homemaker outside the home, and with tasks (Table 11-1).

We must keep in mind that the homemaker is not the only worker to consider in designing work content, work methods, and workplaces, but that deference to the wishes and needs of the major worker may be a deciding factor in some instances.

Paid Services

Paid helpers and services in the market can assist family members in reducing the amount of household work they do. Some tasks can be taken or sent outside the home, others must be done on the premises, and with some the procedure is optional. A variety of options for hiring help are available for various tasks, but information about the extent of hired help is available mostly in bits and pieces rather than from a broad investigation focusing on combinations used within families.

For tasks that must be done within the home, such as many cleaning tasks, only one option for paid services exists—to hire help to come into the home. This is becoming more and more difficult. Paid domestic help is less available now than in former years, especially in some regions of the United States. Of employed women 14 years of age and over, 17.6 percent were private-household workers in 1940; this proportion dropped to 10.3 percent in 1950 and in 1965 to 8.2 percent (U.S. Department of Labor, 1966:89). Although the total number of employed women increased from 1,192,000 in 1940 to 2,464,800 in 1965, the number of private-household workers decreased from 210,000 in 1940 to 202,500 in 1965.

Part of the change in availability of domestic help has occurred with the growth of industry, its mechanization, the decrease in skill needed for operating machinery and assembling parts of products, and the increased need for secretarial workers. Greater mechanization of the household and improved housing conditions and facilities have also freed women from much of the work within their own homes. Women seeking employment outside the home may find work in business and industry more attractive than domestic work in someone else's home; in contrast, others may prefer domestic work but the poor working conditions and lack of fringe benefits may make it impractical to seek such work.

In recent years, new business concerns specialize in cleaning jobs, such as window washing and carpet and floor cleaning. In this era of mass production, the day may come when a cleaning crew will service an entire neighborhood at one time—clean, polish, and wax surfaces within most of the homes in a given neighborhood. These organized businesses may make it more possible for families to choose hired help for some work that must remain within their home.

For those families who do have help come into the home to work, the degree of skill of the help as well as the definition of the job to be done will be determinants of the amount of planning that must precede their arrival and their supervision during task performance. Certainly some arrangements for day and time of day will be involved, and in many instances standing plans may be made and checked.

Two studies, one in Georgia and the other in Ohio, illustrate the use of hired help within the home (Holmes, 1962, 1965). More of the gainfully employed than nonemployed wives reported paid help. The same pattern of greater use of paid help by employed wives was found in each of four task areas: child care, laundry work, general housework, and sewing.

The employment of baby sitters is not to be overlooked as one type of paid help. Although many families rely on relatives, neighbors, or older children in the family to look after the young ones, many teenagers earn money through baby sitting.

The seasonal employment of teenagers to help with lawn care and gardening and outdoor work around the house represents another method of obtaining paid help for another group of household tasks.

Delivery of items to the home relieves the homemaker and other family members of certain parts of tasks. In the case of delivery of purchases made in person or by mail order, such as clothing, furnishings, and nonperishable items, the carrying is eliminated. Home delivery of food relieves family members of some work, especially choosing and transporting. Standing orders for certain quantities of food also eliminates some of the need for planning, although a review of the plan is probably necessary on frequent occasions along with steps to adjust the standing plan. Whenever standing plans are used, or as long as they can be kept in effect, the time and attention to make arrangements is eliminated.

The trend for home delivery of milk has been to shift to deliveries on fewer days per week and a smaller proportion of fluid milk to be home delivered (National Commission on Food Marketing, 1966). On a national basis before World War II, deliveries were practically every day but during the war shifted to every other day due to restrictions on the use of motor vehicles; now the trend is toward two deliveries per week in some market areas. In the 1930's, it was not uncommon for 70 percent of all fluid milk sales to be on home-delivery routes. In contrast, 30 percent of fresh fluid milk was home delivered in 68 Federal order markets in November, 1963; this proportion varies among markets, however, such as 17 percent in St. Louis in 1963, close to the average in Minneapolis-St. Paul in 1961, and above the average in Rochester in 1964 with 41 percent home delivered.

Eating meals out is another technique of hiring help. Not only is the preparation of the meal transferred to paid services but also purchasing food, washing dishes, and the accompanying storage activities.

Work can also be delegated to paid services by taking or sending out the items that need attention. The washing, ironing, and dry cleaning can often be done either way; in either case, a family member continues to do some of the task—gathering, sorting, special spot treating, and storing. Counting, making a list, and checking are added tasks. When the commercial concern collects the items from the home, arrangements must be made for them to be collected; sometimes standing plans can be used. If the arrangements are made, it may also be necessary for a family member to be at home so that pickup can occur. After the work has been completed, it may also be necessary to be at home so that the items can be delivered. These facets of the problem that accompany paying someone else to do the work should not be overlooked when one is trying to identify the personal costs of accomplishing the task. The more seasonal jobs such as getting the rugs or furniture or draperies cleaned would be included in this category of having things collected or possibly taken out to be serviced.

Deacon (1960) compared time and money costs with four laundering arrangements; these ranged from all laundering done at home to all items sent to a commercial laundry to be completely finished. Use of commercial services averaged between 0.4 and 1.1 hours weekly to make the arrangements, gather, itemize, transport if necessary, check, and store articles. Ironing accounted for almost one-half of the total time when all of the washing and ironing tasks were done at home. The ironing done commercially was the most substantial time saver of the 3 major jobs of washing, drying, and ironing. Deacon's data suggest that help received from commercial services may make substantial savings in time through the elimination of a task but some tasks may be added in order to make use of the commercial service.

Whenever an option exists for hiring help, it is appropriate to identify the amount and type of preparatory and terminating work that remains within the family so that savings in personal effort can be compared; this provides a sounder basis for choice in way of proceeding.

Supplies, Materials, Equipment

The modern family has at its command an impressive assortment of supplies, materials, and equipment to help reduce the amount of personal effort to accomplish household work. Technological advances, applied to those things used in homes, have brought about marked changes in how hard a family member must work, how the work can be done, and when it can be done.

Historically, three changes have occurred to improve the quality of housing and reduce work costs: piped water, central heating, and electricity (Table 11-2). Piped hot water is a further improvement. Too often these are taken for granted and completely overlooked when the question of technological advances is considered. Probably the greatest work saver of these is piped water because the amount of lifting and carrying represents a high cost of physical work, and this work is com-

Table 11-2. Selected Housing Characteristics

Facilities in dwelling units	Area	1940	1950	1960
			Percent	
Piped water	United States	70	83	93
	Urban	94	96	99
	Rural-nonfarm	56	68	80
	Farm	18	43	75
Central heating	United States	42	50	65
	Urban	58	63	75
	Rural-nonfarm	27	31	42
	Farm	10	18	34
Electric lights	United States	79	94	—
	Urban	96	99	—
	Rural-nonfarm	78	90	—
	Farm	31	78	—
Mechanical refrigeration	United States	44	80	—
	Urban	56	86	—
	Rural-nonfarm	39	72	—
	Farm	15	63	—
Kitchen sink	United States	—	85	—
	Urban	—	95	—
	Rural-nonfarm	—	74	—
	Farm	—	55	—
Clothes washing machine	United States	—	—	73
Clothes dryer	United States	—	—	17
Air conditioning, room units	United States	—	—	11

Source: U.S. Bureau of the Census. U.S. Census of Housing: 1940, Volume II, General Characteristics, Part I, U.S. Summary; 1950, Volume I, General Characteristics, Part I, U.S. Summary; 1960, Volume I, States and Small Areas, U.S. Summary.

bined with the inconvenience that accompanies heating small quantities of water and the coordinating of help from various family members to accomplish the carrying in and out of the water.

The supplies, materials, and equipment used in the various task areas make a difference in the time required to do the task, the number of operations involved, the omission of parts of the work, the amount of physical work involved, and the achievement of the standard of quality desired by the worker.

The material out of which clothing and household items are made can affect the personal effort for their care. The choice of synthetic fibers, blends of synthetic and natural fibers, and specially treated durable-press garments can eliminate much, if not all, of the ironing. In many cases, the method of handling the garment can make a difference in whether or not pressing is needed after washing.

We need research to determine guides for procedures in laundering the "miracle" fibers so that the worker really takes advantage of the potential savings in effort. We need to identify procedures that will minimize input, especially when there is a mixture of laundry items of various fibers. Are we merely transferring ironing time and work to other parts of laundering, such as the special attention to rescue the garments from the dryer at the point at which the drying cycle is just completed, or the time we spend straightening items when we hang them to drip dry? If we can identify procedures that will minimize the attention needed with use of dryer or hanging lines, we may truly be able to reduce the total input for getting clothes clean and ready for wear again.

Estimates of the number of homes with household appliances sketch for us the present situation and the change over time in the work situation within homes. Data for the saturation level for selected appliances in homes wired with electricity are given for 1950, 1960, and 1965 in Table 11-3. Substantial increases are apparent for all of these appliances between 1950 and 1960 and some increase for all but one between 1960

Table 11-3. Estimated Saturation Levels of Selected Appliances in Homes, Expressed as Percent of Homes Wired with Electricity

Appliance	1950	1960	1965
Refrigerators	86.4	98.0	99.5
Freezers	7.2	23.4	24.2
Dishwashers	2.0	7.1	13.5
Food-waste disposers	1.9	10.5	13.6
Coffeemakers	47.8	58.3	71.7
Mixers	26.4	56.0	72.8
Washing machines	71.9	95.4	81.4
Dryers	1.2	19.6	26.4
Vacuum cleaners	56.5	74.3	83.5
Air conditioners, room	0.5	15.1	24.2

Source: 1950 data: *Electrical Merchandising* (1951, 83:1:74). 1960 data: *Electrical Merchandising Week* (1961, 93:4:42–43). 1965 data: *Merchandising Week* (1966, 98:5:25).

and 1965. The exception is for washing machines; presumably, the decreased proportion of homes with a washer is associated with an increased number of self-service laundries and of apartments with common facilities in the building rather than in the apartment.

Evidence seems to be inconclusive with respect to time savings with the addition of some equipment. Some researchers believe that some of the conflicting evidence may come from a change in standards that accompanies the acquisition of new appliances. The work specialist needs to examine other personal costs besides time in analyzing the help received from equipment.

Data from a study in Sweden (Horowitz, 1964) demonstrate that in some instances the size of the task must be increased to help average the work costs. The time costs for hand and machine laundering of synthetic fiber garments and for two locations and types of machines were compared (Figure 11-1). The higher time cost per shirt with a nonautomatic indicates the added cost to get equipment ready and use it and, with the basement location for equipment, to get to and from the place of work. A complex of factors can function to cancel out potential savings in personal costs of work with equipment.

The supplies, materials, and equipment that are available permit a homemaker and her family to design selected characteristics into or out of their homemaking work. We can look forward to many more technological advances. The variety of choice requires knowledge of the purchaser so that an informed decision can be made. The variety, the anticipated increase in variety, and changes in choice behoove us to keep up with new developments so that we can take advantage of change and be in a position to make a considered judgment as to whether change is desirable.

The range in choice of supplies, materials, and equipment also requires increased attention during marketing and shopping so that we select what is most appropriate for our own work situation as well as our other limitations, such as money, family preferences, and compatibility with other possessions. The increased variety may also require more attention within our own home so that we can be certain to select the right item—especially in regard to cleaning and food supplies that are appropriate to the occasion.

Constant questioning will be needed to identify the effect of new supplies, materials, and equipment on the various personal costs of work. If they decrease the amount of physical work, have they caused an increase in the amount of thinking that is necessary? Or has the time span for the amount of thinking that is involved merely been shortened? Is the amount of thinking required with various items for different tasks

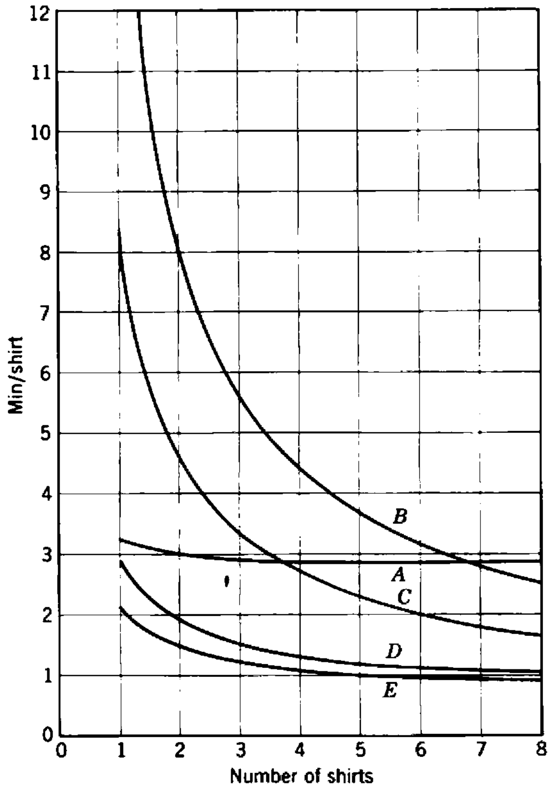

Figure 11-1. Time costs per shirt with varying numbers of shirts per wash and washing situations. *Key:* *A*, hand washing; *B*, nonautomatic washer in basement; *C*, nonautomatic washer in bathroom; *D*, automatic washer in basement; *E*, automatic washer in bathroom. (*Source.* Horowitz, 1964, p. 36.)

compatible, or are we asking homemakers to pay too much attention at similar stages in tasks done in parallel so that the work has been increased in difficulty rather than decreased?

Ideally, consumers will have sufficient choice in the market so that they have freedom to design the content of a given task and the structure of the content among tasks.

The Place of Work

Where the work is done often has a direct impact on the type and amount of input by the worker. Although the task or part of a task may be a major determinant of the place of work, some choices may be possible thus permitting some control of personal costs associated with differences in place of work.

Fixed and Unfixed Workplaces

A fixed workplace is a permanently located area, one set aside for a particular activity. It is already set up and ready for use. In contrast, the unfixed workplace is set up when the task is to be done and taken down afterwards.

The costs of getting ready to do a task are kept to a minimum when the appliance, tools, supplies, and materials are already assembled. Eliminated are: the time of the worker to get a place ready; the thinking through of where the needed items are stored; planning for the use of the space; and the physical work to lift, carry, place, and eventually replace items.

Advantages of an unfixed workplace may include opportunity to vary the place of work in order to favor improved working conditions (light, temperature, ventilation), to add variety, to facilitate doing tasks concurrently, or to permit an increase in companionship or proximity to radio or television.

The permanency of workplaces and single-purpose use may be directly related to cost of space in the home. However, a high frequency of use of space for specific activities may justify setting aside space for them. The multiuse spaces may have keen competition for use at certain times, little demand at others. Recognition of possible conflicts is essential in planning a functional amount of space in homes.

In practice, not all fixed areas that are planned for specific activities are so used. Not only do the appliances and work surfaces function for other tasks, but the space surrounding them is used for setting up temporary workplaces for household tasks, business activities, and hobbies.

The provision of a fixed versus unfixed workplace for a particular task is prescribed by the characteristics of the processes involved and the equipment for carrying them out. The heavy weight of an appliance, cabinet, or work table also determines the permanency of a workplace.

The goal of reducing worker input for getting ready to perform and complete a task may dictate an established setup. A practical criterion is frequent repetition of a task. The more frequently the repetition, the more the saving in worker input with a fixed workplace.

Location in the House

Studies are needed that focus on the question of the story or level used in the house for household tasks and comparative advantages and disadvantages from the worker's point of view. What effect does work location have on the worker's input?

Involved in work location are not only distances walked and weight carried but also the mental activities needed to keep tasks under control. Proximity to another task may often reduce the amount of attention that must be paid or amount of short-term memory that must be used. Mechanical warnings provide helpful reminders, but auditory and visual cues help the homemaker to keep track of the work progress during inactive work periods; these cues may reduce the extent of task interruption needed to attend to the other task. The worker's preferences for place of work should also be taken into account in assessing the personal costs of working in various locations.

Space relationships among rooms and the level of the house are important not only to the work specialist but also to others. Specialists in human development and relationships are concerned with planning functional areas with respect to the interaction among family members, the socialization of children, and personal needs for privacy. These factors, as well as our concern for task accomplishment with minimum input, must be included in planning homes.

At Home or Away

Not all tasks can be taken away from the home and done elsewhere by a family member, but flexibility in place exists for some tasks. The most complete set of alternative arrangements currently exists for care of clothing. Some choice exists for marketing, shopping, banking, and paying bills. The telephone and postal service make it possible to carry on some of each task while at home. However, food marketing is difficult to accomplish by telephone; few markets now assemble and deliver orders. It is, essentially, a task that must be done off the premises. Technology may provide a choice in the future.

In contrast, most of the cleaning and upkeep of the house must be done at home. Much of the material to be worked on is fixed, and we take the tools and supplies to it. Some parts of care of the house, such as rug and furniture cleaning, may be done away from the home but usually not by a family member.

Many factors enter into the choice of the place of work. Studies of this dimension of management are lacking.

HOW MUCH WORK IS DONE?

To answer this question, it is necessary to consider both output and input—the quantity of work accomplished and what the homemaker puts into doing it. Measurement is a problem with both. Measures of output are often task-linked and therefore not comparable from one task to another. Most measures of input are common to all tasks although they may not always provide a meaningful measure of input for a given task. Measures of personal input are complex since physiological and psychological processes are involved. The study and measurement of the human costs of work were previously discussed in Part I; in the present section, we identify the amount of various measurable inputs.

Input

The most frequently used measures of input are time, energy, and trips. No less important are other types of movement and positions, the thinking required to do the activity, and the worker's feelings about the input and related conditions. We are necessarily limited to identification of more objectively measured inputs; the affective and cognitive costs are less measurable.

Movement—Trips, Reaches, Distances

The amount of movement from place to place provides a general measure of physical work. The amount of movement is grossly described by the number of trips or times a person walks between places of work and the number of reaches between work surfaces, storage areas, and appliances. The amount of movement is further quantified by measuring the distance walked or reached.

Trips may also indicate psychological demands placed on the worker, since each trip represents a start and a stop in work. Attention must be shifted from the work being done when a trip is made. Action is interrupted.

The total number of trips provides a gross comparison of different conditions and methods of work but does not identify high cost factors. Excessive movement may be associated with a poor situation related to one or more of the following: (a) the workplace–its placement in relation to other workplaces and its frequency of use; adequacy of work surface for the activity carried on; adequacy of storage space for the items used first at the workplace; appropriateness of supplies, tools, and utensils for the activities carried on at the workplace; the organization of the items used there; (b) the worker–work plan, body mechanics, skill, procedures; and (c) the activity–the materials, supplies, or equipment used; and the quantity of work done.

The significance of differences in number of trips may be associated

Table 11-4. Trips, Distances, Reaches for Selected Homemaking Tasks

Task	Source[a]	Amount of movement
Meal preparation and cleanup, laboratory studies	(87)	Trips, average number/meal Breakfasts without baking—92 and 141; with baking—103. Dinners without baking—112 and 116; with baking—143 and 177. Dinners with frozen main dish—81 and 98 without baking, 122 with baking; no freezer use, 195 with baking. Distances walked
	(31)	Dinner—485 to 665 feet; basic distances between centers—1 to 10 feet.
	(30)	Breakfast—284 to 491.
	(56)	Breakfast—1,256; dinner—1,732; basic distances between centers—2.6 to 17 feet. Variation in distances walked with number of people served, kitchen arrangement, menu.
	(51)	Menu for 4: 151 to 182 trips; 570 to 805 feet.
	(5)	Breakfast: 45 trips; 252 to 338 feet. Luncheon: 62 trips; 325 to 425 feet.
	(111)	Dinner menu for 3: 114 to 144 trips plus 419 to 512 steps; averaged 4 steps/trip.
	(60)	Breakfast: 380 to 490 feet. Dinner: 450 to 775 feet. (3 shapes of kitchens, no relation to distances)
	(18)	Dinner for 4: maximum average, 72 trips; turns of 90 degrees or more or side steps averaged 72.
	(80)	84 meals for 4 weeks: interunit trips, 2,005; unit—doorway trips, 1,375; average/day, 121.
Meal preparation and cleanup, observation data in homes	(5)	In a farm kitchen Breakfast—80 trips, 543 feet. Luncheon—102 trips, 696 feet. Refrigerator isolated from work surface and storage and over 12 feet from sink.
	(85, 86)	In 2 homes, a dinner All areas (appliances, counters, storage, dining) used 436 to 612 times, similar to 494 uses in laboratory study (84); storage uses 3/10 of total. Use of china storage for 8 persons for dinner 37 trips and reaches before and 29 after improving storage.

Table 11-4. Trips, Distances, Reaches for Selected Homemaking Tasks (*Continued*)

Task	Source[a]	Amount of movement
Meal preparation and cleanup, researchers' estimates	(114)	Farm kitchens, wood burning stove, from estimates for a year: 481 trips/day, average 0.4 to 0.5 mile/day in various kitchen layouts.
	(10)	Estimated distances in 56 kitchens for preparation and cleanup of 2 meals using standardized procedures: 152 to 597 feet, average 329, with more than ⅓ of kitchens requiring 350 feet and over before reorganization and 1/10 afterwards. With second test meal, average 887 feet before and 616 after reorganization, average distance 30 percent less. Average 20 to 32 relocations/kitchen.
	(74, 75)	Basic distances for equipment, supplies, place of work for 6 tasks: storage of 53 items averaged 5.8 feet from place of use; work surfaces averaged 6.9 feet apart; averaged 10.5 changes in place of work out of 14 possible for 6 tasks. Total basic distances averaged 378 feet, 305 feet if distances omitted for canned vegetables and potatoes stored out of kitchen. Direction of reach for 53 items: ⅖ stored above elbow height and ½ of these behind doors; ⅗ below elbow height and ⅔ behind doors.
Food preservation	(38)	Canning 14 quarts of food averaged 155 to 200 trips, 321 to 522 feet; lowest distances with L-shaped counter.
Laundry washing, laboratory studies	(59)	For 3 loads, 91 to 110 trips with automatic and semiautomatic washer, 345 nonautomatic.
	(81)	For 4 loads, 38 trips, excluding trips under 5; distances, 183 to 315 feet with wringer washer.
	(20)	For 5 loads, average trips 54 to 62, average steps, 247 to 250, average motions 378 to 464 with nonautomatic washer.
Washing, observations in homes	(4)	40 to 612 steps to collect and carry soiled items, 36 to 928 to wash and prepare items for drying, total steps 739 to 1,440/

Table 11-4. Trips, Distances, Reaches for Selected Homemaking Tasks (*Continued*)

Task	Source[a]	Amount of movement
Washing, observations in homes		week. Variable conditions among 7 homes.
	(99)	With spinner washer before and after organization of work area: trips, 131 reduced to 55; distances, 996 to 354 feet; body movements, 72 to 8. Trips for supplies only reduced from 60 to 2. A trip was a movement of 3 feet or more.
	(69)	No running water, 411 families: average distance 25 feet, range 3 to 330, between water supply and washing equipment; disposal of water: from tubs to disposal, average 31 feet. Observation of 37 families: average 14 feet, cold water supply to equipment, 8 feet for hot water; 12 feet for disposal of water. Average distance to clothesline, 25 feet, range 10 to 40.
Drying laundry, laboratory study	(23)	1 load, 8 lb: total 93 to 112 reaches and bends with clothesline, 57 to 59 with dryer.
Care of house		
Clean living room	(76)	Average 8 trips from room, range 1 to 25, majority to remove an item other than furniture, then to get supplies or equipment. Handling of furnishings: ⅔ handled, average 42, surface items handled averaged 17.
Make bed	(62)	For 3 subjects, 6 methods: 23 to 262 feet, 27 to 59 "elements" or movements.
	(42)	40 to 108 steps; variation from methods of work usually used by 2 subjects, new method, height of bed.

[a] Sources are identified at the end of this chapter.

with the total number involved, repetitiveness of the task, importance of the task in homemaking, and importance of minimum input.

How many trips are made to do the work of the home? How far does a homemaker walk? How many reaches does she make and how far does she reach? Data from a number of investigations provide partial answers to these questions (Table 11-4).

Table 11-5. Quality of Women's Positions During Homemaking Work

Task	Source[a]	Quality of position
Meal preparation		
Storage work	(56, 57)	Of 444 reaches to use storage facilities, 14 percent outside comfortable range. Excessive strain required to use storage space 20 inches or closer to floor. Angle of bend 58 degrees to open drawer 13 inches from floor. Space relatively easy to use: 27 to 63 inches from floor for worker 5 ft 4 in. tall.
	(17)	Awkward reaches (above 60 and below 20 inches, behind doors, behind front row articles in base cupboards): average number ranged 12 to 27 for breakfast, lunch, dinner.
A dinner	(56, 57)	Comfortable angles of bend from −5 to +15; of 349 positions, ⅔ comfortable; proportion varied with storage areas.
Baking	(58)	Angles of bend −10 to +30 did not require excessive strain for 9 subjects; between 65 and 124 bends/subject, average of 28 in difficult range. Base cabinet shelves difficult to use with ½ to 9/10 of bends over 45 degrees.
Use dishwasher	(118)	Extent of neck bend not significantly different for front-opening and top-opening dishwashers; greater angles of slump related to front-loading but larger back bends related to top-loading dishwasher. Greater back bends to load lower racks, greater neck bends to load upper racks.
Load, unload dinner dishes for 6	(115)	Number of positions: 181 to 195 arm motions, ⅔ to load machine; 53 to 70 body motions (reaches, bends, swings); loading under 5 minutes, unloading under 3 minutes.
Ironing	(49)	Average angle of bend decreased for 3 of 4 subjects as board raised from 31 to 35 inches; decreased angle of bend at preferred level compared to 31-inch level.
Washing		
Sorting	(79)	Sorting on floor: about 9/10 of time spent at an angle below 45 degrees—back flexed, horizontal with floor.

Table 11-5. Quality of Women's Positions During Homemaking Work (*Continued*)

Task	Source[a]	Quality of position
Washing Sorting	(81)	Sorting on floor, short period for normal upright positions. Table sorting: arms held up with elbow above bust fatiguing and occurred if piles set too high or work surface too high.
Use washers	(59)	Number of bends, 98 to 427, majority 45 degrees or less severe. Automatic straight front opening, 60 percent of 265 bends over 45 degrees—not in comfortable range.
	(81)	Transfer five 8-lb loads of damp wash from spinner washer basket to receptacle: 49 to 64 body twists, average degree of twist 14 to 21.
Hand wash clothes	(112)	African subjects, average deviation from average body alignment of 185 degrees: 109 degrees, ground level; 61 degrees, bend-over level; 7 degrees, stand-up level. Total changes in position during 28 minutes: 25, 31, and 5 respectively for the 3 levels. Average deviation from average angle of knee bend of 176 degrees: 15, 10, and 3 degrees.
Bedmaking	(42)	Average angle of bend 34 to 62 degrees. Angle of knee bend 0 to 40 degrees, averages 2 to 9 degrees.

[a] Sources are identified at the end of this chapter.

Some tasks considered separately may seem to require comparatively small amounts of movement, but the effects from various tasks accumulate and especially when poor organization of storage, design of equipment, or workplace is prevalent and action is discontinuous. Poor working conditions and excessive movement also take their toll in other types of personal costs of work.

Quality of Positions

Uncomfortable working positions are one aspect of movement that can quickly increase the costs of work, especially when the uncomfortable positions must be maintained for a period of time. The level of the work surface is an important source of uncomfortable positions. The floor, an ironing board, bed, appliance, or a counter may function as a work surface. The level of storage areas may also require uncomfortable positions. With either storage or work surface, the level may be too low or too high.

Data describing the quality of women's positions during work are given in Table 11-5.

Weight Lifted and Carried

The amount of movement is further quantified by identifying the weight of objects lifted, moved, and carried. Heavy weights may cause excessive strain or pull on ligaments, tendons, or muscles in arms, legs, and back, especially when one uses poor body mechanics.

Several tasks are of particular concern to us because the potential amount of weight lifting may be high. These include laundry, care of infants and young children, food marketing, and certain house tasks. Some data will help us appreciate a homemaker's input and the need for critical evaluation of work plans (Table 11-6).

Carrying water and other supplies for long distances are two problems in villages in developing countries (Walker and Hauck, 1964). Women and children often are observed carrying head loads—their present solution to transporting loads to and from the stream or market. The weight of such loads averaged between 18 and 47 lb in Nigeria. These loads represented a sizable increase over body weight, since the loads averaged from one-fourth to two-fifths the weight of the person carrying them. Means of alleviating the continual heavy work from carrying are urgent in many places in the world.

The weights lifted and carried by a homemaker have actually received little attention in formal studies. A reference table (Table 11-7) summarizes our informal survey of weights that might be found in homes. A family could weigh the objects they are using. This factor could be examined carefully during the purchase of new objects.

Examination of the weights lifted and carried during household work is important because the worker can use this information to design her workload. The design of a workload for amount of weight moved may center around the questions of how much, what combinations of tasks, and how can weight lifting be avoided.

Homemakers can study their workload with respect to amount of weight lifting for a given period by using questions. For a given task: Should I do all of this task today or some today, some tomorrow? For the day's work: Should I do these particular tasks today, or should I schedule them on different days? How much lifting and carrying do

Table 11-6. Weight Lifted and Carried for Homemaking Tasks

Task	Source[a]	Weight
Washing	(77, 108)	Range in water retention, various clothes washers: 50 to 135 percent. Weight of wet laundry related to weight of dry load and efficiency of washer in extracting water.
	(106)	Dry household linens averaging 1 lb or over: double and single sheets; bed spreads; bath mats; table cloths; women's: pajamas, housecoats; men's: wool shirts, pants, overalls, jackets, pajamas.
	(79)	35 to 45 lb of soiled linen carried to laundry center by ¾ of women in study.
	(81)	49 lb lifted/8-lb load with semiautomatic washer, rinsing in spinner; 85 lb, rinsing in tub.
	(117)	Estimated water used weekly with nonautomatic washer: 74 to 124 gal/household, average 95 gal.
	—	Note: About 15 gal needed to fill washer or 6 buckets of water, each about 20 lb.
Care of house	—	Weight of water, cleaning equipment, furniture.
Care of children	—	Weight of child, child care and play equipment.
Food preparation	—	Quantity of food; weight of utensils, small appliances; affected by method of storage—nest of 3 glass bowls over 4 lb, separately under 1 lb to 2 lb.
	(25)	Stack of 4 Dinner or luncheon plates, 4 to 6 lb Soup plates, 2 to 3 lb Cereal bowls, 1½ to 3 lb Serving bowls: 1 to 3 lb/bowl Platters: ½ to 8 lb
Food marketing	(52)	Food purchased on major shopping trip: about 60 lb/family, women in labor force; about 75 lb if not in labor force; households averaged 4.3 and 4.5 respectively.

[a] Sources are identified at the end of this chapter.

Table 11-7. Approximate Weight of Selected Household Items

Task area and item	Approximate weight[a]
	Pounds
Laundry	
Ironing board	15–20
Iron	3–5
Drying rack (wood, 4-feet high)	5
Care of house	
Vacuum cleaner	14–24
Case of attachments	10
Small cleaner	8
Floor polisher, electric	9–12
Step stool, foldout steps	12
Step ladder, 3 step, metal	5
Bucket, plastic	1
Mop	2–3
Food preparation	
Electric mixer, standard	4–17
Electric mixer, portable	2–3
Electric coffee maker, 8 to 10 cup (percolator)	2–4
Electric coffee maker, 8 cup (vacuum)	5
Electric blender, 1 quart, with base	6–11
Electric blender base	5–7
Electric fry pan with cover	5–6
Electric fry pan cover	1–3
Fry pan, 10 inch	2–5
Fry pan, nest of 3 ceramic	10
Fry pan, nest of 3 cast iron	8
Other	
Portable television	14
Sewing machine, electric portable in case	20–25
Card table	10–15
Table lamp	4–9
Potted plant, medium	5–10
Typewriter, manual, portable in case	10–15
Typewriter, electric, portable in case	25–30

[a] A single item weighed when a single weight is listed.

I want to concentrate within a given time span—an hour, a morning, a day, two days, and so on? For example, should I combine grocery shopping with doing the week's laundry at the self-service laundry? This combination of tasks means that considerable weight may be lifted during the time span of a few hours.

A variety of ways can be used to avoid weight lifting. The choice of materials in utensils, the choice of equipment, and the choice of supplies affect the amount lifted. The type of storage may be another factor, with functional storage an advantage. The question of whether a stronger person might do the work or whether the task can be delegated to paid service may also be asked.

The power of wheels to alleviate the work of homes is often overlooked. Wheels can be used to help transfer loads from one area to another. Basket-like utility carts can be used for several tasks, especially transferring laundry, groceries, and purchases to and from the automobile. A flat-surface cart is useful in the kitchen and other areas of the house.

Our work methods should also be examined with respect to whether they are helping us to avoid lifting weights. Items placed on the floor, such as bags of groceries, require an unnecessary input from the worker. These bags, difficult to place on and lift from the floor, might better be placed on chairs, a table, or a kitchen counter. The disadvantages to the worker of sorting laundry on the floor should not be ignored.

A method of reducing the amount of work at a given time is to divide the amount of weight into two or more loads. The 16-lb load of wet laundry could be transferred in smaller quantities rather than the entire load. The bags of groceries do not have to be loaded completely full; the bagger at the supermarket can be asked to distribute the weight among the bags and not to fill them all the way to the top. The bucket of water does not have to be filled completely—a half bucket may be a more reasonable load for a homemaker who is limited in the amount she can lift. Such limitations occur after illnesses or surgery and often accompany some chronic conditions, such as arthritis.

Given an idea or two, homemakers are ingenious in the ways they devise for getting around the amount of input at either a given time or for all tasks. Much of the physical work in homes has been eliminated but the lifting and carrying of weights requires continued attention in many instances or excessive loads will not be avoided.

Homemaking Time

Homemakers contribute a substantial portion of their time to homemaking work. As noted earlier in this chapter, many homemakers receive help from other family members, and some of the helpers make a sizable time contribution. By and large, however, the homemaker is primarily responsible for managing the work of the home and much of her time is required for this.

Over the years, an impressive number of studies have focused on the

Table 11-8. Weekly Time Spent in Homemaking by Rural Farm Homemakers and Other Family Members, as Reported in Four Studies [a]

Study	Homemaking time spent by						Homemaker's total working time	
	Homemaker		Other household members		All members			
	Hours	Minutes	Hours	Minutes	Hours	Minutes	Hours	Minutes
U.S. Bureau of Home Economics	51	40	9	15	60	55	61	15
M. Wilson, Oregon	51	34	9	28	61	2	63	42
J. Warren, New York	51	54	11	36	63	30	60	40
Wisconsin	52	46	7	44	60	30	60	46

[a] For the first 3 studies, refer to Kneeland (1928b, 1932); Wilson (1929); and Warren (1938, 1940). Data were collected in the four studies as follows: about 1926; 1926 and 1927; 1936; and 1953, respectively.

Source: Cowles and Dietz (1956:30).

use of time for homemaking work in the United States. The method of data collection and the time period to which the information pertained have varied among the studies. Comparisons among studies are complicated somewhat because time spans differ and the amount of detail that can be obtained also differs with the technique.

Data collected in Wisconsin in 1953 represented the most recent published study available to us, but this study by Cowles and Dietz (1956) provides a point of departure for our examination of homemakers' time input. The remarkable fact, when we examine the data compiled by Cowles and Dietz (Table 11-8), is the similarity over the years of homemaking time spent by the homemaker, other household members, and all members. Homemakers have allocated almost one-third of their week to homemaking.

In these studies, homemakers were rural farm homemakers, and the dual contribution to home and farm business can be identified through an examination of the homemaker's homemaking time and her total working time; the difference is about 10 hours. Some of the homemakers in the Wisconsin study were employed away from the farm so that paid employment as well as work on the family business is represented.

Cowles and Dietz (1956:30) indicated:

"The studies not only showed substantial likeness in amount of working time spent per week by the homemaker but were agreed on relation between household size and number of hours worked. . . . in the Wisconsin study the larger the household the greater were the hours worked by the homemaker and by the other members of the household. These findings substantiate those of the other investigations."

Table 11-9 from Cowles and Dietz is included to illustrate the fairly steady increase in homemakers' homemaking time as the number of persons per household increased. The trend of contributing about 10 hours to other work in addition to homemaking time is fairly consistent with each size of household.

Total number of homemaking hours and total work varied with the age of the homemaker in the Wisconsin study. Homemakers less than 35 years of age averaged 58 hours of homemaking time and 65 hours of total work time for a week. With increased age, to 50 years or more, the homemaking hours dropped to 45 hours and total work time to 54 hours. The average age of the children for these two extreme groups was 5.1 years and 19.3 years, respectively. Women aged 35 to 49 were about midway between the other groups. The average number of persons per household was just over 4 for each group. It is reasonable that homemakers who are younger and have young children have a higher home-

Table 11-9. Weekly Time Spent in Homemaking Activities by the Farm Homemaker or by Other Household Members and Homemaker's Total Work Week in Households of Different Sizes, Wisconsin, 1953

Persons per household	Homemaking time spent by: Homemaker		Other household members		All members, total		Homemaker's total working time	
	Hours	Minutes	Hours	Minutes	Hours	Minutes	Hours	Minutes
2	38	58	1	5	40	3	48	56
3	47	5	4	37	51	42	55	18
4	55	57	4	31	60	28	63	39
5	55	36	6	49	62	25	62	45
6	59	49	6	36	66	25	64	22
7 or more	64	55	27	22	92	17	76	25
Average, all households	52	46	7	44	60	30	60	46

Source: Cowles and Dietz (1956:31).

making time input than homemakers who are older and have older children.

In 1943, time data were collected from 183 Vermont farm homemakers (Muse, 1946). These recall data for a week's time are fairly similar to those compiled by Cowles and Dietz.

Data from another study in 1943 describe time use for different groups—white and Negro homemakers residing in Mississippi towns. The 160 homemakers kept records for one week. Dickins (1945:4) commented as follows:

> "The most interesting thing about this table is not the differences in the use of time (white homemakers averaged somewhat less time in work activities, more time in personal activities than did Negro homemakers), but the similarities in the use of time. About one-third of the 168-hour week was devoted to work by all four groups, about four-tenths to sleep and rest, and the remainder to other personal activities."

These data are not too different from those of farm homemakers in the studies cited by Cowles and Dietz and of the Vermont farm homemakers (Muse), although the latter group was slightly higher in its proportion of time allocated to homemaking.

The shorter time span of one day's use of time rather than time use during a week was used by Wiegand (1953, 1954) in her study comparing farm, city, and employed city homemakers in 1952. The rough approximation of about one-third of the homemakers' time devoted to homemaking holds true for the farm and city full-time homemakers but not for the employed city homemakers (Table 11-10). The employed city homemakers used only one-sixth of the 24 hours for homemaking time but almost one-half for total work time. The work time of the employed city homemakers was substantially larger than that of the city and farm full-time homemakers. The employed city homemakers used less time for sleeping and resting and for various leisure activities.

The homemaker's increase in homemaking time with an increase in number of household members was also evident in Wiegand's data: the homemaker's average time for homemaking increased from 5.3 to 8.9 hours/day as the number in the household increased from 2 to 6 or more. Wiegand also found some variation with the stage of the family cycle. In households in which the youngest child was under age 4, the average time was nearly 9 hours; in households where a child was under 2 years of age, the homemaker averaged more than 9 hours for homemaking.

In a pilot study in Syracuse, New York, data were collected in 1964 from 60 homemakers (Walker and Vatter, 1965). Differences among three middle socioeconomic levels were not significant. All workers' time

Table 11-10. Homemakers' Use of Time on One Weekday (95 Farm, 102 City, 53 Employed City Homemakers, New York, 1952)

Activities	Type of Homemaker			
	Farm	City	Employed city	All
	Hours			Hours
Total work	9.0	8.1	11.5	9.2
Homemaking	7.6	7.4	4.1	6.8
Farm work	1.0	0.0	[a]	0.4
Paid employment	[a]	0.3	6.8	1.6
Other work	0.4	0.4	0.6	0.4
Sleeping, resting	8.7	8.4	7.8	8.4
Personal care	1.9	2.0	1.7	1.9
Community activities	0.4	0.6	0.2	0.4
Other leisure activities	3.5	4.5	2.6	3.7
Unaccounted-for time	0.5	0.4	0.2	0.4
Total	24.0	24.0	24.0	24.0

[a] Less than 5 minutes.

Source: Wiegand (1954:13).

for a day averaged about 9 hours, the homemaker's time about 7 hours, and the helpers' time about 2 hours. The average time used for homemaking by all members of the family differed with the number in the family: from 6½ hours for 2-member households to 14 hours when there were 6 or more in the family. These data suggest that homemaking time in New York State had not decreased between 1952 and 1964. The size of the homemaking workload for all workers in 24 families with a full-time homemaker averaged 10 hours compared to 7 hours in 16 families where the homemaker worked outside the home 20 hours a week or more. The homemaker's homemaking time shifted from 8 hours for full-time homemakers to 4½ hours for employed homemakers (Walker and Nordenstedt, 1966).

Homemaker's use of time has been studied in other countries as well as in the United States. Two recent studies suggest some similarities to employed women in the United States. Klein (1965) describes the workload of employed women in Zurich, Switzerland: the 649 married women were employed full time for the week; their employment hours averaged over 46 and their work at home about 29 hours, for a total of over 75 hours. The time varied with presence of children; if no children, work time at home averaged 24 hours and total time almost 73 hours;

with 3 or more children, work time at home averaged 34 hours, total time over 80 hours. These are long work weeks.

In the second study reported by Klein, differences in the average working day of married French women with and without employment were identified. The time data are similar to Wiegand's. The report of the French homemakers included the point that the presence of a child under age 3 means an addition of about 2½ hours to a woman's working day.

Our review of homemakers' time allocation to homemaking work indicates considerable similarity over the years and in different parts of the United States but variation with employment, age of homemaker, and age and number of children.

Time Allocation Among Tasks

Knowledge of when and where the greatest time costs occur helps to evaluate the use of time. The allocation is generally not equal among the 5 or 6 household task areas or among the various subcategories.

Using the studies of Cowles and Dietz (1956) and Wiegand (1954), the following general statements provide a point of departure. Meal preparation and cleanup consistently account for a large portion of time; together, they account for better than one-third of the time used for homemaking. Other tasks, such as washing, ironing, cleaning, and marketing receive varying amounts of time—from about 10 to 20 percent each. Physical care of family members is one of the more difficult tasks to classify in a time study, for it is hard to separate physical care from the time used with children for their social and educational development or for recreation. However, it appears that about 10 percent of the homemaking time is allocated to physical care of family members. Practically speaking, those tasks that are most time-consuming may deserve more attention for finding ways to minimize the homemaker's input.

In brief, the 85 rural Wisconsin homemakers used about 20 hours per week for food preparation and clearing away, 11 hours for care of house, 4 hours for sewing and mending, 7 hours for laundry, 7 hours for care of family, and almost 4 hours for purchasing and management; the task areas accounted for 37, 21, 8, 13, 14, and 7 percent of the homemaker's homemaking time, respectively (Cowles and Dietz).

Cowles and Dietz determined some factors that were associated with long or short working hours during a week in their Wisconsin study. They selected 28 records with the lowest time expenditures and compared them to the 28 with the highest time use. The results of their comparisons are summarized briefly in Table 11-11.

Table 11-11. Factors Associated with Differences in Time Use by Wisconsin Homemakers with Long and Short Working Hours

Task area and sources of difference	Time used/week High group	Low group	Other
	Hours		
Food activities	28	17	
(a) the necessity of preparing special meals or packing lunches for family members unable to eat with the family at the usual time or place or in need of special food. (b) the amount of baking done. (c) the character of the kitchen arrangement.			No significant difference from equipment owned, such as dishwashers, or place where family ate.
Laundry operations	9½	4	
(a) the possession of hot running water. (b) the number of children, especially those under 10 years of age, necessitating laundry, especially washing, several times per week.			Almost all had nonautomatic washers. Some relation between place of storage of soiled clothes, supplies, and equipment and place where washing or ironing was done.
Care of house	16	6	
(a) house size measured by the number of rooms and the number of stories. (b) the possession of a vacuum cleaner.			More help from other family members in high group.

Source: Compiled from Cowles and Dietz (1956:33–34).

Cowles and Dietz also indicated several less measurable factors of importance in explaining the differences in high and low weekly hours spent in all homemaking activities: standards for orderliness; pressure from other types of activity; and methods of work. Two additional factors, place of storage of equipment and materials in relation to place of use and the multiple use of the kitchen also seemed important. Earlier, we noted differences in distances traveled in kitchens before and after reorganization in a study by Cowles, Steele, and Kishler (1958); that study was an outgrowth of the Cowles and Dietz time study. Their supposition that there were differences in input associated with place of storage of equipment and materials was substantiated.

Wiegand found some variation in proportion of homemaking time with location and employment of homemaker (Table 4-2). However, the major importance of food preparation and dishwashing was consistent. The increased proportion of time for care of family members with the full-time city homemakers reflects a higher proportion of families with children in that group. The proportion of time used for each homemaking activity shifted when the hours for homemaking varied from less than 4 to 10 hours or over (Table 11-12). The largest proportion was for food preparation and dishwashing in all cases but was substantially greater when the total time for homemaking was lowest. With low time input, the less postponable tasks assumed increased importance during the time span of one day.

Wiegand also indicated other relationships. For food preparation, the homemaker's average time increased slightly with absence of piped hot water. More pronounced increases in homemaker's time occurred with an increase in the number of complex meals served: from 1.5 to 1.8 and 2.3 hours with 0, 1, and 2 complex meals, respectively; the same pattern was found when the number in the household was controlled. For care of house, the homemaker's time increased with an increase in the number of persons in the household and the number of rooms in daily use. Ease of keeping the house clean seemed related to better quality of housing facilities, newer houses, and lower number in the household.

Data collected in 1961 and 1962 from Indiana rural and urban homemakers help us identify factors with time use for three tasks: dishwash-

Table 11-12. Proportion of Total Homemaking Time Used for Each Homemaking Activity During One Day (95 Farm, 102 City, 53 Employed City Homemakers, New York, 1952)

Hours for homemaking	Number of homemakers	Food preparation	Dishwashing	Care of house	Care of clothes	Care of family	Marketing records	Total
		Percent of time						
Less than 4	55	44	24	14	8	5	5	100
4–5.9	37	29	17	22	19	6	7	100
6–7.9	65	23	14	20	22	11	10	100
8–9.9	53	23	13	19	24	11	10	100
10 or over	40	16	10	25	25	15	9	100
All homemakers	250	24	14	20	22	11	9	100

Source: Wiegand (1954:17).

ing, washing clothes, and regular care of house. Homemakers in Benton and Marion Counties were interviewed from May through August, 1961; they kept records for 4 weeks spaced throughout the year at intervals of about 13 weeks. Of the time records received, 111 families each kept records for 4 weeks, providing a total of 444 records for analysis by da Fonseca (1964) and Purcell (1965). Hook (1963) analyzed the first week's records for use of time for regular care of the house in 93 rural and 97 urban families in the study.*

Hook indicated significant factors associated with homemaker's use of time for regular care of house as follows: place of residence (less time if rural—370 minutes versus 436 minutes per week); cleaning equipment (less time with vacuum cleaner only compared to vacuum cleaner and floor polisher); attitude toward regular care of house (least time if disliked, most if liked); homemaker's evaluation of ease of caring for the house (less time with ease of care). Total time differed significantly with other factors. Hook accepted her general hypothesis that time spent in regular care of the house was dependent upon factors within the family, physical environment, and homemaker's attitude.

Homemaker's attitude was also a significant factor in time allocated to dishwashing: with a neutral attitude toward dishwashing, homemaker's average time per week was least—323 minutes compared to 345 if disliked and 360 if liked (da Fonseca, 1964). Together, homemakers averaged 341 minutes per week. Homemaker's average time allocation to dishwashing decreased as the number in the family increased; this was accompanied by an increase in helper time and total time. Homemaker's average dishwashing time generally increased as the number of meals served increased. Use of a dishwasher did not significantly reduce homemaker's time for the task (one-fifth owned a dishwasher). Almost 2 minutes of helper time were necessary to reduce the homemaker's time by 1 minute. This may be related to lack of skill of helpers or a slower pace by all workers when socializing is combined with working and attention is divided.

Purcell's (1965) analysis of time used for washing clothes did not include a separate analysis of homemaker's and helper's time; however, since helper time accounted for only 4 percent of the total time, the data pertain largely to homemakers. The average time per family was 235 minutes per week for washing clothes. Time for laundry did not decrease much with increasing automation; automatic and nonautomatic

* Data from da Fonseca, Hook, and Purcell are from Indiana Agricultural Experiment Station Research Project No. 1169, "Time Use in Homemaking Activities." Leader of the project is Dr. Sarah L. Manning, Home Management and Family Economics, School of Home Economics, Purdue University, West Lafayette, Indiana.

washers were used with and without clothes dryers, but the dryers were not always used. The time per washer load averaged 27.2 minutes. With dislike of the task, the average time increased per washer load compared to time with a neutral or favorable attitude: 33.7, 25.1, and 27.6 minutes, respectively. However, only 5 of the 111 homemakers disliked the task. Time for washing clothes increased consistently with each additional person in the family; time per person decreased with increasing family size; and the time per washer load decreased with increasing family size. The frequency of washing was not related to time use. Purcell judged variability among factors to be extreme. Analysis of variance identified significant differences among means for three combinations: number in family and average minutes per family; number in family and average number of washer loads per family; and homemaker's age and average number of washer loads per family.

A complex of factors rather than a single factor seems to be associated with variation in homemaker's time allocation to each task area. Further study is needed to identify key combinations of factors associated with variation in time use.

Output

The amount of work accomplished by a homemaker is influenced by a variety of factors, including her standards and preferences, number in the family, age of children, environment, housing condition, and in some cases, possession of equipment. One or more of these factors may be operative for a given task at a given time.

The measure of the amount of work done is often expressed as the number of items, units of measure, or the area—room, house, story. The amount of work done may be further quantified by broadly identifying content of the task, such as a simple or complex meal. Less informative are general measures (such as all of it, the complete task, what is needed) or the time period (such as a week) which should suffice for the work.

Food

Data describing homemaker's output for meal preparation and food preservation are presented in Table 11-13.

The number of meals eaten at home and lunches packed vary with employment of homemaker, age of children, and logically with the distance the husband's place of work and children's school are from home. Earlier we noted that preparing lunches for family members to carry was one factor associated with higher time use for food activities

Table 11-13. Output in Homes for Meal Preparation and Food Preservation

Task and measure	Source[a]	Output
Meal preparation		
Number of meals	(2)	9 out of 10 meals eaten at home or as home-prepared lunches eaten away from home during a week. If employed homemaker: fewer meals eaten at home, more meals away from home, more lunches carried.
	(32)	About ¼ of employed and of full-time homemakers purchased meals during 1 week, averaging 3.4 and 3.3 meals respectively; meals prepared in home averaged 17.6 and 20.2 for 1 week; prepared packed lunches in ½ and ⅓ of homes, generally 5 days for report week.
	(33)	Under ⅕ of employed- and nonemployed-wife families purchased meals away from home in a week. Meals prepared at home in a week averaged 18 for families of employed wives, 20 nonemployed; some meal preparation by paid worker in homes with preschool children and employed mothers, ⅓ and ⅖ open country and urban, respectively.
	(11)	Over ⅘ of meals eaten at home, slightly more for rural than urban families.
	(15)	White and Negro urban and rural homemakers: average/group, 62 to 101 meals served during report week to family members, 1 to 4.5 meals to other persons; packed lunches, 10 to 30 percent/group; no noon meal in 15 to 25 percent/group. Purchased meals: ¼ to ⅓ of meals not prepared by homemakers.
	(110)	1/10 did not prepare a noon meal if full-time homemaker, ⅖ if employed city homemaker.
	(52)	Meals provided: 84 percent if wife in labor force, 93 percent if not; more lunches carried if wife in labor force.
	(91)	Lunches prepared in ½ of families, averaging 8.1 for report week if prepared, 3.7 all families; guests in ½ of families, averaging 3.4; average number of meals for week, 73 for 100 families.
Complexity of meals	(109, 110)	3 meal types based on amount of food handling: minimum, moderate, complex; 1 complex meal prepared on preceding day by ⅗, 2 by 1/10, 0 by 3/20 of families.
	(100, 101)	4 meal types based on length of preparation time and amount of food handling, type 1 simplest, type 4 most complex; for preceding

Table 11-13. Output in Homes for Meal Preparation and Food Preservation (*Continued*)

Task and measure	Source[a]	Output
Meal preparation		
Complexity of meals		day combination of meal types 1—1—3 for ⅖, types 1—2—3 for ⅕ of families.
	(2, 53)	Most frequent pattern of meal types 1—1—3 (using preceding system).
	(2)	Type 1 for over ½ of meals eaten at home; ½ of menu items ready to serve, 3/20 time-consuming.
	(11)	Modified preceding system of meal types, but type 1 again most simple, 4 most complex; most frequent patterns of meal types 1—1—3, then 1—2—3, then 1—1—2.
Number of menu items	(15)	4 items or less, breakfast and evening meals, Negro families, 5 items or more, white families.
Number of persons served	(101)	Size of household and time used for meal preparation not closely related.
Guests at meals	(39)	Farm households in 4 regions similar: ½ had extra people at regular family meals 1 time/week or oftener. Company meals, less than 1 time/2 weeks by ½ of households/region. Number of guests: 2 for regular family meals in ⅓ of homes, 4 or more for company meals in majority of homes.
Food preservation		
Quantity, methods, weight, proportion of total food consumption	(39)	Almost all of farm families in 4 regions preserved some kind of food: fruits by 9/10 in each region; vegetables by 9/10 in NE, S, NC regions, 7/10 in W; meat and poultry, variable with no more than 3/10 preserving poultry in any region. Canning, freezing, and other methods used. Median number of quarts of fruit 100 to 138, vegetables 75 to 100 for NE, S, W regions; of meat 25 to 34 for S and NE.
	(67)	Average of 160 lb of food preserved by canning and freezing in 1954 for 6,000 housekeeping households or about 1/10 the weight of vegetables, fruits, meat, poultry, fish used in the households during the year. Differences among urban, nonfarm, and rural families: averages of under 60, 200, and over 600 lb, respectively.
	(65, 97)	Preserving by ⅗ to 9/10, most for full-time farm homemakers. Freezing by ½ of employed and full-time nonfarm and ⅘ of full-time farm homemakers. Almost all canned food.

Table 11-13. Output in Homes for Meal Preparation and Food Preservation (*Continued*)

Task and measure	Source[a]	Output
Food preservation		
Quantity, methods, weight, proportion of total food consumption	(15)	½ to ¾ preserved food during 1955, most for white rural employed-wife families, then Negro rural employed-wife families.
	(32)	Almost ½ of employed and nonemployed Georgia town wives preserved food. Medians of 86 and 91 lb, but ranged from 2 to 1,200 lb. Methods used: freezing for ½, canning, ¼ to ⅓ of each group.
	(33)	Urban: 3/10 employed-, ⅖ nonemployed-wife families preserved some food in a year, averaging 261 and 186 lb, respectively, for those reporting food preservation. Open country: 7/10 employed- and over ⅘ nonemployed-wife families preserved some food, averaging about 670 lb each.
	(91)	Some home production by ⅖ during previous year, accounting for less than ¼ of these families' total food consumption. Canned and froze food.
	(48)	Larger proportion of rural than urban homemakers estimated producing ½ amount consumed; urban employed part-time homemakers ranked lowest. Canned and froze fruits and vegetables; froze meat more often than canned it.

[a] Sources are identified at the end of this chapter.

(Cowles and Dietz). The frequency of packing lunches and the increased time costs suggest advantages of examining work methods and organization of workplaces for potential improvements to reduce work.

Dishwashing is closely related to meal preparation in the sense that it is a supportive task; the content of a meal, number of people served, and sometimes the amount of food prepared affect not only the quantity of work but also the content of dishwashing and therefore the amount of work. A meal with a home-mixed baked product, a meal with a number of cooked items, or a greasy broiler pan affect quantity, condition, and type of item to be washed. Although we separated the output for the task of meal preparation and dishwashing, we should not lose sight of the manner in which meal preparation can affect dishwashing. Many homemakers and their children are well aware of the relationship; children responsible for dishwashing have often appreciated the fact that their mother planned a meal that required few cooking utensils so that they could complete their work and be off quickly to other activities.

Clothing

Laundry tasks are interrelated just as the tasks of meal preparation and dishwashing. However, the relationship among laundry tasks may not be as close as between meal preparation and dishwashing. The number of loads of clothes that are washed determines the number of loads that are dried. However, the number of loads washed and dried may not be directly associated with the amount of ironing, for all items are not necessarily ironed.

The amount of ironing done is sometimes expressed as number of items ironed, number of baskets of clothes ironed, and type or name of article ironed. The identification of the type of article (such as fussy, easy, starched, or flatwork) or the item (such as a shirt, dress, or pants) further quantifies the output, just as the complexity of a meal further describes the output for meal preparation.

Folding items is another part of the laundry task. The output may be identified by the number of items folded and further quantified by the size of the items folded, the design (such as fitted sheets versus unfitted sheets), or the intricacy of the folding. Of course, the folding may be a part of removing clothes from the drying line or from the dryer, or it may be a part of the ironing.

The number of items folded and the item vary with the family composition; in families with an infant or a baby, the number of diapers folded per week or in families with children the number of overalls, T-shirts, or socks may be an important part of the job. The amount of laundry and particular items that are done commercially will also affect the content of the folding and ironing tasks.

Data describing output for care and construction of clothing are compiled in Table 11-14.

Other Tasks

Some measure of output for marketing and shopping was given in the information about the number of marketing periods during a week. Another indicator could be the number of bags of groceries or number of items purchased. The output could be quantified by identifying the weight of the bags or packages, their size, and the number of stores the homemaker had to visit to make the purchases. The time period for which the purchases were made and the person for whom the purchases

Table 11-14. Output for Care and Construction of Clothing

Task	Source[a]	Output
Washing Number of loads	(98)	Over 10 loads/week for ¼, 3 loads or less for ⅕, 4 to 9 loads for majority.
	(73)	8.6 loads/week; highest and lowest average number of loads for: summer and winter, respectively; preschool children and all-adult households; 7 to 10 and 2 in family; automatic washer + dryer and automatic washer only. Practically all washing done at home for 444 record weeks.
	(117)	10.2 loads/week, automatic washers, 8.4 full loads, 4.1 small loads; number of loads related to family type—least with all-adult families, more if children in family.
	(41)	Over 9 loads/week for 3/10, range 1 to 24 loads.
	(29)	9.3 loads/week, range 1 to 35 loads; average/day from 2 to 3.6 loads.
	(43)	3 loads/washday with automatic washer, 4.2 if nonautomatic; 2 loads/day if daily washing, 4 loads/time if weekly.
	(101)	5 loads on record day if nonautomatic washer, 2 if automatic; no relationship to number of persons in household; fewer loads if children in family than if all-adult.
Washing Number of items	(109)	Average of 27 articles washed on day of interview.
	(12)	Average of 135 to 143 items laundered/week/family over 12-week period.
	(106)	Average 66 items for 300 weekly washings, range 25 to 128, over 1½ years.
Ironing	(101)	Average 22 pieces on record day, some households over 40. Another group of families, 2 to 71 items for record week, 20 to 39 items for ½ of households.
Sewing	(39)	Some sewing by ¾ of families with children, ⅔ all adult. Women's dresses by majority in NE, S, W. If children, ½ of homemakers made children's garments, nightwear.
	(34)	Median number of items 5 to 28/year/family, higher median as household size increased.
	(6)	⅗ or more of homemakers making items made 1 to 6 items/year/4 categories of items.
	(116)	Few families limited sewing to one type of article; for a given type, at least ½ made 6 dresses or

Table 11-14. Output for Care and Construction of Clothing (*Continued*)

Task	Source[a]	Output
Sewing		slack suits last year, 10 children's garments, 4 pieces of nightwear, 4 large items for house or farm.
	(65, 97)	¼ of employed, ⅔ full-time farm, ⅖ full-time nonfarm homemakers sewed clothes. ⅓ to ½ mended a lot.
	(32)	⅖ employed, ½ nonemployed wives sewed during 1957, averaging 5 and 6 garments, respectively, for total group, 13 and 11 for those who sewed. Nonemployed wives averaged more large household items.
	(33)	Urban: 3/10 employed, ⅗ nonemployed wives sewed, averaging 7 and 9 garments during a year and 2 and 3 household items, respectively. Open country: ⅗ employed, ½ nonemployed wives sewed, averaging 6 and 9 garments, and 1 and 2 household items during year, respectively.

[a] Sources are identified at the end of this chapter.

were made do not seem to be as significant as some other indicators of the output.

Identification of output for care of the house is perhaps more difficult than for some task areas. The output might be described in at least four ways: the area cleaned, process used, time span for the cleaning, or number of items cleaned; any one of these methods of identification is rather inclusive. Descriptive information about homemakers' output for care of the house was included in earlier sections. The output for care of the house seems to be variable among families, partly due to the variation in family composition, housing situation, and standards of the homemaker, as well as the amount of work demanded for other task areas in a given home.

For the task area of care of children, the homemakers' output is perhaps the least quantified of all the task areas. The age of the child, his maturation, and his personality determine the workload. The child who receives help with bathing, dressing, and feeding represents a greater output by the homemaker than the child who is old enough and independent enough to care for himself. The task involved in care of children may also help identify the output. Dressing a child for outdoor play represents a different output from dressing a child for indoor play.

Getting a child dressed may represent a different amount of work when the child is pokey rather than fast or consistent in his attempts to dress himself. A number of dimensions therefore may need to be examined in quantifying the output for care of children.

Input and Output Related

The relationship between output and the personal costs of accomplishing it has been implicit in much of our description and analysis of the input from movement, weight lifted and carried, and time. These physical and time costs and the less measurable affective and cognitive costs should be examined together rather than in isolation to assess what a person puts into her work to obtain a given output. The complex of personal costs must be determined for a particular output to compare work methods, working conditions, equipment, materials, or supplies. Use of other resources beyond the human resource will necessarily be brought into the picture so that decisions about allocation of resources are not made in isolation.

For a brief consideration of various relationships between the personal physical input and output, imagine laundry work under different work conditions and work methods. Relate the output—loads of laundry—to various physical inputs: distances walked, with and without loads; total weight and weight of separate loads lifted and carried, such as dry and wet laundry, water, drying racks; number and duration of static positions to sort or hang laundry; distances reached to hang and take down laundry. Various interrelationships among the preceding cost factors should also be identified, such as the duration of static positions and weight involved. Physical work for other tasks can be studied and summarized in a similar manner.

Work Units

The relationship between time and amount of work accomplished has been the object of study for many years at Cornell University. Dr. Jean Warren (1938, 1940) developed the first homemaking work units to provide a basis for comparing time costs in the household. Further development and updating was effected by Walker (1955, 1957). Current research by Walker and Vatter (1965) is designed to refine and update the homemaking work units for New York State households. At Purdue University, a major project directed by Dr. Sarah L. Manning is also under way to develop work units for Indiana homemakers.

A homemaking work unit is defined as the amount of household work done in 1 hour under average conditions by an average worker. Quality

Table 11-15. New York State Homemaking Work-Unit Chart (Based on Work in Households of 250 Families in Genesee County and Auburn, New York, in 1952)

Homemaking activity	Work done	Work units
Dishwashing	Number of persons for whom dishes are washed	
	2 persons	0.9 unit/day
	3 persons	1.0 unit/day
	4 persons	1.2 units/day
	5 persons	1.5 units/day
	6 or more persons	1.6 units/day
Meal preparation	Types of meals served	
	Type-1 meal (very simple)	0.3 unit/meal
	Type-2 meal (simple)	0.5 unit/meal
	Type-3 meal (moderately complex)	0.8 unit/meal
	Type-4 meal (complex)	1.0 unit/meal
Physical care of family members. (Playing with and reading to children not included)	Age of family members cared for daily	
	Youngest member under 2 years old	2.0 units/day
	Youngest member 2 to 5 years old	1.0 unit/day
	Youngest member 6 to 10 years old	0.6 unit/day
	Youngest member over 10 years old	0.0 unit/day
	Second member under 5 years old	0.5 unit/day
	Second member 6 to 10 years old	0.3 unit/day
	Second member over 10 years old	0.0 unit/day
	Third member under 5 years old	0.2 unit/day
	Third member over 5 years old	0.0 unit/day
Washing clothes	Number of tubfuls washed	0.5 unit/tub
Ironing clothes	Number of pieces ironed	
	1 to 9 pieces	0.2 unit/piece
	10 to 29 pieces	0.1 unit/piece
	30 or more pieces	0.07 unit/piece
	Each piece = 1 piece, except that:	
	2 towels or napkins = 1 piece	
	6 handkerchiefs = 1 piece	
Regular care of the house. (All *daily* and *weekly* tasks)	Composition of households during the week	
	All-adult households	4.0 units/week
	Households with children under 18 years of age	7.0 units/week

Source: Walker (1957:36).

of work is not considered. A work unit permits a homemaker to compare her rate of work with an average. An optimal rate of performance is a rate of work at which the cost of work to the individual per unit of output is at a minimum. The optimal pace for a homemaker may represent a balance between minimum personal input and necessary output. The relationship between time and quantity of work permits a broad comparison of work methods, working conditions, materials, equipment, and other factors that might be associated with rate of work. A work unit does not identify factors causing high input by a given homemaker but does permit her to compare her output during a given time for a given task against the average.

Work units have been developed for 6 major homemaking task areas for New York State households. Walker (1955, 1957), using time data collected by Wiegand (1953), derived work-unit values for meal preparation, dishwashing, physical care of family members, washing clothes, ironing clothes, and regular care of the house. Approximately 78 percent of the total time used in homemaking was accounted for by these 6 tasks. For each activity, various factors were studied to determine the one

Table 11-16. Definitions of Meal Types for New York State Homemaking Work Units

Breakfast types	Noon and evening meal types
Type 1	*Type 1*
Any number of easily prepared foods or 1 or 2 items requiring some preparation plus any number of easily prepared foods	Any number of already prepared or quickly prepared foods
Type 2	*Type 2*
3 dishes requiring some preparation plus any number of easily prepared foods or 1 time-consuming dish plus any number of easily prepared foods	Leftovers somewhat changed in form plus Type 1 or 1 time-consuming dish plus 1 to 4 already or quickly prepared foods
	Type 3
	1 time-consuming dish plus 5 or more already or quickly prepared foods or 2 or 3 time-consuming dishes plus Type 1
	Type 4
	4 or more time-consuming dishes plus Type 1

Source: Walker (1958:7).

that had the most decided influence on the total time for a given task. The results are summarized in Table 11-15. Meal types are defined in Table 11-16.

Subsequent research by Suneson (1961) yielded tentative work-unit values for marketing. Suneson concluded that the independent variable (number of family members eating regularly in the home) and the dependent variable (time used for all food shopping activities) could be used as a *guide* for families; the correlation between time and selected variables was not sufficiently large to consider one as a predictor of time used for shopping. Suneson's guide for a work unit for all food shopping activities in a week is as follows:

Number of persons eating regularly in home	*Work units*
2	2.8/week
3	3.2/week
4	3.5/week
5 and over	4.0/week

Work-unit values for two tasks for Indiana homemakers have been developed: dishwashing and washing clothes. For dishwashing, da Fonseca (1964) proposed 4 work units for general use by homemakers in evaluating their work. The dishwashing work units are given in Table 11-17. The values for the number of meals eaten are lower than Walker's values for number of persons for whom dishes are washed if Walker's values are converted to a weekly basis and 3 meals a day per person is assumed. The values of da Fonseca for a dishwashing work unit for a week are based on a substantial amount of data and are from data collected more recently than the data used by Walker, about 10 years later. Together, these may account for differences.

For washing clothes, Purcell (1965) suggested the value of 0.5 hour per washer load as the work unit for the Indiana homemakers. To determine the weekly or daily load, the work-unit value is multiplied by the number of loads of laundry. This value coincides with the value for New York State homemakers.

Homemaking work units are useful for homemakers if they want to assess their use of time. Walker (1957:4) states clearly some limitations and advantages of work units:

"Work units are not meant to dictate to families what should be done with their time; they provide a means for comparing the amount of time used by a particular family with the amount of time that is used in

Table 11-17. Dishwashing Work Units for Indiana Homemakers

Proposed dishwashing work unit	Factor	Work unit
I	Number of meals eaten	Task-hours
	20–39	5
	40–59	6
	60–79	7
	80–99	8
	100–119	8
II	Number in the family	Task-hours
	2–3	6
	4–5	7
	6–7	9
	8 and over	12
III	Meal class	Task-minutes
	1	15
	2	25
	3	35
	4	60
	Add task-minutes together for different daily combinations of meal classes.	
IV		

$$\text{Task-hour} = \frac{235 + 4.5\ (\text{number of meals eaten}) - 30\ (\text{number in family})}{60}$$

Source: da Fonseca (1964:84).

average households to do a similar amount of work. What is done in the average situation may or may not be desirable for a particular family, but, as differences are discovered, the family will have to some extent an objective basis for deciding whether to continue the present arrangement or to make a change. If a change is made, the work units provide a tool for evaluating the effect of that change on methods of work, equipment, or standards. The work units enable one to measure roughly the amount of work to be done in the home; they do not provide a measure of how well it is done, by whom it is done, nor with what equipment it is done. Neither satisfaction nor quality is measured by the work units."

Workload

The work units can be used to describe the workload in a home or for a homemaker. The values for the 6 task areas, although they do not account for the total workload, have been used by several researchers to study the families' or homemakers' workload in their particular studies. For the 100 families in Suneson's (1961) study, the average workload for meal preparation was 1.3 per day, the range 0.3 to 2.1 units. The average workload for tasks done daily was 3.3 units, the range 1.2 to 5.9; the tasks included were meal preparation, dishwashing, and care of family members. For tasks not necessarily done daily, the work units for a week averaged 11.6; the tasks here were washing, ironing, and regular care of house. The families ranged in size from 2 to 10 and averaged 3.7 members.

Bailey (1960), also studying New York State families, identified the partial homemaking workload. The average for the 200 families with 1 to 3 children was 3.8 work units per day for meal preparation, dishwashing, and physical care of family members; families with employed homemakers with elementary school children averaged least with 3.2 work units, compared to the highest workload of 4.9 for the families with full-time homemakers with preschool children.

Maloch (1962) determined the workload for the 6 task areas for 120 homemakers with children under 8 years of age. The number of children ranged from 1 to 6 and averaged 3 per family. The total workload of the homemakers ranged from 4.5 to 9.6 and averaged 6.9 units per day. No relationship was found between the work-unit value and the attitude toward most and least liked tasks. Maloch stated that perhaps her use of a tool designed for general tasks was too major a deviation from the original purposes of the homemaking work unit.

Gage (1960) found the mean daily workloads for 50 families and homemakers in New York. The total workload for the 6 homemaking tasks averaged 5.1 units; the homemakers' workload averaged 4.4 units, somewhat lower than in Maloch's sample. Gage's sample excluded families with children under 6 years of age; almost all of the families were 4 to 6 member households, the remainder 3 members.

Data from Gage's and Maloch's investigations are given in Table 11-18 to permit several comparisons: workloads for homemakers from families with differences in age of children; the workload for each of the 6 task areas and the relative importance of each; the homemaking versus homemaker workload within Gage's study; and the variation in number of work units for each task within Maloch's study.

Knowledge of the homemaking and homemaker's workload helps a

Table 11-18. Homemaking and Homemaker Workload for 6 Tasks

Workload		Gage (1960:86, 157) Homemaking	Gage (1960:86, 157) Homemaker	Maloch (1962:71) Homemaker
		Work units per day		
Total, 6 tasks	Mean	5.1	4.4	6.9
	Range	3.5–7.0	2.0–6.4	4.53–9.59
Meal preparation	Mean	1.3	1.2	1.4
	Range			0.86–2.10
Dishwashing	Mean	1.3	1.0	1.4
	Range			0.60–1.60
Physical care of family members	Mean	0.5	0.4	1.7
	Range			0.50–2.70
Washing	Mean	0.5	0.5	0.8
	Range			0.12–2.14
Ironing	Mean	0.4	0.4	0.6
	Range			0.00–2.62
Regular care of house	Mean	1.0	0.9	1.0
	Range			0.60–1.00

family assess the practicality of the wife's engaging in paid employment outside the home. There is a limit to the amount of work a wife can assume; there is also a limit to the amount that can be delegated to paid help without substantially reducing the family's net real income. The potential employer as well as the homemaker must take into account the impact of the workload at home and its inflexibility if they are to estimate realistically rate of absenteeism and continuity of employment.

Family problems that demand a homemaker's presence at home mean absenteeism from remunerative work. Rollins (1963) pointed out that money contributions to the family income on the part of wives are not a new phenomenon, but that the place of work has changed from being centered within the home to outside the home. Consequently, the earning and homemaking activities are separated in time and space and their coordination is competitive rather than complementary. The opportunity of alternating active and inactive work times on earning and homemaking activities, of overlapping their active work times, or of interrupting and interweaving active work times is lost.

Workload Value

The value of the work done at home represents an omission in the national income accounts; the measure of the wealth of our nation is thus underestimated. Work units can be used to determine the economic value of a homemaker's work in the home or the value of household production.

Gage (1960, 1964) concluded that two problems were involved in valuing household production: measurement of work accomplished and the valuing of the products of economic endeavor. For the former, Gage chose the homemaking work units, or units-of-work as she preferred to term them, because the rate of work was fixed as average and the quantity of work and time were measured simultaneously. The value of the unit-of-work is obtained by determining the prevailing wage rates for the corresponding kinds of labor—laundress, child care, domestic cook, general housecare, and the like.

In her research, Gage (1960) interviewed 50 homemakers in Tompkins County, New York, to learn the number of units-of-work produced by each homemaker on one day. She then multiplied the units by the prevailing wage rates for each type of work. The 50 homemakers averaged 4.4 units-of-work valued at $5.93. The value of the homemakers' daily contribution ranged from $2.63 to $7.71. The total workload in these families, as accounted for by the 6 homemaking work units, averaged $6.69 in value. Gage concluded that these homemakers chose to perform that part of the workload that had the greatest value.

Gage's study demonstrates the potential use of work units for determining economic value of household production. Such information has been helpful in lawsuits involving the loss of the homemaker's services through death or disability. Work units based on more recent and more extensive studies will increase their usefulness as a measure of workload value.

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PART III

The Workplace

CHAPTER 12

Functional Design and Arrangement of Workplaces

Workplaces are a major part of the team that is needed to accomplish household tasks. The quality of the design of the workplace in terms of the requirements of the task and of the worker has an important effect on the ease with which the action is accomplished. The problem of relating task and worker requirements for design of workplace is described by the term functional design.

THE CONCEPT OF FUNCTIONAL DESIGN

The concept of functional design can be better understood through examination of its elements, functional and design. The noun "function" can mean a special purpose or any quality or trait so related to another that it is dependent upon and varies with the other. Thus, "functional" defined as serving a function could be reworded to "serving a special purpose."

The second element, "design," can mean a plan or scheme, purpose in view, aim, intention. In the field of art, for example, it can mean the arrangement of details which make up a work of art. Comparing plan and design, we find that plan is a general word for a proposed method of action or procedure, while design implies a settled plan and heightens the suggestion of purpose.

From the preceding analysis, the following working definition of functional design is proposed: the arrangement of the important parts to serve a special purpose. Applied to household workplaces, we say that a functional design for a workplace is a design meeting the requirements of the work and the worker. Our problem is to determine and coordinate the requirements of the task and worker.

Background Information

Home economists have long been concerned about the relationship between the worker and the workplace and about the design of the workplace to accommodate the activity for tasks. Pioneers in the field have included Hildegarde Kneeland, Lillian Gilbreth, Maud Wilson, Marianne Muse, Mary Koll Heiner, and Helen McCullough. They emphasized design criteria for the work situation rather than standardized work methods and conditions, since homes differ widely.

In the mid-forties, Heiner (1945:10) commented on the need for research in kitchen design. She pointed out that although manufacturers were considering appliances in terms of interrelated function rather than as isolated units, the corollary, economy of effort on the part of the worker, should follow. She then indicated:

"The dearth of basic information underlying the new trend, both as to physical efficiency and as to the more subtle physiological and psychological aspects of kitchen activities, however, gives one pause.

"Research on the kitchen may seem fairly inclusive. But when differences are considered in terms of design requirements due alone to climate—which, in turn, influences food habits, buying practices, methods of cooking and storing—the limitations of data available are evident.

"Few as are the known data on specific equipment and its arrangement, those about the user herself are practically negligible. Body structure as related to the effective use of equipment is an almost totally unexplored realm. The same is true of the psychological aspects of space or its absence, and the bent for or against traditional patterns of work or of storage arrangements."

Progress has been made but many of the questions still remain.

Considerable impetus was received during World War II to design machines and equipment to fit the human capabilities. The urgency of the war situation pushed along research to eliminate human error and reduce strain and effort. Following the war, researchers continued to be aware of the need for knowledge of man's behavior during work and the consequences of using machines and controlling various parts of work. This awareness led to the goal of designing machines that would be consonant with man's dimensions and abilities.

Various names are applied to subject matter concerned with the relationship between the machine and the operator: human engineering, biomechanics, psychological problems in equipment design, the human factor in equipment design, applied psychophysics, systems research, applied experimental psychology, and engineering psychology. Mead (1948:305–306) defined the field of human engineering as: "that endeavor which seeks to match human beings with modern machines so that their combined output will be comfortable, safe and more efficient." The field, then, is concerned with the coordination of people and machines.

In Great Britain after World War II, a society was formed to bring together those people who worked in the field of human engineering. "Ergonomics" was the name chosen for the society. It was coined from the Greek *ergos:* work and *nomos:* natural laws. The Ergonomics Research Society brought together workers from a variety of disciplines: anatomists, physiologists, psychologists, industrial medical officers, industrial hygienists, design engineers, work-study engineers, architects, illuminating engineers, and in fact anyone whose work was related to any aspect of human performance (Murrell, 1965). The society soon became an international organization and its conferences have served to bring together many scientists to discuss problems of common interest.

In the United States another group, The Human Factors Society, was organized to serve a function similar to that of the Ergonomics Research Society. The technical journals published by these societies, *Human Factors* and *Ergonomics,* provide excellent source material.

As advances in technology have occurred, the importance of systems research has grown. The impact of automation with the increased emphasis on mental work, such as paying attention and processing information, and the decreased emphasis on physical work have served to point up the need to determine the optimum allocation of functions within a system to man and to machine. In some cases the goal becomes one of not overloading the man yet giving him enough to do so that he pays sufficient attention at appropriate times.

In the home the relationship between the homemaker and the machines that she uses is a continuing one with considerable variation that stems from the variety of tasks that are done and, therefore, the processes and machines that are used. The need for speed of response may be less in the home than in military and industrial situations, but the importance of coordinating the homemaker's requirements and the task requirements into suitable designs of workplaces is no less critical.

Implications for Designing Workplaces

The object of considering the requirements of the worker in designing workplaces is to determine the conditions that result in a minimum of strain on the worker and require a minimum of effort to do the activity

The words strain and effort must be broadly interpreted to include not only physical strain and effort but also the affective, cognitive, and temporal costs of work.

The object of considering the requirements of the task in designing the workplace is to determine the conditions that will expedite the activity. Availability of needed space, items, and facilities makes it possible for the worker to do the work without allocating much attention to the situation itself. Work that does not contribute directly to the output is avoided. The rhythm of productive activities is not broken. The various parts of the action for a task are not prolonged unnecessarily due to adverse conditions.

One set of conditions is not satisfactory for all household tasks. Many tasks require a particular setup due to requirements for specialized equipment or facilities, type of supplies, and work surface on which to manipulate items or carry out processes. Characteristics of each part of the workplace must be designed to facilitate the performance of the specific task.

The equipment, storage, and work-surface requirements for a workplace are determined primarily by the nature of the activity, but these must be tempered by the worker's requirements if the design is to be truly functional. The information included in Part I, The Worker, and Part II, The Work, must be coordinated and translated into criteria for creating and evaluating physical arrangements for work.

To develop the physical design of workplaces, a number of aspects must be considered:

1. Location in vertical space
   - Height of work surfaces
   - Height of shelves, drawers, bins
   - Height of appliances or their parts
   - Weight and size of items to be stored
2. Location in horizontal space
   - Supplies, tools
   - Adjacent workplaces—height
3. Spatial arrangement of parts
   - Work surface—appliance relationship
   - Distribution of work surface
   - Location of drawers, doors, bins
   - Location of controls
4. Amount and dimensions and space for
   - Work (length and width of surface; depth of basins)
   - Worker at work—one and more than one
   - Storage of supplies and other items

5. Provision of special features
    Utilities (electricity, gas, water; drainage)
    Duplication of facilities
    Ventilation
    Lighting

Task and worker requirements must be related to each of these aspects to achieve a functional design. Throughout we must recognize that compromises are made between task and worker requirements and the design requirements for the place of work.

The preceding list of design considerations for a workplace should be combined with other factors, such as those discussed in the next section.

Additional Considerations

In designing workplaces for specific tasks we necessarily focus first on conditions that will expedite the task or tasks at that place. However, for those tasks done concurrently with other tasks or for tasks that require more than one workplace, the requirements for the workplaces cannot be considered in isolation. Conditions for other tasks must be brought into the picture so that the designs can be coordinated. Factors external to the work, such as the cost, family preferences and practices, and housing, are additional considerations that require attention for an optimal solution.

Our concern for the design and arrangement of workplaces must be sufficiently broad so that all important factors are considered. The work and workplace must not be examined in isolation from the effects on the family—the development of the children, the well-being and happiness of the family members, the interaction within the family and with other social groups in the community. In some homes it will be important to look at the effects on the homemaker's ability to work outside the home and to control the work within the home.

The style of living for a particular family is an important consideration. Does a family desire to be together during certain activities within the home but not during others? Does the homemaker prefer to work separately, free from distractions or her children's help? What proportion of activities are done outside the home? How do the family members structure their time and space use? These aspects must be taken into account in planning the allocation of space and equipment for household tasks, for they may influence the amount of space, either upward or downward, that is allocated to task performance.

Another area of concern must be the effects of workplace design and location on the timing of events. One might ask whether the equipment and supplies add more inflexible events to the list of inflexible household and nonhousehold activities around which the homemaker and the family must already work. Is more mental work needed to coordinate tasks or to carry out a number of plans simultaneously with technological changes in supplies and equipment or with a particular design of workplace? The work specialist must be alert to more than just the effect on total time allocation to tasks. The timing of the work and the thinking required are important dimensions to keep in mind.

Recommendations are necessarily based on current task content and our current knowledge of the human costs of work. We must be alert to changes brought about by technology in supplies and equipment and examine them in terms of how they might affect task content and worker requirements. We must also be alert to new measures of the human costs of work. The object is to be able to make a knowledgeable choice of design characteristics of workplaces.

THE CENTER CONCEPT

The basic components of workplaces are the work surface, storage, and major appliance or equipment. For many tasks all three components are essential to satisfy the needs of the task and the worker. The bringing together of these parts of a workplace to serve a particular function results in a center.

The idea of a center has appeared in the literature in home economics for many years. Wilson (1939) promoted the idea in kitchen planning and ironing (Wilson and Shively, 1949). In subsequent publications Wilson (1947a, b) continued her explanation of the usefulness of kitchen centers: "The modern kitchen is organized on the work center principle as nearly as space and cost limitations permit. Ideally, the work surfaces will be adequate for the tasks done there, and the equipment and supplies used in connection with each task will be stored within easy reach of the work surface" (1947a:5).

At Cornell University, Cushman (1929, 1936, 1951), Heiner and McCullough (1947), and Jonas (1938) also favored the planning of centers. Cushman (1951:2) pointed out the merits of having centers: "A good way to get the greatest satisfaction from our work and play is to simplify the 'befores' and 'afters' as well as the job by making a center or a place where the activity can be carried on in the easiest, quickest, most satisfactory way."

Wilson (1938:9) suggested the following procedure: "A fundamental principle in planning the various parts of the house is that each part should be planned to suit the function or functions it is likely to be called upon to serve. The first step in kitchen planning, therefore, is to list the functions of the kitchen."

In another bulletin, Wilson (1939:3–4) further explained the idea of planning centers: "It is easy to keep the kitchen in order if utensils and supplies can be kept near the place where they are most often used. In order to plan cabinets with this goal in mind, it is necessary to group the various uses of the kitchen into units, or centers." Wilson continued with a description of the centers needed in the average farm kitchen for work with foods. Her description of the sink center suggests the content and ideas of organization:

"Sink proper—for processes requiring water or draining.

"Counter space—for receiving soiled dishes, stacking, and draining, and for handling foods that require washing.

"Placing for garbage container; stool.

"Storage space for dishpans and drainer; dishwashing supplies and small equipment; towels in use; clean towels; cooking vessels, pans, strainers; small equipment used in the preparation of foods at the sink; supplies of foods requiring soaking or washing; vegetable cutting board."

The description ends with additional items appropriate for the sink center such as glasses used for between-meal drinks of water and flower containers.

Wilson (1947b) distinguished between ~~workplaces~~ and centers: a workplace consists of a work surface and nearby storage for tools and supplies used there; a center, however, is planned to serve a function or a group of functions. Researchers at Servel, Inc. (1947) (formerly manufacturers of a gas refrigerator) noted that kitchen activities were most easily performed according to appliance function. The workers at the University of Illinois Small Homes Council (Goodyear et al., 1945) also used the idea of a center to facilitate the flow of work.

The center concept has continued to be used. In brief: "A center is a place where you can do a particular type of work because the equipment, supplies, utensils, storage space for these, and the counter space needed for the activity are all located together" (Steidl, 1959:4).

The Merits of Centers

The advantages of centers are:

"Centers save you effort, time, and thinking because you have organized your supplies and equipment where you use them first and you have provided storage, work, and holding space for them. Centers reduce the distance traveled in the kitchen, since many trips are made between the equipment and the counter and the storage space. If these are within reach of one another, work is greatly reduced. Work can be more continuous because fewer changes in your place of work and less searching are necessary" (Steidl, 1959:4).

Evidence of the interrelatedness of the three main parts of a kitchen center—storage, counter, and appliance—is obtained from an analysis of the work for 36 meals in well-organized kitchens in laboratory studies (Steidl, 1962). Trips within centers (work surface, storage, appliance) accounted for about 50 percent of all the trips in the kitchen. Almost as many trips or movements, then, were made *within* centers as *between* them.

In another study, data were collected in 2 home kitchens (Steidl, 1961a); the frequency of using each of 4 areas was determined from memomotion films made before and after adding functional storage devices to the kitchen cabinets. The types of areas were appliances, counter, storage, and dining. Trips between storage, counter, and appliances averaged 111 to 165 during a meal for each pair of areas: storage and counter, storage and appliance, and counter and appliance. The prevalence of working back and forth between the components of workplaces substantiates the recommendation that these three types of areas should be placed together for a particular type of kitchen work.

Cowles, Steele, and Kishler (1958) effected savings in distances traveled in 56 kitchens through the reorganization and storage of materials, tools, and movable equipment. The kitchens were not remodeled. In a preliminary test of the reorganization, savings averaged one-fourth of the original distance in one-third of the kitchens. In a second test with a more elaborate meal, savings ranged from about 10 to 50 percent of the original distance required.

In the 56 kitchens over one-half of the separate items of food and pieces of equipment needed some change in location. Of the items needing relocation over four-fifths could be changed without remodeling. The work area most in need of reorganization was the range center, then the sink center, dining and serve center, and mix center. These facts suggest that much can be done to improve working conditions without remodeling. Persons in rented or temporary situations can be encouraged to organize their supplies and utensils according to place of first use. Ridder's (1952) research also documents the need for teaching principles of organizing kitchen centers.

DESIGNING COMPONENTS OF CENTERS AND WORKPLACES

In this section we shall examine the component parts of a center—the work surface, storage, and appliance.

Work Surface ✓

The dimensions for the three parts of work surfaces must be planned separately: the height, width, and depth. The total amount of surface needed for the task and the allocation of the surface are related considerations.

Height. The height of the work surface must be keyed to the worker requirement of maintaining good working posture. The height of the elbow is the important landmark for determining the desirable height of work surfaces for household tasks, because of the need to maintain a posture and arm position that avoid static work and the fatigue arising from it. For standing work, plan the height of the work surface so that it is 3 inches below the height of the elbow or slightly more depending on the activity.

Width. The width of the surface (side-to-side measure) is probably more closely related to task needs than to worker needs if a minimum of 18 inches for standing space is provided. Several aspects of the activity affect the width of the space required: the number of items used, their size or the size of the container holding them, and what is done to and with the items. Together, these factors may increase the space beyond the minimum needed for the worker. Of course, too minimal an amount of work surface will require more work, such as greater attention to find a place to put things, additional motions to rearrange the items, and the subsequent increases in time loss and dissatisfaction with the workplace.

The functional limits for the width of work areas range from 48 to 58 inches for the maximum and 40 inches for the normal work area (Heiner and McCullough, 1948; Barnes, 1963). For seated work, the average horizontal distance within reach is less: 39 and 32 inches for the maximum and "comfortable" reaches, respectively (Johnston, 1957).

The maximum work areas identify the distance that can be reached while maintaining a balanced position; the distance represents the side-to-side reach of both arms with finger tips bent so that items can be grasped. The normal work area represents the distance reached without extension of the upper arm, with only the forearm extended. The normal

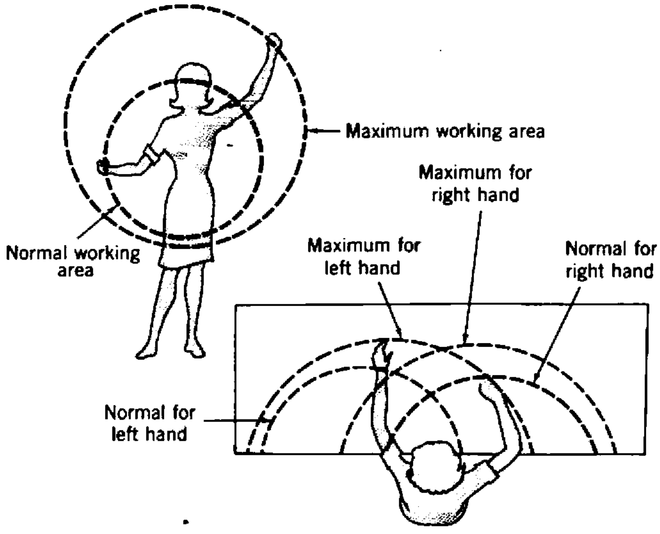


Figure 12-1. Maximum and normal working areas. (*Source.* Heiner and McCullough, 1948, p. 10.)

working area represents that area where most of the manipulative action would ideally be done (see Figure 12-1). A work surface about 36-inches wide would be within the normal reaching distance of many women and would not require a change of position, particularly when seated for work. The maximum width of about 60 inches would accommodate many women as they work without making them shift position. Of course, the shifting of position when standing could have advantages if the work continued over a period of time because shifting position would improve circulation in the lower extremities.

Depth. The depth of the surface (front-to-back measure) is determined by three factors: the distance that can be reached comfortably, the activity, and the items that must be used and stored temporarily during use. The normal working-area depth of 14 to 16 inches for women and the maximum work-area depth of 24 inches suggest that much of the activity that involves manipulative motions may be done within the 14- to 16-inch range, but the 24-inch distance is not an excessive depth for the work surface since it can be reached without assuming an off-balance position. When the minimum or normal work-area depth is all that is provided, the worker has little space for placing those supplies or small tools that are used intermittently. The temporary storage of such items on the surface can eliminate getting in and out of storage and possibly some stacking of items that need to be used again. It also permits the worker to return all items at one time rather than intermittently as the work progresses.

Certain activities require space for free swinging and turning motions. With the maximum work-area depth, the worker has more chance of making free swinging motions. Some space for maneuvering both the tools with which she works and the supplies that she uses is advantageous. A comprise between the use of the maximum depth of 24 inches for women and the optimal depth for items that may be stored under the work surface may be necessary. When the depth for storage is too great, poor use may be made of the space or nonfunctional conditions may result.

Amount and allocation. The total amount of surface needed for work (determined by the width and depth measurements) will vary with the activity. It may also be affected by the allocation of the surface to more than one place; when this is done, a greater amount of surface may be needed because some of the advantage of spacing objects is lost.

The allocation of work surface into two portions rather than one seems to be influenced primarily by the sequencing of use of areas within the workplace and by the relationships between centers. The flow of work will not progress smoothly when surface is not provided on both sides of those appliances in which the work processes are actually sequenced from one surface to appliance to a second work surface. Although the total amount of surface may have to be increased if it is divided, the disadvantage of not allocating some work surface on both sides of an appliance will not be equalized by increasing the total amount of surface on one side of the appliance.

The total amount of work surface for a given center may need adjusting if it functions simultaneously for other centers. In a kitchen, one surface may function as a loading, unloading, and work area for the refrigerator, as a working area for the mix center, and also as a stacking and holding surface beside the sink. In some cases all functional uses occur within a short period of time. The minimum, then, for the center requiring the largest area, would not be adequate for those occasions when the same surface is needed simultaneously for its three functions.

Storage

The creative work of Maud Wilson, Mary Koll Heiner, and Helen E. McCullough has been influential in improving the functional design of storage in kitchens and other areas of the home. The quality of commercially designed and custom-built cabinets has profited from their basic work and thinking. The following principles and guides for the design of the storage facilities and organization of items within them is based largely on their work although the presentation differs from their publications (Wilson, 1933, 1939, 1947a, b; Heiner and McCullough, 1947, 1948; Mize, Heiner, and Warren, 1953; Heiner and Steidl, 1954; Heiner, 1947; McCullough, 1949, 1952, 1953, 1959; and Jonas, 1938).

Although based largely on research and thinking for design of kitchen storage, the directives that follow are fundamental and can, therefore, be used for storage in other areas of the home. The principles and guides take into account various aspects of the four components of the worker's input and the function of storage during task performance.

Many tasks require a variety of supplies and tools but not all are needed at the same time. Tasks done at a particular center also vary in content from time to time and this is reflected in the items used. Storage should be such that there is sufficient holding space for all items needed for a group of related tasks done at the same place; the space should permit ready access to each item.

Principles

Three principles provide the basic directives for functional storage. Following a brief discussion of each principle, guides are given for implementing the principles.

Principle I. Store Frequently Used Items at Place of First Use

This first principle requires an analysis of the work done at a particular center to determine what items are used to do the work and their relative frequency of use. The function of the center provides one key to what should be available. Identification of the needed items guides us in planning the amount of storage space and its characteristics. The second key, frequency of use, provides a criterion when it is not possible to store all the items used first at a center. Those that are used more often should be given priority since their availability will have a greater effect on the amount of work.

Organization of items according to place of first use means that less work is needed. A standing rule for where one item can be found bypasses the need for much thinking and eliminates a search. The preparatory and supportive actions for a task are facilitated. Extra time and effort are not spent in walking to get items. The doing of the task can proceed without undue interruption.

Storage at place of first use generally has merits over storage at place of last use. For those items that do not need cleanup at another center, there is no argument since place of first and last use are identical. However, for those items that must be washed or cleaned in some manner before storing again the question is a legitimate one. Storage at place of first use gains support from the fact that the getting ready and doing of a task is generally less routine and the timing more critical than for the putting away; decisions are necessary with respect to what is needed. At the start of a task the worker may not always be able to identify all items needed; also, she may not have the work space for temporarily placing them. By the time the putting-away stage is reached, it is a matter of gathering together those items that were cleaned and replacing them at a given center. The putting away may vary in content, but it is predetermined and, therefore, less demanding of the worker. For these reasons, storage at place of first use is generally favored.

Principle 2. Place Items so They Are Easy to See, Reach, Grasp, and Replace

This principle favors reduction of mental and physical effort, time, and dissatisfaction. Visibility and accessibility are the key factors.

Unnecessary costs can mount steadily through repeated use of poor storage. For the preparation and cleanup of a dinner, storage areas were used over 100 times (Steidl, 1957, 1961a). The average duration of each use of storage was 4 seconds in one study and 5 seconds in the other. The total time for storage work ranged from 8 to 13 minutes, or about 10 to 15 percent of the total time. Instances of extra handling (handling or relocating a stored item or items to get or store another) were determined (1961a); the average time for each use of a storage area doubled with extra handling—from 3.4 to 7.2 seconds. The increased amount of time is relatively small but the consequences extend into the other components of the worker's input. Feelings of better organization and greater ease of work were expressed with more functional storage.

Principle 3. Determine the Worker's Limits of Reach

This principle is specifically directed toward keying the physical limitations of the main worker, with respect to her reach, to the design of the storage and placement of items within it. The maximum reach upward helps determine the height of the top shelf; the level must permit the worker to grasp items from the shelf, but, if the worker reaches across a surface to the shelf, the reaching height is reduced. For these reasons, the distance must be carefully determined.

The worker's normal reach describes the area most suitable for heavy items and most frequently used items if the criterion of minimum input is used. Occasionally we may knowingly choose to place frequently used items outside the normal reach in order that the main worker's use of certain muscles and joints can be increased rather than kept to a minimum or in order to satisfy other family members' preferences.

Guides

To put the three principles into practice, a number of guides are given. In turn, these suggest that the design must be keyed to the dimensions of the items to be stored.

Guide 1. Sort Items to Be Stored According to the Function of the Center

The key question is: Where do I use it first? One consequence of storage according to function of center is that items must be sorted according to type of work not according to form or content. Packaged goods, utensils, and small tools are distributed at various centers rather than kept together.

Guide 2. Store Unlike Items One Row Deep and One Layer Deep
Guide 3. Stack Only Those Items Having the Same Dimensions

Unlike items must be stored singly if they are to be visible and accessible without moving other items. Moving items includes the rearranging that is necessary when storage is more than one row deep and when items are nested or stacked. Items are logically stacked when a choice will not be made from the stack, i.e., if it is just as satisfactory to use the top item as the bottom one or any other. The height of a stack of like items may be determined by the number ordinarily obtained at a given time, such as two cups, or by the stability of the stack. For example, too many cups of certain shapes might be toppled over if care is not exercised during grasping and replacing.

Guides 2 and 3 are implemented by using narrow shelves, half shelves or step shelves, door shelves, drawer dividers, hanging panels, hooks, and racks.

Guide 4. Provide Sufficient Clearance for Grasping and Replacing Items

Stacked items can be obtained from storage if sufficient space is allowed for the depth of the item *plus* fingers *plus* some leeway or margin of freedom. To obtain unstacked items, finger space *plus* some leeway is needed. Space for maneuvering is necessary so that less precision is required. As the amount of precision increases, controlled motion and visual attention increase. For stacked items the depth of at least one of the items must be included as free space so that a single item can be obtained; otherwise it may be necessary to remove or tilt the stack to grasp or replace an item.

Provide adjustable shelves to help implement this guide. When the location of shelves is not fixed, that extra bit of space for sufficient clearance can be obtained. Freedom to relocate shelves also means that adjustment can be made when the dimensions of canned, packaged, and bottled supplies change. Our purchases vary from time to time, and manufacturers change the container sizes and introduce new products in new sizes. Our organization of stored items may also be varied more readily. Movable shelves can also mean less wasted space between shelves and may make it possible to add one or more shelves in a cabinet.

Guide 5. Place Frequently Used, Heavy Items within Normal Reach

The physical input of the worker can be kept lower when frequently used items and heavy items are within the normal work curve. We have better control and less chance of strain in lifting when objects are close to elbow level. Total distances reached can be kept lower if the more frequent moves are shorter.

This guide provides a criterion for organizing items within a center. If items are heavy but infrequently used, compromise may be essential due to the potential damage to intervertebral discs and ligaments incurred with lifting from a poor position, especially for older persons. Compromise may be necessary also when the number of lighter weight, frequently used items exceeds the available space. An additional criterion may be that those items that are expendable within a single use are placed outside the normal reach since a reach to replace them would not occur immediately.

A useful technique to help bring oblong items within reach when they cannot be stored within the normal work area is to store the items vertically rather than horizontally. Files, racks, and vertical partitions facilitate this storage method.

Guide 6. Organize Items within the Storage Space to Reduce the Search and Facilitate the Flow of Motions

The arrangement of items within a center can facilitate work beyond the advantages gained from having them available at the place of work, easily accessible, and visible. The ideas given here suggest ways of organizing within the framework suggested by the preceding guides.

One suggestion is to group items serving a similar purpose. Selection of a particular cereal, fruit, soup, or spice can be made more easily when all cooked cereals, all canned fruits, or all dried fruits are together; visual identification is aided since the area of search is narrowed. In our thinking we categorize items; if we sort and arrange according to logical operating categories, we help to minimize the mental work to carry out a plan.

A second suggestion is to keep together the parts of a piece of equipment when the parts must be assembled before any use. The parts of a food grinder are logically kept together since the grinder cannot be used until it is assembled. Parts of a coffee maker, however, may or may not be kept together. When the base is filled with water and then carried to the range, the additional parts and coffee are logically stored at the range for assembly there—the place of first use. In contrast, when boiling water is added to a drip coffee maker, all parts and the coffee are kept together at the range in accordance with the principle of storage at place of first use. The reader is cautioned not to confuse the idea of keeping together parts that must be assembled before any use and the principle of storage at place of first use. The two are not contradictory; the former is intended to supplement the latter.

Awareness of the order of using items or groups of items provides a third suggestion. For some tasks we must select a series of items and often we remember them or get them in a particular order. To set the table, do we not determine whether we need knives, forks, and spoons in that order? Ingredients in some types of recipes may be combined in a usual order and ingredients might then be organized to facilitate obtaining them from storage.

A fourth idea is to position items for use. This facilitates the flow of motions and eliminates extra ones. Items to be held with the left hand while something is done to them with the right hand are logically placed toward the left. A tool held in the right hand is logically grasped by that hand. Extra movements to rearrange the position of the item are avoided and productive action can be more continuous.

The principles and guides for the design and organization of storage are relevant to all activities in the home not only in the kitchen; our numerous examples from the kitchen are not meant to imply such limited application. Most work and nonwork activities require many items and they require storage: laundry supplies; cleaning supplies and equipment; clothing, cosmetics; medicines; bedding and other household linens; gift-wrapping and mailing supplies; games, phonograph records, projectors, slides, films; and carpenter and repair tools to suggest a few (see Bratton, 1963, and McCullough, 1952). Functional design and organization of storage areas for these items facilitate the activities.

Appliances

The design of the appliance, a third part of many centers, should be analyzed to determine the effect on the content of the work as well as the effect on the worker's input. An analysis of factors influencing the effectiveness of the design for a particular type of work is also essential, for the performance characteristics will determine whether the appliance will do a satisfactory job; such analysis is beyond the scope of this book, however.

One way to study the design of the appliance with respect to what the user must do to operate or maintain the equipment is to imagine what you do to operate the equipment or actually use it if possible. Go through the motions, get the feel of working with or at the appliance.

Identify ways in which the design of the appliance affects the content of the job with respect to the type of action. Do certain features require excessive preparation before the appliance can be used? Will this work be irritating because it delays the start of action and requires attention and extra time? By the same token, will the cleaning up and putting away extend completion of the task?

The type and amount of physical action is also affected by the appliance design. What positions must the user assume—stand, sit, bend, squat? What motions must be made to operate the appliance—grasp, push, pull, lift? Are work levels keyed to the worker's dimensions? Can body weights be kept in alignment during use of the appliance? Can static work be avoided?

Note the weight that must be lifted or moved if the appliance is not stationary. Is it cumbersome to move or carry, especially on stairs? Are there casters to help move the appliance, and are they sufficiently substantial, large, and free moving for the weight of the appliance and the type of floor covering which will be traversed?

Which type of processing does the appliance do, which types are left for the worker to do? Is the division of labor agreeable to the operator? How much cleaning of the appliance is needed after use? How intricate is care of the appliance?

In what ways has the design of the appliance affected the amount of attention that must be paid? Do mechanical devices automatically control the temperature, the time, rate and sequence of action, or the addition of supplies? Can the devices be set without a complicated series of steps?

The design of controls and their placement also play an important part in the amount of attention needed to use them. A careful analysis will be needed to determine how well the worker's abilities and limitations have been taken into account.

Do controls move in the expected direction or are they reversed from the usual procedure? Any reversal will demand that the user change a standing plan and learn a new one for use with such an appliance. A new habit will have to be developed, one adapted to a particular situation.

Are controls marked clearly? Can the on-off positions be distinguished easily or is an on-off device merely identified? Are intermediate settings marked so that the control setting can be adjusted accurately?

Must controls be set in a particular sequence and before the appliance is started? Can the user learn to make the necessary decisions before starting the operation? Can decisions be altered if the worker has second thoughts about the task requirements?

Are controls easily accessible? Will it be dangerous to reach them while the appliance is in use? Are the controls arranged in logical order? A poor location of controls increases the amount of attention and precision needed to adjust them and also increases the chance for accident.

How easily can dials be read? Are the digits or words sufficiently large and well arranged to be quickly read? Are the markings more precise than required for the task? Can the worker obtain essential information for making judgments?

Is an indicator light provided so that a quick glance will give essential information—on, off, danger? Are expected colors used to code various situations, especially if more than one situation is indicated: green for on and normal, red for danger, amber for caution? Is the indicator light sufficiently bright to reveal whether it is lighted? Woodson and Conover (1964) caution against using more warning and indicator lights than necessary, especially when they serve little purpose, since this reduces the attention value.

Warning devices are essential to alert the worker to a need for action or to a particular type of change in a system. Are auditory warning signals provided when the worker is likely to be away from the appliance at a critical time or when the worker has a heavy demand on processing visual information? Auditory signals may be speech or nonspeech signals; the latter include bells, buzzers, and tones. Auditory signals are in contrast to visual displays which include lights, dials, counters, and pictorial displays. The visual displays may provide qualitative or quantitative information. The auditory signals may provide either a warning or more specific information about the nature of a change. Visual displays and auditory signals may be combined.

Check lists developed by human engineers provide criteria for the design and use of visual displays and auditory signals; for example, refer to Morgan et al. (1963) or Woodson and Conover (1964). Further details can be obtained from other references such as Murrell (1965) and Gagné (1962).

The less extensive coverage in this section on analyzing an appliance for demands made on working position and movement should not be interpreted to mean they are less important than the design and location of controls, displays, and signals. The coordination of appliance design and the worker's physical inputs is a vital key to functional design of appliances. Directives already presented for work surface and storage design are appropriately applied to equivalents of using work levels and storage facilities in appliances.

Some appliances are not a major part of a center but rather a part of a worker-equipment team, especially for cleaning tasks and some food preparation tasks. Analyses of the visual and kinesthetic demands placed on the operator in terms of design and location of controls and dials or other displays and manipulation of the equipment are strategic in coordinating worker abilities and demands made by the appliance.

SPACE ALLOWANCES FOR WORKING

How much space should be allowed for the person to permit satisfactory performance of various activities? This and the related questions of space allowances for more than one worker and for passageways are relevant to the concept of functional arrangement of centers and workplaces. Cramped positions contribute to dissatisfaction with the working situation, dislike of the activity, and less effective performance of the task. Inadequate space for another person to walk past a worker or a workplace, through a hallway, or for one to go up and down stairs with a load requires restricted movement and extra attention to one's movement and positions.

Three questions must be answered if adequate space is allowed for working: What is the basic position? What is the basic movement or elemental activity? Is additional space needed for part of an appliance or storage facility? The worker's basic position may be to stand, sit, walk, bend, squat, or kneel. The elemental activity may be to reach, carry, push; open doors, drawers; operate appliance; manipulate equipment, tools; arrange various items such as sheets, towels, supplies. A part of an appliance, storage facility, or furniture, such as a door or drawer, requires a certain amount of space when opened; space for this structural facility must be provided in addition to space for the person's basic position and activity.

Table 12-1. Mean Body Measurements of 230 Women and 20 Men

	Women	Men
Heights (standing)	Inches	
Top of head	64.0	69.8
Eye	59.5	64.9
Shoulder	52.3	57.3
Elbow	39.6	43.4
Palm	29.7	31.9
Thumb tip	26.6	28.8
Heights (seated)		
Seat to top of head	33.4	35.6
Seat to eye	28.7	30.5
Seat to shoulder	21.5	22.9
Seat to elbow	9.0	9.3
Floor to under knee	14.9	17.6
Floor to top of thigh	20.7	23.1
Floor to top of crossed knee	24.7	28.0

	Women	Men
Lengths	Inches	
Sitting (buttocks to front of knees)	23.4	25.1
Seat (buttocks to back of knees)	19.3	20.4
Lap (abdomen to front of knees)	13.3	15.2
Total arm (acromion to thumb tip)	25.0	27.0
Forearm (olecranon to thumb tip)	14.7	16.2
Widths		
Maximum body	18.4	20.6
Shoulders	14.4	16.4
Upper body	17.8	19.7
Lower body (standing)	14.5	14.3
Lower body (sitting)	16.2	16.0
Elbows extended	33.6	37.7

	Women	Men
Thickness	Inches or pounds	
Maximum body	10.9	11.7
Lower body	10.7	10.9
Girth		
Bust, Chest	36.6	37.4
Hip	39.0	
Bent at hips		
Arms down, length	32.8	33.2
Reach from bent position (buttocks to thumb tips of arms extended)	45.0	48.2
One knee kneel	33.5	
Weight (pounds)	140.5	167.4

Source: McCullough et al. (1962:4).

Space for the basic position can be determined from measurements of the individual. Reference tables, such as Table 12-1, provide average dimensions of women and men; the drawings in Figure 12-2 illustrate these dimensions for women. Such body measurements as these are essential in designing places for work and nonwork activities; by taking into account the space requirements for the average person, sufficient horizontal space can be provided for the legs when the individual is seated (23 to 25 inches), enough distance between seat and elbow (9 inches), and so on.

Space allowances for basic movements are also related to personal preferences and work habits as well as to body size. In fact, body use may be more important than body size in determining space needs (McCullough, 1955, 1957; Nichols, Russell, and Wood, 1961; McCullough et al., 1962).

Actions within a task vary in amount of space needed; the most space-consuming activity is logically used to determine critical space measurements. In bedmaking, unfolding the bottom sheet, spreading it over the mattress, and tucking it in required more space around the bed than doing any other part of the activity—removing bedding, turning the mattress, and remaking the bed with sheets, blankets, spread, and pillows (McCullough et al., 1962).

Space for basic movements as given in Table 12-2 combines the data

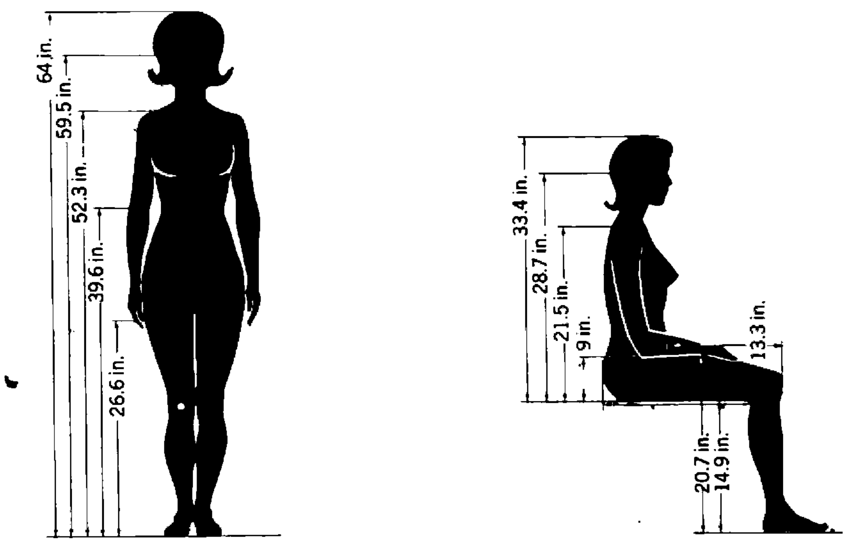


Figure 12-2. Body measurements of women. (*Source.* McCullough et al., 1962, p. 4.)

Table 12-2. Clearances for Satisfactory Performance of Certain Activities

	Inches
Walking activities	
Walk past seated person	24
Walk between wall and table	26
Walk between two walls	26
Walk past standing person (12-inch body thickness plus 26-inch walking space)	38
Walk with elbows extended	40
Two people passing	52
Edge past seated person	16
Edge past standing person (12-inch body thickness plus 16-inch edging space)	28
Edge past person in armless chair (20-inch sitting space plus 16-inch edging space)	36
Sitting activities	
Sitting at table, armless chair	20
Sitting at table, armchair	22
Sitting relaxed in an armless chair	30
Rising from chair at folding or typewriter table	30
Rising from table, armless chair	32
Rising from table, armchair	34
Rising from an armless chair in a confined area	38
Rising from an armchair in a confined area	40
Foot extension under table	20
Foot extension under desk	22
Bent positions	
Forward bend	34
Kneeling on one knee[a]	38
Activities with equipment, appliances, furniture	
Using kitchen base cabinet[a]	36
Using refrigerator[a]	36
Using wall oven[a]	36
Using range oven[a]	38
Using dishwasher[a] (based on dishwasher 24 inches wide)	42 × 44
Serving seated person (20-inch sitting space plus 24-inch walking space)	44
Using desk	36
Using bookcase	36
Using furniture with drawers	40
Using file cabinet	42
Using coat closet, one person	42
Using coat closet, two persons	46 × 60
Cleaning ends of furniture[a]	16
Cleaning under bed, bookcase, davenport, or studio couch[a]	48

Table 12-2. Clearances for Satisfactory Performance of Certain Activities (*Continued*)

	Inches
Activities with equipment, appliances, furniture	
Using and cleaning studio couch[a]	98 × 119
Using and cleaning bed-davenport[a]	110 × 112
Removing equipment from cleaning closet[a]	42 × 48
Bedmaking[a]	22
Space at end for opening and making studio couch or bed-davenport[a]	22

[a] Measurements of these activities were taken of women only. All other measurements were taken of both men and women or were derived from a combination of body measurements and activity measurements.

Source: McCullough, Philson, Smith, Wood, and Woolrich (1962:5; Table 2 adapted).

for the basic position, the action, and the space needed for structural facilities. The researchers point out that these space allowances were adequate for a minimum of 82 percent of the subjects in their studies for some activities and for all subjects in others. The standards given for clearances for the elemental activities can be applied to a wide range of activities besides the specific household activities. Some of the elemental activities are illustrated in Figure 12-3.

Further information for space allowances for working is included in the various sections for particular tasks.

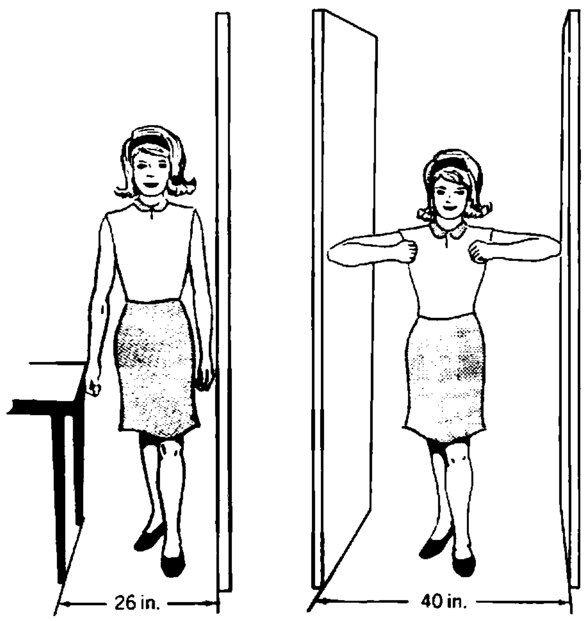
ARRANGEMENT OF CENTERS

Some tasks require the coordination of processes. The functions of more than one center are needed. Action on a given process is often intermittent. The arrangement of the centers for a given task thus becomes an important consideration. The arrangement can be planned to minimize the amount of movement the worker makes and to provide sufficient space for free and easy movements. A good arrangement can also reduce time, attention, and dissatisfaction.

The location of centers in the arrangement often influences the design of each center—the amount of work surface or its allocation, and the location of the storage facilities. The design of the centers generally cannot be finalized until the center is located.

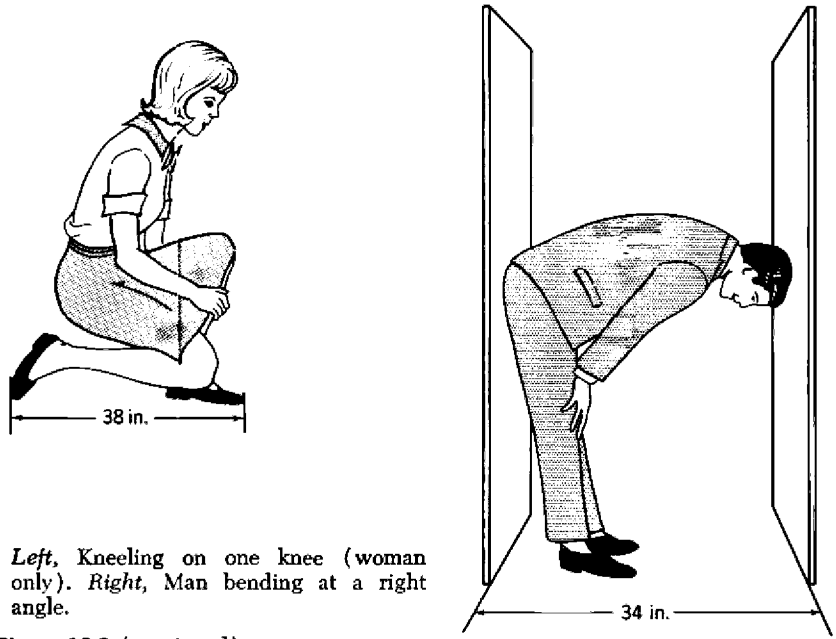
The planning of the arrangement of the centers is influenced also by aspects external to the task, such as the structural features of the room,

Left, Walking between two high walls (space adequate for both men and women). *Right,* Two people passing (figure derived; twice the space for one person to walk between two high walls).



Left, Walking between high wall and 30 in. high table (space adequate for both men and women). *Right,* Walking with elbows extended (space adequate for both men and women).

Figure 12-3. Space requirements for elemental activities. (*Source.* McCullough et al., 1962, p. 6.)



Left, Kneeling on one knee (woman only). *Right,* Man bending at a right angle.

Figure 12-3 (continued)

the layout of the house, activities of other family members, and tasks done concurrently.

Although the following principles are based primarily on our work and thinking for functional kitchen arrangements, they are appropriate for other work areas.

Principles of Arrangement

How can centers be grouped to facilitate work? Planning a functional arrangement of centers requires examination of two problems. The first problem is: Which centers should be given choice locations? Decisions about key factors should be made first. Every decision puts constraints on subsequent decisions. The centers that are focal points in the work should be located first so that fewer compromises are necessary.

The second problem in planning an arrangement is: Which centers should be connected and grouped together? Each center can have only two adjacent centers, and some can have only one. Criteria are needed to help determine the relative importance of various groupings.

Criteria for arranging centers can be obtained from studying the movement between areas. Trips describe this movement. Therefore, trips provide a meaningful basis for decisions about the arrangement of work areas when the tasks require the repeated use of a number of functional areas during a given period of time.

Trips provide information needed for locating the center for a good flow of work. A major determinant of the trips—the worker's movements—is the process involved in the work. For example, in the kitchen each area or center can be set up for a different type of process, such as cooking, refrigerating, or assembling ingredients for baking. The trips show which functional areas to adjoin to facilitate carrying on the processes—or to have a good flow of work.

The grouping of functionally related areas can help the homemaker judge the progress of work and achieve greater continuity of action through better timing of trips. The ability to see and hear what is going on at a nearby center helps the homemaker anticipate what is going to happen and better estimate the time that will be needed before she must go to the nearby center to resume action. This permits her to continue as long as possible before interrupting her work. Her timing of action can be closer. A trip represents a stop and a start—a shifting of attention from one place or type of work to another. The arrangement of centers can help eliminate useless trips and unnecessary shifts of attention.

Trips also provide information for locating the centers to reduce the worker's movement. Less movement can be achieved by arranging the centers so that the most frequent trips require the shortest distances.

The question of which centers to locate first can be answered partly by studying the total number of trips to and from each center. The frequency of use of a center indicates its relative importance for carrying out the tasks and provides one criterion for deciding which centers to locate first in a layout. Factors external to the task may also be important considerations.

Which centers should be connected and grouped together is determined not only by the movement of the worker between each pair of centers but also by her movement among all the centers. Trips between one center and another indicate only which two centers to place together, while the pattern of movement among centers shows which three or four functional areas to group together. Further information is gained by examining the consecutive use of certain centers. The extent of working back and forth between a pair of centers on the same or different jobs provides additional information about the strength of the linkage between pairs of centers.

Two other methods of examining trips also contribute information of value in planning the location of centers for a good flow of work. One is the direction of trips within pairs of centers. Are there more trips from Center A to Center B or is the reverse true? This is useful information because a lack of balance in the flow of work to and from each center in a pair provides an indicator of the sequence in which to place centers in a layout.

Another method is to determine the part of the center used first when it has distinctive parts such as the sink center. In meal preparation and cleanup, work can be reduced if it is possible to go directly to the part of the sink center to be used, since a functional sink center has work surfaces to the right and to the left of the sink bowl(s). The routing of the work between the sink center and other centers can be facilitated by having centers placed appropriately to the right or to the left of the sink center.

Three principles are of help in planning the arrangement of centers. They require knowledge of the movement between centers and of the processes in the task.

Principle 1. Plan and locate the most important centers first.

Principle 2. Place closely related centers together.

Principle 3. Place centers to the right or left of centers with distinctive parts to fit the routing of work.

These three principles provide the basis for guides for the arrangement of centers for kitchens, laundry areas, and sewing areas. The guides are included in Chapters 13 and 14.

The Shape of the Layout

Work centers can be arranged so that the lineup forms a U, L, straightline or single wall, corridor, or irregular shape. Part of the lineup may not be against a wall; rather, it may extend into a room to form a peninsula or it may stand free as an island. Each shape has advantages and disadvantages to the worker and for the design of storage. Some of the advantages and disadvantages may be shared by more than one layout because they have common elements.

1. *Layouts with Some Centers at a Right Angle to Others*

Centers placed at right angles shorten the walking distance between them. Such placement may permit more reaching from center to center without having to walk or get up from seated work. Inspection of ongoing processes at the adjacent center may be possible without interrupting action to make a trip.

The depth of the storage space in the corner of the right angle can be a distinct disadvantage because many items are not easily accessible and some get lost. Special storage devices or designs are needed to bring the contents of the cupboard toward the front.

To some families, layouts with two right angles may have the disadvantage of enclosing the space and interfering with the movement of persons working simultaneously. The boxing-in effect of a U shape may require more adjustment to who moves when and where than in a more open area such as an L shape. Of course, the distance between the sides of the U can be increased so that the work space is wide enough for the workers to move about in easily.

2. *Layouts with No Centers at Right Angles*

The advantages of a shortened distance between some centers are lost when no centers are placed at a right angle. More space for workers to be side by side at adjacent centers may be realized. The advantage of no deep-corner storage may be a distinct asset.

The straightline and corridor shapes are examples of layouts without a right angle.

3. *Layouts with Doorways or a Passageway Between Centers*

Doorways between centers or at both ends of a corridor layout provide a traffic lane for others not working in the task area. The disadvantage of this is that the worker may have to dodge children or adults who are just going through the room—just one more factor to take into consideration while doing a complex task.

Doorways between centers also unnecessarily increase the distance walked during work for a particular task. Every time a doorway is passed, we walk 2½ to 3 feet farther than if the centers were adjacent. If the doorway separates two frequently used centers, such as the sink and range, the increased distance could easily total 75 to 90 feet during the work for *one* dinner with baking (an average of 30 trips, based on data in Steidl, 1962:12). Avoiding such placement of doorways may be of particular help to the physically handicapped who want to limit their walking.

LOCATION OF WORK AREAS AND WORKPLACES

The worker, household tasks, and nonhousehold tasks should be taken into account in determining the location in the home of work areas or rooms such as the kitchen or laundry, or of separate workplaces such as a business center. In the previous section, we discussed principles and guides for arrangement of centers for a given work area—for tasks requiring the coordination of processes and subtasks. Now we focus on the broader problems arising from the coordination of a variety of tasks and family activities.

A number of questions can serve as guides, but relatively little research provides definitive information about the effects of the layout of homes on patterns of work and play and of relative satisfaction with such effects. Over time, variation in family activities and content of household tasks requires people to adjust to the constants in their housing environment. One objective is to make as knowledgeable a choice as possible of an arrangement of work areas which will produce as many advantages as possible for the changing family situation. Considerable imagination and foresight are demanded to project into the future.

A practical approach in planning the location of work areas is to relate the nature of household work and the impact on the worker. One work characteristic to consider is the continuity of action, because it influences which tasks are done separately, which intermittently, and which concurrently. Can the location of the work areas be such that intermittent action on selected tasks will be facilitated? Short distances permit selection of visual and auditory information to help control action and reduce the use of short-term memory. Tasks with relatively short inactive work periods are more easily coordinated with other tasks when work areas are nearby.

Do some tasks have similar qualities in the type of action so that the worker may prefer to do them together? Or is the converse true? Clean tasks do not combine well with dirty tasks, wet tasks with dry tasks.

Tasks for care of children change with their age, but for many years the supervision of children is an ongoing task. Are the household task areas so located that the homemaker can monitor the indoor and outdoor play areas as she works?

Can workplaces for less frequently recurring tasks be set up and left up sufficiently long so that the input for getting ready to do the task is not too costly?

Which level of a house will be most satisfactory for a work area? Will one level eliminate carrying of equipment or of materials on which work must be done? Does noise from operating equipment favor isolating it on one level and thus outweigh other considerations, such as the distance to get to and from the work area when the worker's action is intermittent? Or does separating noisy equipment outweight the advantages of obtaining visual and auditory information about the progress of the action?

Consideration of such questions as these for each work area will contribute to a more functional location for work areas and help develop a good compromise.

DESIGN OF WORKPLACES FOR THE PHYSICALLY HANDICAPPED

The basic information given throughout this book and brought together in this chapter provides the background essential for adapting situations to meet the special limitations of physically handicapped persons. Space does not permit us to make specific suggestions for designing workplaces for the physically handicapped. The many dedicated people who direct their talents toward the rehabilitation of the disabled can select material appropriate to the particular restrictions with which individuals must cope, whether it be limitations in distance to be reached, weight to be lifted, amount of walking, rate of work, and quantity of work.

Although knowledge of the physical component may contribute largely to implementing the independence of the physically handicapped, the other components of the worker's input cannot be disregarded. Knowledge of the affective, cognitive, and temporal costs of work can be used to temper the physical costs. Awareness of the content and structure of work can help the disabled as well as the healthy person to design his work and work situation.

Just as the rehabilitation specialist can learn from the material in this book, so can the work management specialist learn from research and work in the rehabilitation field. Examples of research directed toward design of workplaces for the handicapped include McCullough and Farnham (1960, 1961b) and Bevacqua, Gerhold, and Ruef (1960). A resource book for families and professionals concerned with rehabilitation (May, Waggoner, and Boettke, 1966) includes many illustrations, a bibliography, and lists of other sources. The *Journal of Rehabilitation* and *International Rehabilitation Review* provide current information for professionals.

We shall always be challenged to identify the particular limitation around which we must plan and to devise the means of meeting the challenge whether we are concerned with the use of the human resource for handicapped or healthy individuals.

CHAPTER 13

Design and Arrangement of Kitchen Centers

This chapter provides an application of the rationale presented in Chapter 12. The application of the principles and guides is keyed somewhat to the present day models of equipment, materials, technology, and styles of living. The creative work-management specialist need not be restricted by our application at this point in time. The problem will always be to analyze the impact of new models of appliances, changes in supplies, and mode of living on the design of centers and their arrangement and location with reference to the worker and the work. The potential complexity of meal preparation, importance of timing and coordination of operations, the potential variation in the task content from one occasion to another, the discontinuity of much of the action, and the frequent repetition of the task necessitate a carefully planned work area. After-meal cleanup, although more routine and a supportive activity, imposes further design requirements on the kitchen.

DESIGN OF KITCHEN CENTERS

Our discussion focuses on one center at a time, even though in practice centers are often merged rather than kept as discrete work and storage areas for a particular function. The merit of separately considering each center is that basic information is available so that various combinations of centers can be worked out for different kitchen plans and to match individual preferences.

Not all parts of every center are discussed. The dearth of published research for some aspects, especially appliance design, as well as competition for use of space in the text precluded a complete analysis of every center. That which is included should suggest an approach for applying knowledge of work and work costs to all parts of centers.

Sink Centers

A sink center provides water and drainage for food preparation and cleanup. To facilitate work with water, not only the sink is essential but also work surface and storage. Since most sink centers function for both food preparation and cleanup, sufficient storage space must be planned to accommodate supplies and utensils used first with water for both tasks. The most space-consuming parts of the tasks done at the sink determine the amount and allocation of counter beside it.

Sink Design

(The design and placement of the sink requires careful consideration of a number of factors if fatigue from work is to be reduced. The duration of much of the work at the sink makes it important to help the worker maintain good posture. The interrelatedness of several factors makes this a particularly complex problem to solve.

Four parts of the design of the sink affect the posture of the worker: the thickness of the front barrier; the height of the floor or bottom of the sink bowl; the height of the top of the sink rim; and the depth of the sink bowl.)

The depth or thickness of the front barrier must be as narrow as possible, 3 inches or less. (The thickness of the front barrier is the distance between the inside of the sink bowl and the outside of the bowl or the frame.) The narrower the barrier, the more possible to keep the upper arms vertical during work.

In a study (Crew, 1948) of work at sinks with a 3-inch and a 5-inch front barrier, a significantly larger number of women complained of discomfort when the sink barrier was 5 inches thick. Manufacturers, builders, and carpenters can do much to ease the human cost of working at the sink by careful attention to this dimension of the barrier. A narrow frame at the front of a sink should continue to be incorporated into the original design by the manufacturer. Plans for installing a drop-in sink bowl must include proper provision for a narrow frame at the front of the sink. Care at this stage of construction can forestall discomfort.

The height of the floor or bottom of the sink bowl must be sufficiently high to permit the worker to grasp (not just touch) items from the sink floor with little or no bending of back or shoulders and with a minimum of head bending to see items. Bending to work becomes tiresome because small muscles in the neck and back work harder to maintain the unbalanced positions. Damage to these muscles in the neck may occur over a period of time (Metheny, 1952). When the sink floor is too low, workers sometimes avoid bending their back by bending their knees and standing off balance. Such compensating positions can contribute to backaches, one hip becoming larger than the other, and curvature of the spine.

Care must be taken that the top of the sink rim is not too high. When it is too high, the worker may have to work with raised shoulders—an uncomfortable position to maintain. Careful analysis of the combined effect of the height of the sink floor, height of sink rim, and thickness of sink rim is necessary in placing the sink. The depth of the sink bowl (i.e., from the top of the sink rim to the floor of the sink bowl) thus becomes a critical dimension, since it may become the dimension that can be adjusted to provide the height of both the floor of the sink bowl and the sink rim that will be satisfactory for the worker.

The depth of the sink bowl (top to bottom) must be keyed to the type of activity as well as to the comfort of the user. A 4-inch depth may be sufficient for food preparation jobs which do not result in much splashing or do not require much depth for soaking. A 6- or 8-inch depth is sufficient for washing most cooking utensils and larger vessels if used only occasionally. Deeper bowls, while convenient for doing laundry by hand or for disposing of water from a clothes washer, are not appropriate for food preparation and cleanup work since the worker's comfort would be sacrificed.

Two questions, then, seem to be key questions: What height for the floor of the sink? What height for the sink rim? Tentative conclusions are suggested by Crew (1948): for the woman of average height place the floor of the sink between 30 and 32 inches and the height of the sink rim between 36 and 38 inches. The smallest number of subjects (3 out of 36) complained of discomfort when the sink barrier was 3 inches, the height of the sink rim 36 inches, and the sink floor 30 inches. However, Crew (p. 16) concluded: "The study gives some indication that the 36-inch sink cabinet on the market is too low for women above median height, 63 inches without shoes." One of the problems of interpretation of data centered around the limitations of using the angle of bend measure since it did not help in setting the upper limits for height of sink rim. In a more recent study (Etzel-Mattsson, 1963) 12 out of 15 Swedish girls preferred a rim height of 90 cm (36 inches) rather than one of 80 or 85 cm. The sink was 16 cm (6.4 inches) deep and had a 10-cm rim (4 inches). Further research is desirable.

Additional considerations include other dimensions of the sink bowl—length and width—and the number of bowls. These factors affect the procedures used in doing tasks and the ease of working, but their effect on the fatigue caused by poor working position is not as important as the factors just discussed.

Some data concerning preference for a single- or a double-bowl sink exist (Steidl, 1958b) but they are far from definitive. The same reasons were sometimes given for opposite choices. The reasons (from 163 urban homemakers with a dishwasher) related primarily to: size; dishwasher; liking (no explanation); doing more than one job; ease of doing specified job; and food-waste disposer.

The advantages and disadvantages of size and number of basins stem from one or more of the following: effect on task procedures, the timing of tasks, the space within the basin for items being worked on, the cleaning of the sink, total space that can be allocated for a sink, proximity of other basins and/or sources of water and drainage, and other kitchen equipment—food-waste disposer and dishwasher.

A variety of designs are available for sinks. One, a long, shallow bowl about 4 inches deep, is promoted for vegetable preparation and for sit-down work. From the standpoint of the work for vegetable and fruit preparation, the sink has merit: it will hold a quantity of produce or will provide sufficient space for several processes such as sorting, trimming, peeling, and rinsing; the shallowness makes it possible to bring the floor of the sink and, therefore, the contents closer to the worker. The shallowness of the sink accommodates food-preparation work but is less satisfactory for cleanup tasks that require greater depth.

With respect to the practicality of the vegetable-preparation sink for sit-down work, both the duration of the work at the sink and the suitability for a comfortable seated position should be considered. The duration of the work will be influenced by the quantity of produce handled at a given time, the amount of processing, and the continuity of action. If the action can be uninterrupted rather than dovetailed with tasks away from the sink and the work itself can be continued for at least 5 minutes, the advantages of being able to sit to work may be sufficient for some women to merit serious consideration of the shallow-bowl sink. However, the 4-inch depth of the bowl exceeds the sit-to-work margin of 3 inches. If space for the thighs is obtained by raising the level of the sink rim above the worker's elbow and forearm level, an uncomfortable working position results; the forearm is not horizontal during work and forms an acute angle rather than an obtuse angle with the upper arm. Motions are restricted and leverage is more difficult. The uncomfortable working position can be overcome by perching on a stool so that the thighs are slanted rather than horizontal. Only when the homemaker finds this perch position comfortable is it logical to consider the shallow-bowl sink suitable for seated work from the standpoint of the workplace design.

Another variation in sink design is the three-bowl sink in which the third bowl is small and planned for disposal of garbage and draining liquids. The small bowl should alleviate the problems of getting rid of liquids when the other bowls are in use. The placement of the small bowl between the two main bowls, however, should be examined with respect to the effects on the worker's motions: the distance reached between the main bowls is lengthened by about 8 inches; precision in placing objects further away may be more difficult because the motion is harder to control and because inspection is further away; transferring heavier objects will require more muscular control because the arm is extended and the weight is further from the person's center of gravity; more frequent shifting of foot position may occur, however, with less pooling of the blood in the lower extremities. Such effects as these would need to be balanced against the merits of having a free drain while the other basins are in use.

Work Surface Design

Sequencing of activities during meal preparation and cleanup favor a division of work surface with some on each side of the sink. For the right-handed worker many activities move from a surface on the right, to the sink bowl, and then to a surface on the left of the bowl. This right-to-left sequence may be typical also for left-handed persons who have learned to use their right hand to cut, pare, or wash and their left hand for holding the item on which they are working. With this procedure the left surface may often be an area on which items are released from the left hand.

Preparation of fresh fruits and vegetables may be the most frequent activity during meal preparation that requires the use of counters as well as the sink bowl. Some of this work may progress from the sink bowl to a counter (potato preparation); other work may progress from the right surface, to sink bowl, to left surface (preparation of vegetables for salads).

The sequential use of space at the sink center during preparation may occur with these activities: selecting the quantity needed, preparing it and washing it, draining, and possibly cutting and combining. With sequential activities, advantages accrue from having a good setup for moving the produce along to the next work space rather than having to stop, store, clean up, and reorganize. The rhythm of work is not interrupted; the worker can progress logically from one activity to the next. Freer, less precise motions may be possible because there are fewer items to work around. Similar advantages accrue as activities for cleanup are sequenced.

More recommendations were found concerning the amount of work surface on each side of the sink to accommodate dishwashing activities than for meal preparation activities. The concentration of many items to be washed during cleanup compared to spacing of activities at the sink center during meal preparation may place such heavy demands on the sink center during cleanup that this phase of work actually determines the space required for a work surface. Recommendations for the width of counters beside the sink (no dishwasher) vary from 18 to 42 inches for the left side and 36 to 42 inches for the right side (Heiner and Steidl, 1951b; Kapple, 1965; Pickett, 1960; Wilson, 1939, 1947a).

The recommendations pertain to systems of work in which the surface at the right side of the sink is used for stacking soiled dishes and utensils and the left for treating clean dishes. In four of the five references cited, the space recommended for the left side either equals or approaches the amount recommended for the right. The system of work differed with the smallest left surface; the sink bowl was sufficiently long to hold a dish drainer and this freed the left counter for a tray.

Homemakers often key their system of work to the amount of work surface. Ideally, the adjustments in procedures are not too costly in discontinuity of action or added work, such as reorganizing items or toweling dishes rather than air-drying them.

Factors influencing the amount of surface needed for holding items before washing include: number in the family; total number regularly served; variety within each place setting; method of serving meals (directly to plates versus serving bowls and platters); number of menu items; stacking versus little organization of items before washing; accumulating most of the china and glassware at the sink center before starting to wash; bringing used utensils to the sink center along with other items rather than leaving them at the range or mix centers; and unloading contents of dish drainers directly to the storage area versus to the sink counter or to a tray on the sink counter. Any one of these factors might indicate the need for different allowances for work surfaces beside the sink.

Dishwasher Design

Three groups of questions serve as guides in evaluating the design of the dishwasher with respect to the impact on the task and the user.

1. How much of the dishwashing task will be done by the dishwasher? Which parts of the task can the worker omit? Are some actions

changed or added? Which items and how many cannot be washed in the dishwasher because of shape, size, material, fragility, or finish? Does the design provide sufficient stability for items? Does the design accommodate enough items?

2. Does the design of the racks and their location require precision in positioning items? Are twisted, awkward motions required by the angle of placement of items? How much organiaztion of shapes and sizes of soiled tableware is imposed? Can all racks be loaded without shifting them?

3. Is the insulation sufficient to keep noises during operation within a reasonable level? Or is the noise annoying to family and guests?

Answers to the above questions must be sought with each dishwasher. Actually loading a model with a few of our own items will provide a partial test. Sufficient flexibility is needed to permit variation in placement of items and to accommodate a range of sizes and shapes of items.

Range Centers

The functions of a range center are to provide (a) heat for cooking; (b) storage space for: canned, packaged, or bottled supplies used first with boiling water or heated without water;. the utensils used first at the range and all covers to cooking utensils; and measuring, stirring, mashing, testing, and turning tools and a can opener; and (c) counter space beside the range surface units and oven for cooking and serving operations.

The appliance in a range center may be a conventional, one-piece range, a split-level or high-oven range, or a built-in, two-piece range. In the latter instance, two centers may be planned—a surface-cooking center and an oven center—rather than one center including both parts of a built-in range; the consumer rather than the manufacturer makes some of the design decisions. Whether a conventional, split-level, or two-piece range is used, a number of design factors require attention if a functional center is planned.

Range Design

The level of the surface units and the level of the oven are critical dimensions because the relationship between the elbow height of the worker and the level of the surface units and oven shelves determine the quality of our body mechanics during work. More specifically, these levels must be 3 to 7 inches below the worker's elbow height to permit leverage and control of items during lifting. Frequent use of deep utensils and surface-cooking units at the back of the range must be compensated for by a lower level to permit better leverage.

Much of the work at an oven involves lifting utensils in and out of the oven and turning broiling food. Good control during lifting is especially critical because the oven door is hot and items that are lifted are often hot; heavy items increase the hazards. Controlled movements and effective body mechanics during lifting can be achieved by relating the level of the oven to the worker's elbow height.

The separate oven can be placed to our advantage or disadvantage. The following guide (Steidl, 1955a:1), based on laboratory research with over 50 women, can be followed for placing a separate electric oven at a functional level: "Place your separate electric oven so that the top side of the fully opened oven door is between 1 and 7 inches below your elbow height."

The level for comfortable use of the oven depended more on each homemaker's elbow height than on her standing height or her body build. In every case, the level of the opened oven door was between 1 and 7 inches below the homemaker's elbow height. A 3-inch level was the most popular. With the levels preferred, the top surface of the opened oven door ranged from 30 to 41 inches above the floor, with the majority between 34 and 39 inches. The height of the support for the separate oven would be between 27 and 32 inches from the floor.

Grady (1962) found that a central shelf location between 40 and 44 inches in the wall oven was best for the 6 subjects in a laboratory study. The wall oven in three-fourths of 50 homes was placed with the oven-door level between 1 and 6 inches below the homemaker's elbow height and this was a satisfactory level (Woodson, 1961). McCullough and Schoeppel (1956) recommended placing the oven so that the opened door was slightly below elbow height. They noted that this facilitates easy transfer of baking dishes from counter to oven.

The effects of the various oven-door levels on the body positions of two homemakers as they lifted food, inspected it, and turned it over in the oven can be seen in Figures 13-1 and 13-2. As is true with many situations, a compromise is needed between the optimal level for lifting during baking or roasting and the optimal level for work during broiling.

Space is needed in front of an open oven to stand and work. McCullough et al. (1962) recommended 36 inches for using a wall oven, 38 inches for a conventional range (Figure 13-3). In the unpublished data on which the guide for placement of the separate electric oven was based (Steidl, 1954), most of the cooperators were within 46 inches from the front of the oven to the farthest extension of their hips as they

Mrs. A has the top of the opened oven door at a practical level for her—3 inches below her elbow height.

Mrs. B has the top of the opened oven door first at 1 inch and then at 7 inches below her elbow height. Notice how much higher she has to lift her arm to turn over broiling meat at the 1-inch level than she does at the 7-inch level.

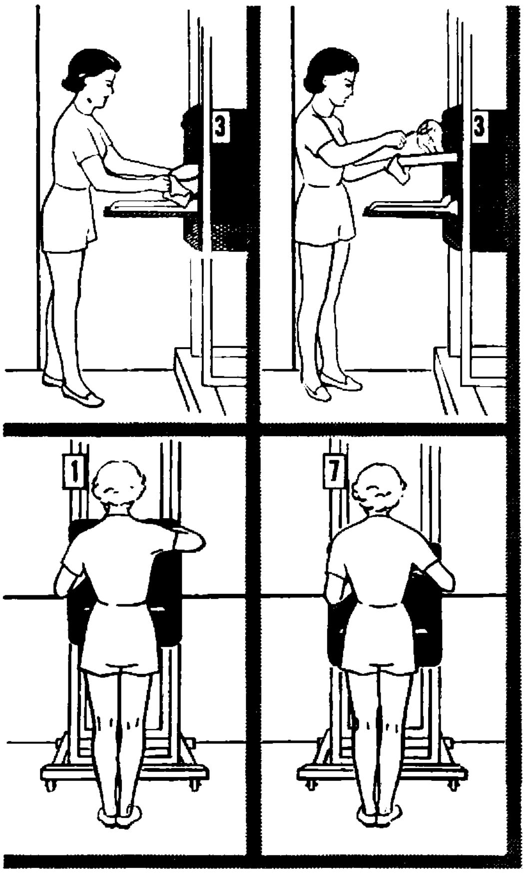


Figure 13-1. Two homemakers use a separate electric oven in the research laboratory. (*Source.* Steidl, 1955a, p. 2.)

used the separate ovens; as the vertical distance increased between the opened oven door and the elbow, the amount of space used beyond the front of the oven increased; the subjects tended to bend over more to use the oven at the lower levels, thus using more space. Notice differences in the space used by Mrs. B (Figure 13-2).

Space is also needed on both sides of the oven for elbow room. Notice the space use (Figure 13-1). Placing a wall oven against an adjacent wall results in restricted movements, particularly on the right for a right-handed worker.

Analysis of the design of the split-level range indicates serious problems for the worker, particularly in connection with the oven level. The

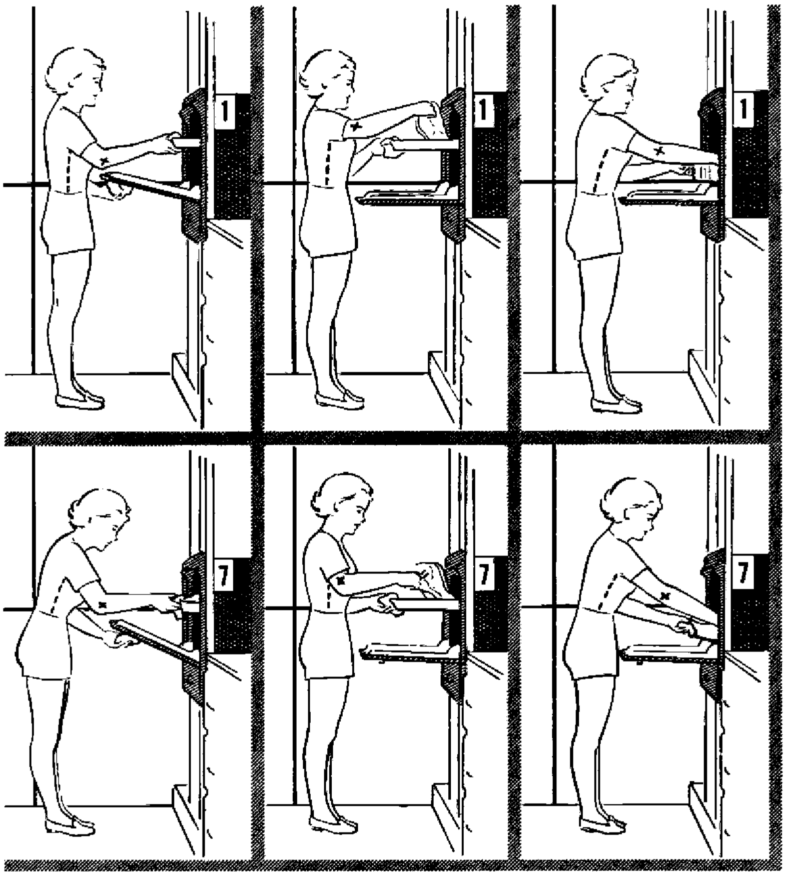


Figure 13-2. Effect of different oven levels on positions to inspect, to turn broiling food over, and to lift a roaster. The top of the opened oven door is 1 and 7 inches below Mrs. B's elbow height. (*Source*. Steidl, 1955a, p. 3.)

oven is too high to permit good control as the individual places or removes heavy items; she has no mechanical advantage due to the required arm position. The hot food is dangerously close to her face. The high oven level is only slightly more favorable for tall women than for average or short women, but the level of the surface units is less favorable for the tall women (Figure 13-4). The design of a split-level range seems to be such that even with compromises in level for both oven and surface units, the design is not functional for women of any height.

None of the 4 cooperators in Grady's (1964) study liked an arrangement of an oven above surface units; an optimal oven level was used and the surface units were placed at a 32-inch height. The 9-inch distance between oven and surface units was inadequate.

The arrangement of the surface units determines the ease and safety of placing and reaching utensils. Criteria for more functional arrangements and location of surface units can be organized around two closely associated factors: the arrangement of the surface units and the location and spacing of the counter surrounding the surface units. The criteria given next are based largely on the evaluations of an experienced worker who prepared and served a surface-cooked dinner menu for a family of 4 at each of 9 arrangements of surface units and counter space (Steidl, 1954).

1. Criteria for grouping surface units are as follows:

Place surface units so that pan handles are automatically separated to permit easy, direct grasp and to prevent their getting hot.

Place surface units close enough to the worker to permit easy reaching, seeing, testing, turning, and stirring.

Place surface units out of the way of each other to make it unnecessary to work over another surface unit—to provide direct access to each surface unit.

2. Criteria for counter space surrounding the surface units are as follows:

The counter space should provide out of the way storage space to permit: supplies to be placed where it is not necessary to work over them; service china to be placed where it can be filled near the surface

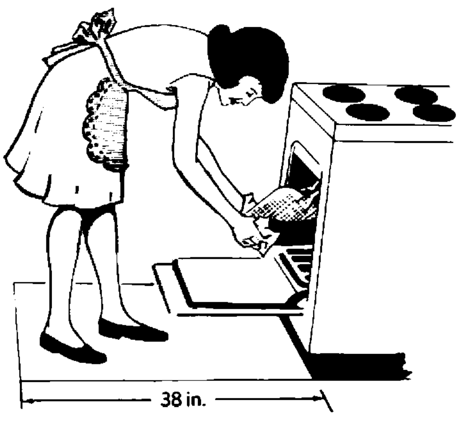


Figure 13-3. Using a conventional range. (*Source.* McCullough et al., 1962, p. 8.)

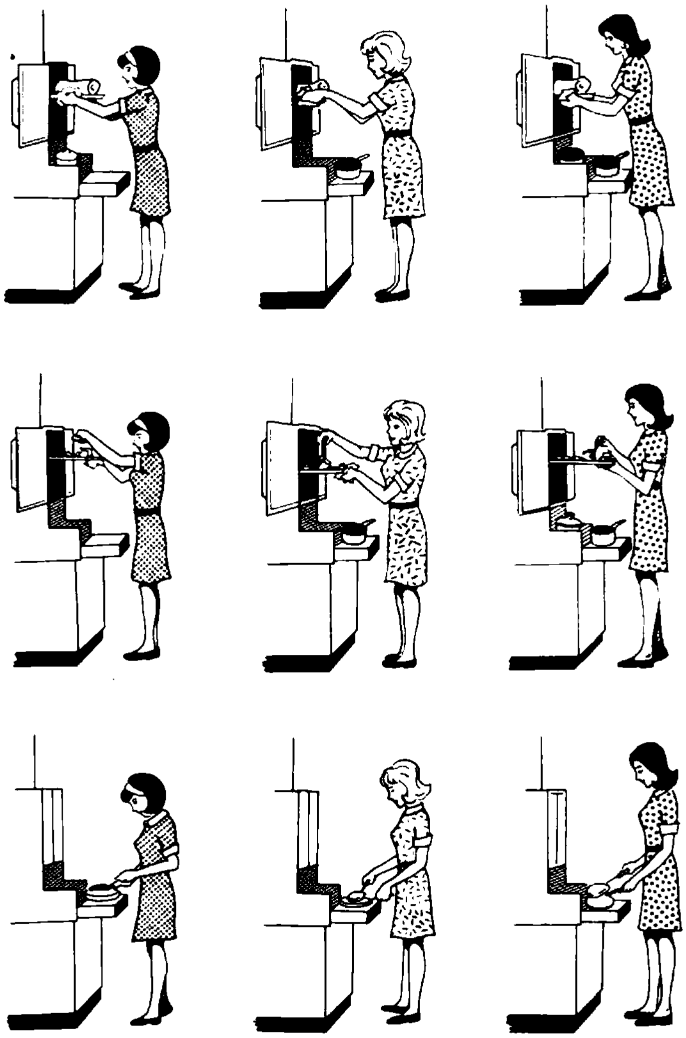


Figure 13-4. Working positions at split-level range. Short, average, and tall students lift heavy roast, turn broiling bacon, and turn pancakes. (*Source*. Dr. Kathryn E. Walker, class project, 1964, Cornell University.)

unit on which the food was cooked; direct access to temporarily stored items without reaching over hot pans.

The counter space should provide work space that is: close to the worker; to the left of the surface units to permit release of items held in the left hand without reaching across the right; not located entirely between two rows of pans because fear of burns makes movements cramped.

The worker in the laboratory study preferred a semicircular arrangement of surface units. This grouping of surface units resulted in a location of counter space that was satisfactory. The semicircular arrangement of surface units was comfortable to use.

The placement of dials and controls for the surface units and the oven is a third factor in functional range design. The criteria of accessibility, visibility, safety in use, and space use are appropriate to apply to the various locations. The logical organization to match the location of the surface units with the controls is also important. The organization should be such that it is logical to match right, left, front, and back units with the appropriate control.

Work Surface Design

A heat-resistant work surface is needed beside the surface units and beside the oven for temporary holding of supplies, small tools, utensils filled with food, pan covers, and service china. Work surface is also needed while food is served, and sometimes when it is transferred from the cooking utensil to storage container.

A minimum counter of 21 × 24 inches should be provided adjacent to the range or surface units. Wilson (1947a) suggested that serving hot foods was the process determining the area for the work surface. If dinner plates are arranged, a 36-inch-wide counter may be needed.

A minimum of 24 inches of counter should be provided beside a separate oven (McCullough and Schoeppel, 1956; Woodson, 1961). The separate oven should not be placed between a line-up of centers because it forms a barrier which gives the worker a hemmed-in feeling and restricts motions. Nor should the oven, counter, and refrigerator form a separate line-up, for this arrangement creates a boxed-in area. Sufficient elbow room is not available, and the worker has no extra expansion space for temporarily parking cookie sheets or other containers. A majority of the 50 women in Woodson's (1961) study had their separate oven at the end of a line-up of centers and found this location satisfactory.

Mix Centers

A mix center brings together supplies, equipment, and utensils needed for assembling and mixing food and the work surface required for these operations. A major appliance is not an integral part of a mix center; an electric mixer or blender is optional.

Although some would argue that a mix center is no longer a necessary part of a modern kitchen since preprocessed foods and premeasured mixes are readily available on the market, it is our belief that we should not generalize. For those families who like to prepare their favorite recipes, in addition to using the packaged mixes for cakes, cookies, muffins, and so on, a mix center is essential. There is a need for a modified mix center, even for those families who assemble batter from packaged mixes, since the beating and cutting operations require utensils and tools and an appropriate work level and amount of counter. Those who are in least need of a mix center are those who rely on the ready-to-bake or ready-to-heat products, since they bypass the assembling and mixing operations. More than one plan for a mix center is appropriate.

Work Surface Design

The level and the amount of work surface are particularly critical at the mix center because the worker handles many items and frequently exerts force. The counter level should be 5 to 7 inches below the elbow height of the worker. Analysis of preference data indicated that a slightly lower average level of 32 inches for beating was preferred than the average of 34 and 35 inches for kneading and rolling (Table 6-5). An important point to keep in mind is that a counter level lower than the present standard of 36 inches would better accommodate the worker at the mix center.

Dimensions of the counter also require special attention if sufficient space is allowed for temporary holding of items in use and for carrying out various operations. Wilson (1947a:25) made the following general recommendation for work surfaces:

> "In the interest of space economy as well as step saving and flexibility in use, work surfaces should be as wide as the arm reach of the worker will permit. Depths of 24 inches to 27 inches enable the worker to assemble supplies and small equipment in a semicircle about the area where the work is done. If no assembly space is required, and if the equipment used in the process permits, the work space may be as narrow as 16 inches."

The nature of the work at the mixing center makes it particularly important to plan counters with a depth of 24 inches.

Wilson (1947a) recommended a minimum width of 36 inches for a free-standing mixing surface and a minimum of 28 inches for a mixing surface adjacent to another unit; making pies with the supplies assembled was the process determining the minimum width. Mize et al. (1956), in an experimental laboratory study, found that 36 inches provided the necessary width in counter area for about 80 percent of the uses, with 52 inches used when unlimited space was provided. Items extended beyond the work surface in over 40 percent of its uses when the width was only 24 inches. A pullout board was useful in supplementing space. Mize et al. further recommended an additional 9 inches of counter space if the cabinet was to be placed at right angles to an adjacent wall so that a person could work without hitting the wall.

The original design for a mix-center cabinet by Heiner and McCullough (1948) featured a work surface 20 $\times$ 36 inches. The professional cabinet makers' model was 21 $\times$ 45 inches (shown in 1949 and later reprints of Heiner and McCullough, 1947). In use in homes, the 20- and 21-inch depth had certain disadvantages: inadequate depth for maneuvering a rolling pin and temporarily storing items; and the depth created a jagged edge in a line-up of kitchen equipment or centers.

The mix-center cabinet used by Mize (1952) featured a work surface 25 $\times$ 52 inches and proved satisfactory in use.

Space used in front of cabinets reached a maximum of almost 4 feet for one worker, but almost all of the uses required no more than 3 feet in front of the mix cabinet (Mize et al., 1956). These data are in agreement with those of McCullough et al. (1962). (Refer to Table 12-2.)

Refrigerator Centers

Work surface adjacent to the refrigerator is essential to expedite transfer operations. Some storage space for containers and small tools may be desirable. Too often the refrigerator is isolated from work and storage facilities; it should not stand alone. Work flows more smoothly when the worker does not have to juggle items to transfer them in and out of the refrigerated storage area; an 18-inch counter beside the door handle eliminates such awkward operations and endless trips. If chilled foods are served at this counter a more liberal amount should be provided.

Refrigerator Design

The appliance in a refrigerator center may be an upright, floor model in which the manufacturer has finalized decisions about level of various parts, or the appliance may be a model that can be placed under or above a counter or at an intermediate level. Body positions during transfer operations become an important consideration, and, even though they may be of comparatively short duration, they are recurring.

A number of features in the refrigerator should be evaluated for their functional design: location of door handle (right versus left side of door); shelf design (provision for storing one-row deep, bringing out contents, adjusting shelf level); storage bins (sufficient depth and width); and frozen food compartment (relative merits of high and low placement).

As is true with the design of other appliances and storage areas, the demand for more space within the worker's normal work area exceeds the supply. Choices are inevitable in arriving at the optimal compromises for a functional refrigerator design.

China Centers

A china center provides work and storage space for items used in serving and eating food; a major appliance is not needed.

At the china center, the main activities for which counter space is required are the transfer operations of items into and out of storage. Other operations may include spreading out salad, luncheon, and dinner plates for filling with food, or glasses, sauce dishes, or other china for individual servings. Service china may also be filled at this center. Such operations generally do not involve exerting force so that a work-surface level just below elbow height permits good body mechanics during work.

A minimum of 24 × 24 inches of counter space is needed for the basic transfer operations of china and service items into and out of storage. Additional width is desirable if more than 4 dinner plates are served at the china center; Wilson (1947a) recommended a 36-inch-wide counter for arranging dinner plates, 28 inches for arranging salad plates.

The repeated use of the storage facilities emphasizes the need for special attention to achieve a functional design.

Adjustments in Amount of Work Surface

The total amount of work surface required in a kitchen may be less than the sum of the work surfaces for separated centers. Some work surfaces can function for more than one center and can accommodate the work if some additional allowance is made. The basic questions to be answered to determine the extra allowances for adjoined centers are: What are the most space-consuming tasks at adjacent centers? Are the most space-consuming tasks done at about the same time or alternated? Or, which tasks, if not most space-consuming, will require work surface at the same time at the adjacent centers?

If the most space-consuming tasks at adjacent centers are done concurrently, it is practical to provide the total basic amount of work surface for the two or three adjoining centers. If the most space-consuming tasks are generally sequenced, the largest basic minimum amount of work surface should be provided plus some extra for any less space-consuming tasks that might occur. For example, the most space-consuming task at the sink center is often the arranging of soiled dishes and utensils; if the refrigerator center adjoins the sink counter surface on which the items are stacked, additional surface must be allowed to accommodate after-meal food storage.

Standards developed at the Small Homes Council (Kapple, 1961, 1965) provide guidelines for determining the amount of kitchen counter space in a continuous assembly. The basic guideline (1965) is derived from the standard for the amount of base-cabinet frontage: 10 feet—liberal; 8 feet—medium; and 6 feet—minimum. The given amount of base-cabinet frontage provides the same amount of counter. The directive for combining centers follows (Kapple, 1965:4): "Whenever two or more counters are combined, the multiple-use counter should equal the longest counter in the group plus one foot. However, the combination of multiple-use counters should not reduce the total base-cabinet frontage below that recommended." An application of this guideline is illustrated in Figure 13-5.

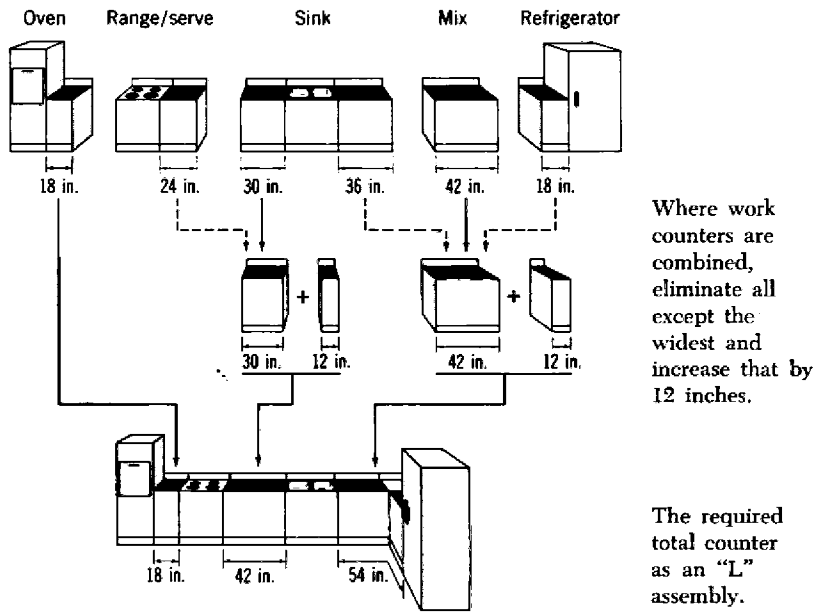


Figure 13-5. Combining liberal-sized counters. (*Source.* Kapple, 1965, p. 4.)

Kitchen-Dining Area Storage Walls

Rather than storage at place of first use, an alternative plan is occasionally preferred. A kitchen-dining area storage wall was designed by Heiner and McCullough (1947, 1948) to functionally store items without requiring as much wall space for cabinets as would be needed for storage one-row deep in conventional cabinets. The storage wall was visualized as forming a partition between the kitchen and the dining room or area, or replacing an existing wall if it was not a load-bearing wall. (See also Heiner and Steidl, 1954.)

Two other features in the Heiner-McCullough storage-wall design may be particularly attractive to some families: upper storage areas can be reached more easily because the homemaker does not reach across work surface, since a work surface reduces the distance she can reach; and she can more quickly inventory canned, packaged, and bottled supplies because they are together. For some, however, the disadvantage of not having items at place of first use may more than offset such features.

Subsequent work by McCullough (1959) at the University of Illinois provided another design for a kitchen-dining area storage wall. McCullough noted two trends that tended to reduce the amount of available wall space in kitchens: greater use of larger window areas and wall-hung appliances. A storage wall provides one remedy for the reduced space for all cabinets.

GUIDES FOR ARRANGEMENT OF KITCHEN CENTERS

The frequency of using a kitchen for meal preparation and cleanup plus the nature of the work make it important to provide a functional work area. The initial step of designing each functional area to satisfy work and worker requirements cannot be bypassed. Some modifications in the designs may be required as plans for the arrangement take form, but it is through initial plans for the optimal that considered judgments can be reached concerning the best compromises.

An impressive amount of research has been done on the arrangement of kitchens. A substantial contribution to the research literature was made from projects at Cornell University Agricultural Experiment Station (Heiner and Steidl, 1950, 1951a; Mize, 1952; Mize et al., 1952; Snow, 1956; Steidl, 1954, 1955b, 1957, 1960); the summary of these projects (Steidl, 1962) represents the most comprehensive analysis available at this time. Other published research is from various state agricultural experiment stations: Washington (Wiley, 1950), Oregon (Wilson, 1938), Utah (Bennion et al., 1956), Indiana at Purdue (Mundel et al., 1948), and Illinois (McCullough and Farnham, 1960, 1961a, b). Various master's theses and popular leaflets based on research contribute helpful information (Housing Specialists, 1957, 1959; Howard, Tayloe, and Parker, 1963).

Two variables to consider in planning the arrangement of kitchens are the style of range and the amount of baking. Differences are pointed out in the following literature review.

Research at Cornell University

Data from the preparation and cleanup of 100 meals in the Cornell studies were organized according to the meal, type of range (one- or two-piece), and amount of baking in the meals. ("Baking" was defined as the preparation of desserts, breads, casseroles, or the like, that require the use of the mix center to combine ingredients and the oven to cook them. When the oven was used only for roasting or broiling meat, the menu was classified as "without baking.") Steidl (1962:35) summarized the relative importance of each center:

"The sink center consistently ranked first in frequency of use (about 30 percent of all trips). The range center almost always ranked second in importance when the kitchen had a one-piece range. When there was a two-piece range, the surface-cooking center ranked second more often than the mix center, but there was little difference in some cases.

"The mix center often ranked third in importance in meals with baking. Least important were the separate oven center and the freezer; rarely did either exceed 10 percent of all trips."

Data are given in Tables 13-1 and 13-2.

An analysis of trips between centers showed the following connections:

"More trips were made between the sink and range centers than between any others. . . . About 25 percent of all trips were between these centers. None of the 3 variables (type of range, or meal, or amount of baking) appeared to consistently affect the proportion.

"Trips between the sink and mix centers were almost as frequent as between the sink and range centers when there was a two-piece range and baking.

"Relative importance of trips between other pairs of centers varied among sets of data, often with little relationship to any of the variables" (Steidl, 1962:10).

Data supporting this analysis are given in Table 13-3.

Table 13-1. Importance of Centers as Determined by Number of trips to and from Each Center While Preparing, Serving, and Cleaning Up 100 Meals for 4 Persons

	Trips in kitchens with:									
	One-piece range						Two-piece range			
	Meals with baking			Meals without baking			Meals with baking	Meals without baking		
	Dinner	Breakfast	Total	Dinner	Breakfast	Total	Dinner	Dinner	Breakfast	Total
Number of meals	39	8	47	12	16	28	13	9	3	12
Number of menus	6	1		2	2		4	3	1	
Number of trips[a]	11,180	1,650	12,830	2,692	2,928	5,620	4,596	2,090	846	2,936
Average per meal	287	206	273	224	183	201	354	232	282	245
	Percent									
Centers[b]										
Sink	30	35	30	31	27	29	31	29	32	30
Range	22	24	22	20	24	22	18	24	23	24
Mix	17	7	16	15	8	11	19	9	9	9
Refrigerator	9	16	10	11	9	10	9	10	9	10
China	11	10	11	12	14	13	9	12	11	12
Dining	11	8				15	7	8	15	10
Oven			11	11	18		5	6	c	4
Door	c					c	c		1	c
Other			c	c	c		2	2		1
	Average number									
Sink	86	72	83	70	40	58	109	68	90	74
Range	63	49	60	46	44	45	64	57	66	59
Mix	50	15	44	33	14	22	66	20	25	21
Refrigerator	25	33	26	24	16	19	32	23	24	24
China	31	20	29	26	26	26	31	27	32	29
Dining	31	18	29	26	32	29	26	20	43	26
Oven							18	13	1	10
Door	2		1	c	1	1	1		2	c
Other							7	4		3

[a] Total number of trips to and from each center is 2 times number of trips between centers.
[b] In kitchens with two-piece range, "range" stands for surface-cooking center and "oven" is separate from surface-cooking center.
[c] Some, but less than 0.5 percent or less than an average of 1.
Source: Steidl (1962:9).

Table 13-2. Importance of Centers as Determined by Number of Trips to and from Each Center while Preparing, Serving, and Cleaning Up Dinners for 4 Persons in Kitchens with a Two-Piece Range and a Freezer

	Trips to and from each center						
	Meals with baking		Meals without baking		Meals with baking		Meals without baking
			Menu item from freezer				
	Freezer not used	Casserole from freezer	Casserole, dessert	Plate meals, dessert	Freezer not used	Freezer used	Freezer used
Number of meals	4	4	4	4	4	4	8
Number of trips[a]	1,562	978	650	784	1,562	978	1,434
Average per meal	390	244	162	196	390	244	179
Centers[b]	Percent				Average Number		
Sink	39	36	32	26	151	88	52
Range	22	13	20	19	86	32	35
Mix	22	22	13	17	86	55	27
Refrigerator	8	10	14	9	32	26	20
Dining	3	3	3	4	11	7	6
Oven	5	9	8	14	22	22	20
Door	1	3	5	2	4	7	6
Freezer		2	4	8		5	11
Freezer counter	c	2	1	1	2	5	3

Source of data: Snow (1956).
[a] Total number of trips to and from each center is 2 times number of trips between centers.
[b] China center was combined with the sink center.
[c] Some, but less than 0.5 percent.
Source: Steidl (1962:10).

The average number of trips per meal represents work uninterrupted by external factors and work done at well-organized and functionally designed centers and can be interpreted as representing a minimum rather than a maximum physical input by a homemaker. More trips would probably be made under less favorable working conditions.

The movement of the worker among centers contributes information beyond that learned from the movement or trips between centers:

"The usefulness of studying only trips between pairs of centers is somewhat limited because the proportion of trips between many pairs of centers is similar and considerably smaller than the proportion of trips between 2 or 3 pairs of centers. After placing together those 2 or 3 centers between which more trips are made, the criterion of frequency of trips between pairs of centers provides insufficient evidence for making decisions" (Steidl, 1962:35–36).

Table 13-3. Trips Between Centers While Preparing, Serving, and Cleaning Up 100 Meals for 4 Persons

	Trips to kitchens with:									
	One-piece range						Two-piece range			
	Meals with baking			Meals without baking			Meals with baking	Meals without baking		
	Dinner	Breakfast	Total	Dinner	Breakfast	Total	Dinner	Dinner	Breakfast	Total
Number of meals	39	8	47	12	16	28	13	9	3	12
Number of trips: total	5,590	825	6,415	1,346	1,464	2,810	2,298	1,045	423	1,468
average	143	103	136	112	92	100	177	116	141	122
range: low	109	84		103	46		133	97	130	
high	227	127		148	138		252	133	147	
	Percent									
Centers used in trips[a]										
Sink and range	22	29	23	22	26	24	22	28	31	29
Sink and mix	15	7	14	15	3	9	20	6	10	7
Sink and refrigerator	6	21	8	7	5	6	6	8	8	8
Sink and china	8	7	8	10	8	9	6	8	6	7
Sink and dining	9	6	8	8	11	10	4	4	9	5
Sink and door	[b]		[b]		[b]	[b]	[b]			
Range and mix	8	4	7	4	2	3	4	5	1	4
Range and refrigerator	3	4	3	3	3	3	2	4	1	3
Range and china	5	7	6	7	7	7	3	4	7	5
Range and dining	5	4	5	5	10	7	3	3	7	4
Range and door	1		1	[b]	1	1			[b]	[b]
Mix and refrigerator	6	4	6	7	4	6	6	2	3	3
Mix and china	3		3	1	4	2	2	2	1	2
Mix and dining	2		2	2	2	2	2	1	1	1
Mix and door							[b]		1	[b]
Refrigerator and china	1	[b]	1	1	1	1	1	2	1	2
Refrigerator and dining	2	2	1	3	4	3	2	2	5	3
China and dining	4	5	4	5	9	7	5	8	8	8
China and door									[b]	[b]
Oven and sink							2	3	[b]	3
Oven and surface-cooking							2	5	[b]	3
Oven and mix							3	[b]		[b]
Oven and refrigerator							1	2		1
Oven and china							[b]	[b]	[b]	[b]
Oven and dining							[b]	1		[b]
Oven and door							[b]			

Sink and range	31	30	31	25
Sink and mix	21	7	19	17
Sink and refrigerator	9	22	11	8
Sink and china	12	8	11	11
Sink and dining	12	6	11	9
Sink and door	[b]		[b]	
Range and mix	11	4	10	5
Range and refrigerator	4	4	4	3
Range and china	8	7	8	7
Range and dining	8	4	7	5
Range and door	1		1	[b]
Mix and refrigerator	9	5	8	8
Mix and china	5		4	1
Mix and dining	3		2	3
Mix and door				
Refrigerator and china	1	[b]	1	2
Refrigerator and dining	2	2	2	3
China and dining	6	5	6	5
China and door				
Oven and sink				
Oven and surface-cooking				
Oven and mix				
Oven and refrigerator				
Oven and china				
Oven and dining				
Oven and door				
Other				

[a] In kitchens with a two-piece range, "range" stands for surface-cooking center and "oven'

[b] Some, but less than 0.5 percent or less than an average of 1.

Source: Steidl (1962:11-12).

Average number

24	24	39	33	43	35
3	9	35	7	14	9
5	6	11	9	11	10
7	9	10	9	8	9
10	10	7	4	13	7
b	b	b			
2	3	6	6	2	5
3	3	3	4	1	4
6	7	5	4	9	5
9	7	5	3	9	5
1	1			b	b
4	5	11	3	4	3
4	2	4	2	2	2
2	2	3	1	2	1
		b		1	b
1	1	2	3	1	2
4	3	2	2	7	3
8	7	9	9	11	9
			5	b	b
		4	4	1	3
		4	b		4
		6	1		b
		2	2		2
		b	b	b	b
		b	b		b
		b			
		7	4		3

' is separate from surface-cooking center.

Five additional methods were devised and used with the data from 40 of the 100 meals to obtain further information about connections among centers.

Five groups of important facts were obtained from the additional data analysis:

1. The flow of work to and from each center in a pair was generally balanced; the center from which the trip was started was as likely to be one as the other of a pair.

2. The order of using centers in successive sets of 3 and 4 center-uses was generally the repeated use of 1 or 2 centers in the set. Round trips were made. The appearance of the sink and range centers in the successive sets was also studied:

"Typically, either the sink center, or the range center, or both appeared in the successive sets of centers—in 75 percent or more of the sets of 3 center-uses and in 90 percent or more of the sets of 4 center-uses.

"Such frequent involvement of the sink and range centers is evidence of their constantly recurring function in the work sequence. This is also additional evidence that schemes suggesting concentrated or exclusive use of centers at only certain periods in the total sequence of work are erroneous" (Steidl, 1962:36).

Disregarding order of center-uses in sets, further study of the successive sets of center-uses provided additional information concerning linkages among 3 centers:

(a) The grouping of sink, mix, and refrigerator centers was more strongly linked than the grouping of range, mix, and refrigerator centers.

(b) The grouping of sink, china, and dining centers was similar in strength to the grouping of range, china, and dining centers when there was a one-piece range; with a two-piece range, the first grouping had the stronger linkage.

3. The study of the consecutive use of 11 pairs of centers showed that for the most frequently used pair, the sink and range centers, as many as 16 groups occurred during a meal; this means that a series of trips were made between the sink and range centers on 16 occasions during the work for a meal. The highest number of center-uses per group was 13 and involved the sink and range. Seven pairs of centers had a maximum of 5, 6, or 7 center-uses in a group. However, many groups had only 2 center-uses.

The number of center-uses per group suggested the following about the routing of the work and the strength of the linkages between centers:

"When the groups had only 2 center-uses, it appeared that the flow of work was such that the facilities of the first center used were not immediately needed to proceed with the task underway, or work was interrupted and not returned to immediately, or the uses of the 2 centers in the pair were not related. When the groups had 3 and more center-uses, the centers were apparently used intermittently to proceed with 1 task, or work that was going on at the 2 centers was being dovetailed. Linkages of 3 and more center-uses are therefore judged stronger than those of only 2 center-uses, and ease of work could be increased by placing together those centers generally used several times in succession and on more occasions" (Steidl, 1962:37).

Reasons for expecting work to be easier if centers used in sequences of 3 and more are placed together include: more movements could then consist of reaching rather than walking; the rhythm of work might not be disrupted so much because the distances and the time for trips would be shorter; and visual inspection of one center from another could be done with little change in pace, and consequently the timing of the trips would be improved.

The linkage of the sink and range centers was strongest, that of the sink and dining centers weakest. For 9 other pairs, either the type of range or the amount of baking or both affected the number of times a pair of centers was used repeatedly without the intervening use of another center. These data again indicate the importance of placing the sink and range centers together and the variation due to conditions.

4. Work for meal preparation and cleanup did *not* proceed around the layout and move along in assembly-line fashion. Use of each area was not concentrated at particular points during the total job. Analysis of the pattern of work through study of fairly large units of movement—every interval of 10 center-uses from the start of meal preparation to the end of cleanup—showed that the sink and range centers appeared in practically every interval. The appearance of other centers was more variable but not concentrated in only a few intervals. The number of different centers used at least once during each interval was also high. For 39 of the 40 meals more than 50 percent of the intervals had 4, 5, or 6 different centers used. The need to dovetail work on the various menu items and the need for the facilities of more than 1 center for most menu items preclude an assembly-line technique.

5. Routing of the work to a particular work surface at the sink center was usual with three tasks that involved china. The three tasks were: setting the table, clearing the table and getting ready for dishwashing, and storing the china. It was concluded that the flow of work would be

helped by providing direct access (a) between the dining center and the counter to the right of the sink, and (b) between the china center and the counter to the left of the sink. In contrast, the pattern of movement between the parts of the sink and range centers and between the sink and mix centers did not favor placing one to the right rather than the left side.

Routing of Kitchen Work

Throughout the foregoing analyses to determine which centers to connect and group together, the variety in sequential use of centers was outstanding. The statement commonly made that work progresses continuously from one end of the kitchen layout to the other is not substantiated.

This idea that work progresses steadily around the kitchen appeared in the literature before formal research studies were possible. It is an example of a notion that has persisted even though later research refutes it. As a matter of record, a brief account of its development and the gradual emergence of a different concept of the progress of kitchen work is given here (Steidl, 1962:18–19):

"Mrs. Christine Frederick, one of the early 'household efficiency engineers,' believed that equipment could be arranged in a fundamental order to match the '4 steps of preparing process' and the '4 steps of the clearing away process.' For the preparing process, the equipment corresponding to each step was storage, table or kitchen cabinet surface, stove, and table or other serving surface. Note that she did not mention the sink for the preparing process. For the clearing away process, the equipment and order for placing it were the stack surface to right of the sink, sink, drain surface to left of sink, and adjacent closets and shelves to left of drain. These recommendations were believed to meet the actual order of work. She said (1919:24–25):

> "'If the storage, stove, tables, sinks, etc., are arranged after this fundamental order, the work will proceed in a progressive, step-saving track, or "routing," as the efficiency engineer calls work which proceeds in a consecutive, orderly manner. If the equipment is not arranged on this principle, the result will be cross-tracking, useless steps and waste energy in all kitchen work.'"

"Hildegarde Kneeland (1929), another pioneer in the field, made similar recommendations for arrangement of kitchen equipment. Their recommendations on arrangement of centers appear to be based on mentally visualizing the work or on limited observations of making a cake or another menu item rather than from detailed records of the work for a number of meals.

"This idea of starting at the right of the layout and proceeding to the left with little retracing of steps has persisted despite the research of Maud Wilson and Marianne Muse in the thirties. Both assembled data from more formal studies.

"Miss Wilson gathered data from 14 families on several visits to their homes, and also obtained estimates from 50 homemakers of the number of times during a year that various dishes were prepared.

> " 'The moves required in the preparation of each dish were listed by the investigator to determine the total number of times that each part of the kitchen served as a starting point or as a destination, the moves for each dish being weighted by the average number of times in the course of a year that it is prepared in the Willamette Valley farmhouse. These data for the moves required for meal preparation were supplemented by similar data for the moves required in setting the table, serving meals, dishwashing, and tending the kitchen fire' " (1938:16).

"From these data, the 4 most important connections with each unit were determined—a far cry from an assembly-line technique.

"In her research, Miss Muse worked first with 2 families in their farm homes. Steps and time before and after remodelling the kitchens were compared. These data were supplemented with laboratory experimentation in which meals were prepared and variables in kitchen arrangement systematically changed one at a time. In discussing arrangements, Muse (1934:24–25) aptly described the flow of work: '. . . it should be remembered that the worker can not commence preparing a meal at one point and from there make one continuous trip around the room to the last point. Rather, she must work back and forth between the table, sink and stove. . . .' "

The analysis of the data from the Cornell studies agrees with the work of Wilson and Muse. Many sequences of center-uses were followed in the process of the meal preparation and cleanup. Although other researchers have not reported specific analyses concerning the movement of work around the kitchen, the data they have reported suggest a substantiation of our conclusions. If one center is a focal point or pivot in the work, the assembly-line technique is precluded.

The more important results of investigations at institutions other than Cornell University are given next.

Other Research

Wiley (1950) studied the preparation and cleanup of a dinner in 6 kitchen arrangements, counting the number of trips and number of steps per trip. She concluded that the sink and mix units, sink and range units, and range and mixing units should be together. Wiley's conclusions and those from the Cornell studies are in fairly good agreement.

Data from a Western Regional Research Project (Bennion et al., 1956) show some differences: the mix center was the most frequently used center with about 25 percent of trips; the range, sink, and table ranked next, each with slightly more than 15 percent of trips. These differences in importance of centers may be associated with the two menus used, one for breakfast, the other for lunch. Apparently preparation work at the sink was light compared to that at the mix and range. Relationships between centers also varied: between 10 and 15 percent of the trips for the two meals in the laboratory phase of the study were accounted for by each of the following: mix–range; mix–sink; mix–refrigerator; sink–range; and serve–table.

Research at Illinois by McCullough and Farnham (1961a) compared arrangements of centers in conventional kitchens and contemporary kitchens; the latter had a divided range and a dishwasher. The total number of trips for "a menu" planned for four people ranged from 151 to 182—similar to the average number of trips for meals with baking in the Cornell studies. In all types of kitchens studied at Illinois, the sink center was used the most heavily (40 to 47 percent), and the range and mix centers ranked second and third, respectively. They recommended that the sink be centrally located, close to the range and mix centers.

McCullough and Farnham (1961a:12) varied the location of the mix center in the layout and concluded:

"The women did not find much difference in convenience whether the mix center was between the refrigerator and sink or between the sink and range. However, the latter arrangement involved more travel because of the greater distance between mix center and refrigerator.

". . . The sequence of centers found most satisfactory was, from right to left, refrigerator, mix, sink, range, serve, and oven. . . .

". . . *having each center complete in itself, with adequate counter and storage space,* is more important than the sequence."

Many of these conclusions were included in a Small Homes Council circular (Kapple, 1965); McCullough was one of five consultants for the publication.

We are in agreement that the importance of having centers cannot be overlooked, for many movements are made within a center between appliance, storage, and work surface. Centers should be planned. This is a basic step that must precede planning an arrangement of centers—a kitchen layout. A minimum consideration in planning the actual layout or sequence of centers is to place together the pair of centers with the highest frequency of trips. Generally, the sink and range centers should be together. This positioning merits attention equal to that of providing centers.

The nature of work in meal preparation is such that the special facilities of more than one center are generally needed for most menu items. Thus some of the trips between centers represent trips for heat, water, and refrigeration—not trips for work surface and nonperishable, stored items in a well-organized kitchen with *centers*. Other trips, of course, are for inspection. This and other types of dovetailing of work on more than one menu item contribute to relationships between centers and the need for a well-planned sequence.

Results of two more studies are pertinent to the question of arrangement of centers. In both investigations the mix and refrigerator centers were combined and identified as the refrigerator unit (Servel, 1947) or refrigerator (Mundel et al., 1948). As a consequence, data are not comparable to the studies cited previously.

In one of these studies (Mundel et al.) three shapes of arrangements were compared: strips, L, and U. The shape was not a factor in the most important linkage of areas: the most frequent trips were between the sink and range. More time was spent at the sink than at any other unit. One dinner menu and one breakfast menu were prepared.

In contrast to two menus in the preceding study and comparatively few in others, four weeks of menus (28 days, 84 meals) were prepared in the Servel study. One worker stored, prepared, served the food, and did the cleanup during the entire test period. Recommendations for arrangement of units were based on first combining appliance, work, and storage into "units" or, in our terminology, centers. They found that the most trips were made between the refrigerator and range units: "During the 84 test meals, eight trips were made between these units for every six trips between the refrigerator and sink units, and the sink and range units" (p. 11). These results may seem to contradict the greater importance of the travel between the sink and range in the Cornell studies, but the combination of the refrigerator and mix centers into one center—the "refrigerator unit"—provides a partial explanation. The place of work may have been another factor. For example, salad preparation may be performed at the sink, mix, or refrigerator depending upon the type of salad and (if a fresh vegetable salad) the preparation of the ingredients. With some systems of work more than one center may be used for various parts of the salad preparation.

The variation among results of these investigations emphasizes the need for the reader to examine the research results with reference to the test situation. The choice of meals, menus, and amount of preprocessed foods used in the investigations is associated with the results—with the relationships between and among centers and the use of time. With greater variety in these factors the combined results may more closely represent the average trips for meals in homes. If only simple menus and preprocessed foods are used, the results would seem appropriate for that type of situation but not necessarily for more complex ones—menus with more menu items and more home preparation of foods. If the more demanding menus provide the basis of the results, the results would seem more appropriate for the more critical situations in the use of the kitchen. Based on an examination of data and thought about the consequences of these ways of proceeding, some of the Cornell researchers concluded that if the kitchen arrangement is adequate for the more complex but representative situations, it will also be workable for the less demanding ones. We believe that the kitchen arrangement should be suitable for more complex menus if the kitchen arrangement is to help the homemaker function most easily.

Specific Guides for Arranging Centers

Guides are presented here in brief to summarize the practical applications of the findings from the research just reviewed. Since the findings are based on routing of work when there were *centers* in the kitchen, the kitchen planner must first develop the appliance-counter-storage groupings before using the guides.

In kitchens with a one-piece range, the centers were sink, range, mix, refrigerator, china, and dining. When the kitchen had a two-piece range, the range center became the surface-cooking center *and* the oven center.

The guides * are organized with reference to the three principles of arrangement of centers discussed in Chapter 12.

Principle 1. Plan and Locate the Most Important Centers First

The sink center is the most frequently used center in the kitchen. Give it the choice location. Work often starts from this center and goes to

* The guides were presented originally in Steidl (1959, 1962) and were based on the Cornell studies. The guides have been modified where necessary to take into account research done elsewhere.

all others. The range center or the surface-cooking center is second in importance. If much baking is done, the mix center is fairly important. All other centers are used less often. The separate oven and freezer are used least often.

Principle 2. Place Closely Related Centers Together

1. Place the sink and range centers close to each other before locating any other centers together. Trips are frequently made back and forth between these centers to continue work on one job or to dovetail jobs.
2. It is almost as important to place the sink and mix centers together as the sink and range centers when there is a two-piece range and much baking is done. It is fairly important to place the sink and mix centers near each other if there is a one-piece range and much baking.
3. After locating the centers between which an outstanding number of trips are made, consider placing other centers together between which trips may be fairly frequent:

 Sink center and refrigerator center
 Sink center and china center
 Range center and mix center (when there is a one-piece range and much baking)
 Range center and china center
 Mix center and refrigerator center (when there is much baking)
 China center and dining center.

Trips are also fairly frequent between these centers:

 Sink center and dining center
 Range center and dining center.

However, neither of these latter pairs of centers was used as repeatedly at any given point in the work sequence as the 6 preceding pairs. Since ease of work can be increased by placing together those centers used many times in succession, it is generally more important to place together the 6 pairs of centers in the first group listed than the 2 pairs in the second one. All 8 pairs, of course, need to have the two centers in a pair in good relationship to one another.

4. Trips are made occasionally between the range and refrigerator centers and the refrigerator and dining centers. Practically no trips are made between all other pairs of centers, so a criterion other than trips is needed before placing them together. For example, even though there are relatively few trips between the separate oven and the mix centers and the separate oven and surface-cooking centers, the time pressures

of completing some meals may make a difference. If meals are served that require both the separate oven and surface-cooking centers close to serving time, it may be easier to complete the meal preparation when these two centers are fairly close to each other.

5. A frequent pattern of work appears among the sink, mix, and refrigerator centers. After locating the sink and range centers in good relationship to each other, consider having the sink, mix, and refrigerator centers together. This linkage is stronger than that of the range, mix, and refrigerator centers.

Another common pattern of work to plan for involves the sink, china, and dining centers *versus* the range, china, and dining centers. The linkage of the centers within each of these 2 groups is about the same when there is a one-piece range, but the former is stronger when there is a two-piece range.

6. It is not necessary to plan a kitchen layout that locates the refrigerator near the service entrance and the range near the dining area. The factory, assembly-line technique of bringing raw materials in at one door, processing them at a succession of areas, and taking the finished product out at another door cannot be followed in the home kitchen. All centers are used intermittently throughout most of the work period.

Work does not progress steadily from one end of the kitchen layout to the other. Many trips are made back and forth between some pairs of centers before another center is used. The sink center to range center sequence is often repeated 7 or 8 times before another center is needed to continue work. Other sequences are commonly repeated 3 or 4 times and generally include the sink center as one of the pair.

7. If there is a freezer, it should be placed at one end of the layout or in another part of the room. The freezer is not used often during meal preparation and cleanup.

8. If you have a dishwasher, analyze how you or others use a dishwasher and modify the guides accordingly. Practical experience and observation suggest incorporating the dishwasher into the sink center.

Principle 3. Place Centers to Right or Left of Sink Center to Fit the Routing of Work

Certain jobs with china are repetitive and the work can be reduced somewhat if the part of the center to be used is directly accessible from another center. Additional information for locating the china and dining centers can be obtained by analyzing the repetitive tasks of setting the table, clearing the table and getting ready for dishwashing, and storing china to determine the routing of work. Consider the following questions:

1. Where is soiled china first placed when it is brought from the dining table to the sink center? Is the counter to the right or left of the sink or is the sink bowl used?

If used dishes are brought from the table to the sink-left counter, rinsed, and stacked on the right counter, advantages accrue from placing the dining center to the left of the sink rather than the right.

2. As the china and utensils are washed, are they placed to the left or to the right of the sink bowl?

If the work moves from right to left, placement of the china center to the left of the sink center would permit storage of china with a direct continuous routing of the work.

3. Is it more important to have centers located to fit one of these jobs rather than another: setting the table, clearing the table and getting ready for dishwashing, and storing china?

The homemaker may have to decide which jobs to favor if the arrangement of centers cannot fit all three.

A functional kitchen design requires more than planning the arrangement of centers. Good planning of storage and counter space is also important in making work easier. The guides in this section are limited to the arrangement of *centers.*

LOCATION OF THE KITCHEN

The traditional location of the kitchen in the rear of the home has shifted somewhat in recent years to more variable locations with less isolation from other activities and other people. More often the kitchen is now partially separated from a dining area or a family room; the kitchen area may or may not include space with a permanent setup for other task areas.

For aesthetic reasons, some may favor isolating the kitchen from other areas in the home. It is a workplace and not always as tidy as the homemaker desires when company comes. Some of the noise from the equipment used in food preparation and cleanup is unpleasant. Sounds from the electric mixer, the dishwasher, and food-waste disposer are not conducive to rest and relaxation. Also, the odors from some foods are not particularly appealing although others are quite enjoyable. Efficient and quiet ventilating systems may make it possible to control the undesirable spread and lingering of odors and reduce the need for isolation of the kitchen.

In many ways, the kitchen is a hub of activity. The frequent changes from food preparation activities to others, including the homemaker's frequent communication with others during meal preparation, emphasize the importance of choosing an appropriate location for the kitchen (Northeastern Farm Housing Technical Committee, 1959a; Smith, 1962; and Smith, Gerhold, and Kivlin, 1961). Satisfaction of the sociopsychological needs of the homemaker for proximity to others as she works favors less isolation of the kitchen. Children are often in and out of the kitchen even if it does not provide a passageway to another room (Steidl, 1961d).

The characteristics of kitchen work are such that we might logically conclude it is important to key the location of other areas to the kitchen rather than the reverse. Meal preparation and cleanup are recurring activities during a day. Some of the work requires intermittent attention over a fairly long period of time. Other tasks may be carried on intermittently with food preparation tasks, especially care of younger children or conversing with older children, yet much of meal preparation requires a considerable amount of the worker's attention. Such demanding characteristics as the discontinuity of the action and the need to key a number of processes for each menu item emphasize the importance of a good location for the kitchen.

The proximity of the kitchen to the eating area or areas is essential to facilitate transfer of the food to be eaten and the transfer of leftovers and used table settings from the dining area to the kitchen.

The related task of grocery shopping should also be considered in locating the kitchen since supplies are brought into the kitchen from outside the house.

The nature of the work in the kitchen is such that many homemakers consider it clean work and therefore prefer to have only clean jobs within the general work area. Some homemakers do not like to mix the task of washing clothes with food preparation work because the laundry, before washing, is dirty and not pleasant to have around food preparation areas. The variety of activities that may be carried on in the kitchen may help determine the location of this important area.

CHAPTER 14

Guides for Other Areas

The basic information in Chapter 12 for the functional design and arrangement of workplaces can be applied to all areas in the home. The functional design and arrangement of workplaces for care of clothing tasks first receive attention in this chapter, for these tasks are repeated often in many homes and the workplace design is strategic in facilitating task performance. In some homes, the construction of clothing is sufficiently repeated to justify special attention to the workplace.

Application of principles and guides to the design of the components of centers for these areas is selective just as it had to be for kitchen centers.

DESIGN AND ARRANGEMENT OF LAUNDRIES

Providing clean clothes for family members includes getting the clothes clean, drying them, and ironing or pressing them; the fiber and its treatment may make it possible to omit the latter. A number of subtasks may be identified as parts of these processes. A washing and drying center and an ironing center facilitate the accomplishment of the total task. Such centers may be a part of a utility room or any other area chosen by the family.

Washing and Drying Centers

Washing and drying laundry are closely related tasks, sometimes interwoven, sometimes sequenced. We have chosen to discuss the design of these areas together to point up the importance of planning for the drying as well as for the washing tasks.

Washer Design

The body mechanics of loading an automatic washer will be affected by the location and angle of machine opening. The top opening machines require more arm lift while the front opening machines require more bending. A straight front opening requires a larger bend than a slant opening (Mize et al., 1957). The location of the drain opening and agitator control in nonautomatic washers may require a large bend. Loading and unloading machines are tasks of short duration, so is checking for items left in the washer tub.

The size and shape of the opening influence the ease of loading. A smaller and square opening was more difficult than a larger and round opening in one study (Weaver, 1951). Top covers which must be detached during loading require a place for temporary storage.

The carefulness with which the load of laundry must be placed in the machine to assure a balanced operation is greater with top-loading than front-opening machines. Some attention must be given to arranging the load.

The duration of time at the machine, the amount of lifting of wet items, and the amount of precision work vary with automaticity of washer.

Families will want to key the amount of choice for water temperature, water level, cycle time, and interruption of the various cycles to the variability in their wash loads and need for special choices. Man-made fibers and treated fibers require some attention to avoid wrinkling if their characteristics are utilized to eliminate the need for pressing. Automatic dispensing of supplies decreases the demands on the homemaker's short-term memory and the need to measure the supplies. These merits have to be balanced against increased cost and potentially greater repairs.

Dryer Design

The angle of the dryer opening (vertical versus slanted) affects the degree of bend and ease of seeing the interior just as with a clothes washer.

The location of the door hinges should be considered in relation to the washer opening. When the dryer door opens away from the washer, laundry can be transferred more directly to an adjacent dryer. If the door is hinged so that the door drops down, the door may catch items as they are transferred to or from the dryer. A clothes basket may also serve the same purpose.

The size of the dryer door opening, the thickness of the door, and the distance the door opens affect ease of transferring laundry and checking for articles left in the dryer drum. The size and shape of the baffles should not conceal items. The interior light should be strategically placed to light the interior, not the opening.

The level at which the dryer is placed determines the positions the worker uses. The usual location on the floor requires bending or squatting. Raising the dryer 12 inches reduces the bending; the worker can work in an upright position most of the time (Frazier, 1953). The higher level eliminates the use of the dryer surface for folding clean laundry and this should be considered in evaluating the merits of raising a dryer. Frazier suggested elevating the dryer 15 to 20 inches so that a cart or basket would not be bumped as the door was opened or closed. Care would be necessary not to elevate dryers with drop-down doors so high that the worker would have difficulty in reaching into the dryer to grasp items.

Drying lines seem to be an important adjunct for many families who own dryers (Eddins, 1964; Hansen, 1963; Purcell, 1965; and Tustison, 1961). And, of course, drying lines or racks are necessary when a dryer is not owned. Some drying lines or bars close to elbow level help to reduce the amount of reaching; small items do not require much vertical hanging space. Large items, such as full-size bedding, require a line length of 7 to 9 feet; extra-large or king-size bedding requires 9 to 11 feet (Sinden and Johnston, 1959). About 124 feet of lines were required to hang the 32-lb test laundry in the same study.

Work-Surface Design

A work surface is essential for the sorting, pretreating, and stain removal that may precede washing. In practice, the same work surface may function for sorting and folding after drying, sprinkling before ironing, and later hold temporarily the ironed flatwork and other items.

The height of the work surface which is comfortable for sorting may be slightly low for other laundry tasks. Sinden and Johnston found that 27 inches was the maximum table height for sorting and 34 to 38 inches satisfactory for pretreating laundry. When the sorting level was above 27 inches, arm fatigue resulted. Mize et al. (1957) provided a surface just under 36 inches. Women in another study (Nichols, Klopfer, and Wood, 1960) preferred a sorting surface from 32 to 36 inches high for sorting into bins above and below the counter. The worker could control level of arm lift by keeping the height of the sorted heaps low and by placing containers of laundry on a bench beside the work surface rather than on it. Placing the containers on the floor would require bending.

Workers required a table area 3×6 feet to sort a 32-lb laundry (Sinden and Johnston). Sprinkling was less space demanding: 2×3 feet were adequate; however, almost 3×6 feet were used when the women were given free area. A moisture-proof surface was necessary. Some allowance for unsprinkled items was desirable.

Folding, a repetitive task, requires a surface below elbow height so that the worker can arrange items without shoulder and arm lift. Sufficient surface is desirable for concurrently folding, sorting, and stacking items.

Guides for Arrangement

Only a few studies have been located that contribute information useful in developing guides for arrangement of workplaces for washing clothes. Methods of counting trips and movement varied, making it difficult to compare results of studies.

Mize et al. (1957:22) recorded trips made between pieces of equipment during the laundry procedure. They varied the type of washer and availability of dryer and found:

"The two pieces most frequently used together were the washer and soiled clothes bin. . . .

"The washer and dryer were the second most closely related pieces of equipment. In arrangements without dryers, the relationship between the washer and a laundry sink ranked second. Loading and unloading washers and dryers required the majority of the trips made in the laundry procedure."

Trips between pieces of equipment were reported by Sinden and Johnston (1959:24) when a wringer washer was used: "When trips were counted during use of the standardized laundry method with the equipment in various arrangements, it was found that having the supplies and sorting area close to the washer minimized travel. . . ."

Trips, steps, and motions were counted in another study of three arrangements of washing equipment (Eyres and Wiley, 1951). The washing unit was a focal point for much of the activity. The importance of having storage for supplies near the washer was assumed.

Based on these studies and knowledge of the flow of work for washing clothes, the following guides for arrangement of the washing area are suggested:

1. Plan two centers—a preparation center and a washing center. Preparation center: sorting table or sorting area, containers for dirty clothes, and storage for supplies and equipment for pretreating particularly dirty or stained articles. Washing center: washer; storage for washing supplies; laundry tub, tubs, or sink.

2. Place the preparation center and washing center in close proximity to each other.

3. Place the washing center close to the dryer. Provide a cart to transfer clothes from the washer to the drying lines or dryer if it cannot be adjacent to the washer. Place the washer and dryer at right angles, at an angle of 135 degrees, or side-by-side, always with the doors opening away from each other for direct transfer of laundry (Sinden and Johnston, 1959; McCullough, 1957).

4. Consider placing centers and dryer so that the work may progress from right to left for a right-handed person, i.e., from preparation center to washing center to dryer. Some researchers feel that the work progresses in that manner (Eyres and Wiley, 1951; McCullough, 1957).

5. Drying lines or hanging bars located near the washer and dryer become increasingly important as more easy-care fabrics are used. Provision for hanging dripping wet drip-dries near the place they are washed is important. No less urgent is hanging space near the dryer so that items can be hung quickly when they have reached the appropriate stage of dryness and are snatched from the dryer. Without nearby hanging space, the special merits of easy-care fibers and fabrics are sabotaged and pressing is required to remove the wrinkles.

Ironing Centers

The three major parts of a center are important for ironing, even though we may not have space set aside for a permanent center. Besides an ironing board and iron facilities are needed for stacking and hanging ironed items and a storage area for supplies and accessories such as spray starches, dampening equipment, and pressing cloths.

The height of the ironing board is a critical design factor since the worker to work-surface relationship is a continuing one throughout most of the task. Ironing boards which can be adjusted are desirable since small differences in body proportions must be accommodated on an individual basis. Whether the worker stands, sits, or perches on a stool to iron, the level of the board must be sufficiently low to permit at least a 90-degree angle between the forearm and the upper arm. Allowance must be made between elbow height and ironing-board level for the height of the iron.

Just as we must avoid too high a level for an ironing board, we must also avoid too low a level. The level must permit an erect posture during work as well as the proper arm and shoulder positions. There will be a continuing need to teach the essentials of relating the worker's dimensions and work-surface level since homemakers will be making this decision every time they set up the ironing board. Some of the fatigue of ironing can be avoided with a proper work level.

Guides for Arrangement

The total task of ironing may include: collecting articles, sorting, sprinkling and arranging, getting out the iron and ironing board and setting them up, ironing, hanging and folding articles, and storing articles and equipment. Ironing is one part of the task that may be done in more than one location. Few formal studies have been found on which to base guides for the arrangement of the ironing area. Perhaps the portability of the equipment and ease of repositioning it are related to the few studies.

Wilson and Shively (1949) recommended placing the clothes basket, racks, and table within easy reach of the worker.

Sufficient space is needed around the ironing board for handling the articles. Sinden and Johnston (1959) found that a woman's dress and a sheet or tablecloth required the most space to iron. Putting the dress over the end of the board and stepping back to fold the sheet required the greatest space.

Practical guides for arrangements of an area for hand ironing are:

1. Provide sufficient space around the ironing board for handling the articles: 32 inches, working side of board; 8 inches, other side; and 18 inches, pointed end. The total space needed is 4 feet 7 inches wide × 6 feet long.
2. Provide a portable hanging bar that can be positioned to the right or left of the worker, as preferred.
3. Provide a nearby surface on which to place finished articles.

Location of Laundry Centers

The concentration of the washing-drying-ironing tasks into one time span favors the proximity of the three areas for some families. If these tasks are coordinated with action interwoven, the locations for these activities should be nearby so that auditory information about the progress of the tasks can be received and the work kept moving.

The permanency of the setup for each of these tasks may influence the system of work. If a short time span is available for each aspect of the laundry task, the less permanent the setup, the greater the amount of work for getting ready to do the task since it may be repeated more often.

The location for the washing and drying activities should be keyed so that action can be sequenced or alternated. The location for drying indoors versus outdoors provides an important factor in deciding on the location for washing. The weight carried when the clean but wet clothes are transferred to the drying area should be taken into account. The intermittency of the work as one checks for dryness of garments, whether they are dried in a dryer or on lines in or out of the house, also influences the choice of drying location since this task will be alternated with others.

Some advantages of a ground-level location for laundry centers include: the access to outdoor drying area may be more direct; the dirty clothes may be separated better from cleaner tasks; and the noise from operating equipment may be separated from leisure and rest areas.

Some disadvantages of a basement location include the isolation of the worker from other task areas; the isolation from supervision of children; and the carrying to and from the area.

The storage area for the ironing board, iron, racks, and other equipment used in ironing should be related to either the variable or the permanent location for ironing. The proximity of storage and use areas is desirable to facilitate the preparation and termination of the task.

DESIGN AND ARRANGEMENT OF SEWING CENTERS

Sewing is one of the more variable tasks in families with respect to the duration and repetition of the task. When done often, the space for sewing might be set aside in the home so that a temporary setup need not be made every time the task is done. The get-ready time can mount rapidly with little payoff when a given area is arranged for sewing and required soon after for another activity.

Design of Sewing Centers

The design of work surface, storage, and workplace for the sewing machine requires attention if they are to set the stage automatically for easier work. Construction of clothing and household items includes a number of tasks that can be done separately yet must be sequenced. Of the component parts of sewing—layout and cutting out, fitting, machine sewing, hemming, and pressing—layout and cutting out may be done separately from the construction of articles.

Layout and Cutting

The height, length, and depth of the work surface are critical dimensions for layout and cutting activities.

The height of the surface is important when arranging the pattern on the material and cutting it out because the work may continue for a period of time (½ to 2 hours, Wise, 1953) and be backbreaking if the surface is too low. The women found the bed and dining or kitchen tables too low. Johnston, Smith, and Wise (1957:6) described the workers' positions:

"The angle at which the women worked ½ to 2 hours at cutting out gives the reason for the backache. When working on the bed, they often stood bent almost at right angles at the hips. They stood, because sitting on the bed usually got the pattern and material out of line. This bent position had to be maintained for some time in order to reach to the center of the work surface. On the dining or kitchen table the angle was not so great. But necessary reaching required the bent position to be maintained for considerable periods. When working on the floor, the women knelt and bent, stood and bent, and squatted over their work, or occasionally preferred to sit on the floor."

Dining and kitchen tables are normally between 28 and 30 inches high.

The height for the cutting table should be adjusted for the comfort of the individual using it. In four studies, a comfortable height varied: from 35 to 38 inches (Bland, Mize, and Simons, 1959); 34 to 40 inches (Johnston, Smith, and Wise, 1957); 36½ to 39 inches (Slaughter, 1954); and 31 to 43 inches (Wilson, Roberts, and Thayer, 1937). In the first two studies, a 36-inch height for the cutting surface was reasonably comfortable for a majority; the shortest and tallest women worked with some strain. In the last study, the median level was 35 inches.

The length (side-to-side measure) of the work surface for layout and cutting of material is important because sufficient space lessens the amount of handling of material and permits us to lay out the longest pieces of the pattern. A liberal amount of space allows more experimentation in layout. The "minimum" length of 56 inches and "adequate" length of 72 inches were determined by Johnston et al. Bland et al. indicated 48 inches as "limited" and 72 inches as "liberal." Auxiliary space for scissors, pins, and pattern was used with the limited allowance.

Sufficient depth (front-to-back measure) of the work surface is needed to avoid extra handling of materials, but too great a depth causes difficulty in reaching. A depth of 36 inches was adequate for most materials and permitted an easy reach; 48 inches caused difficult reaches (Bland et al.). The maximum feasible depth was 36 inches when enclosed on one side, 60 inches when free standing (Johnston et al.).

Space requirements for the worker must be kept in mind when placing the cutting surface in a room or arrangement. Bland et al. found that 12 to 14 inches of space were needed beyond the edge of the material for the worker to position the scissors and bend the arm to cut. Johnston et al. found that a minimum clearance for the worker of 18 inches on the open sides of the cutting area, and preferably 24 inches, was needed for free movement.

Storage

Possessions for sewing vary widely among homemakers. Frequency of use for each item and occasion for use may vary. Some items are used during construction of garments and need to be accessible during machine stitching; some of the same items are used in mending and sewing by hand. Many of the tools and supplies are small. Shallow compartments with divisions are a design requirement to permit ease in locating, grasping, and replacing items.

Various designs for storage of sewing supplies, tools, and larger items have been developed or space requirements determined: Bevacqua, Gerhold, and Ruef, 1960; Bland, Mize, and Simons, 1959, 1961; Johnston, Smith, and Wise, 1957; McCullough, 1952; and Slaughter, 1954. These references suggest approximate dimensions and the variety of forms that storage space can assume. The basic ideas of flexibility in dividing space and sufficient space to keep together frequently used items are applied.

Sewing Machine

The effect of design of equipment on the working position is dramatically illustrated in Figure 14-1 showing a woman operating a sewing machine in a research laboratory (Johnston, Smith, and Wise, 1957). To prevent back and neck aches from sitting with a curved spine in order to see, the operator should sit directly in front of the needle in the sewing machine. The needle should be 7 or 8 inches from the front table edge to permit good vision in sewing. The duration of machine stitching can be varied but many homemakers like to remain seated at their sewing machine for a substantial period of time. Correct alignment of the needle in front of the worker eliminates the fatigue of maintaining a strained position.

Arrangement for Sewing

Proximity of sewing machine, ironing board, pressing equipment, and storage of supplies and tools is of concern for the task of sewing.

The following guides, based primarily on Bland, Mize, and Simons (1959) and Johnston, Smith, and Wise (1957) are suggested for the arrangement of the sewing area:

1. Provide an auxiliary surface near the sewing machine for temporary placement of supplies, tools, directions, and parts of the article being constructed.
2. Provide some storage space near the sewing machine for supplies and tools.
3. Place the ironing board and pressing equipment near the sewing machine.
4. A U-shaped arrangement, with the sewing machine in the base of the U, appears to have more advantages than other shapes of arrangements.

The location of a sewing workroom might be keyed to a laundry-area location or at least the ironing center so that it is not necessary to

Seated to right of work; heights and clearances not adjusted to worker.

Seated in front of work, equipment adjusted to worker.

Figure 14-1. Posture of worker operating commercial sewing equipment compared with posture of same worker operating a laboratory adjusted model. (*Source.* Johnston, Smith, and Wise, 1957, p. 17.)

duplicate facilities or to transport some of the ironing and pressing equipment or the sewing great distances.

SELECTED STORAGE AREAS

Functionally designed storage facilities will expedite the work of getting and replacing cleaning supplies, tools, and equipment as well as clothing and household linens. The location of the storage areas near the place of use of items will help the work to flow more smoohtly.

A number of investigations provide suggestions for space dimensions and design features for storage of cleaning supplies, tools, and equipment, including Bevacqua, Gerhold, Ruef 1960), Hinson and Mize (1963), and McCullough (1952, 1953). Adequate space for cleaning activities also eases the work. Some allowances were included in Table 12-2, based on the work of McCullough et al. (1962); further discussion can be found in Smith and Johnston (1959).

Specific dimensions for design of household linen storage can be obtained from Woolrich and Herrington (1956) and Woolrich, White, and Richards (1955a, b). Design requirements for clothing storage are suggested in Philson (1960) and McCullough (1952), and in discussions of storage walls such as in Kapple (1953) and Philson (1963).

In designing storage facilities for these and other areas in the home and away from home, the principles and guides in Chapter 12 can be used to advantage.

PART IV

Procedures for Designing Work

CHAPTER 15

Motion Study

At times there is a need for change in work methods and the change should be directed toward improvement. The traditional approach to improving work methods has been through the techniques of motion study adapted from those developed largely by Frank and Lillian Gilbreth in the early part of this century for use in industry.

Motion-study techniques consist primarily of observing a specific worker, recording his motions in small steps or elements, and then analyzing the record to find and to eliminate the unnecessary motions. The observation may be made directly by a person who writes the elements of the process while it is going on, or the observation may be recorded by a motion-picture camera and the film record later analyzed by paper and pencil techniques. The basic ideas of industrial motion study were taken over directly for application to the work of the home by such leaders as Christine Frederick and Mrs. Gilbreth.

It is impossible to gauge the extent to which the techniques of motion study have influenced the work of the home both through developments in industry and through educational programs for home economists and homemakers. Even when the attempts to apply motion study to the work of the home have been superficial and inaccurate, they have sometimes been surprisingly effective in producing insights and creative ideas for improving work methods and equipment for the home. However, the limitations of motion study for use in the home have not always been recognized. Nor have home-management specialists or industrial engineers raised, until recently, some long-overdue questions about the validity of the principles and practices of motion study. It is important to evaluate carefully the motion-study techniques and their application to the work of the home and be acquainted with some of the research that has been done to evaluate the techniques.

MOTION-STUDY TECHNIQUES

Barnes (1963:4) defines motion and time study as "the systematic study of work systems with the purposes of (1) developing the preferred system and method . . . ; (2) standardizing this system and method; (3) determining the time required by a qualified and properly trained person working at a normal pace to do a specific task or operation; and (4) assisting in training the worker in the preferred method." Part 1 of this definition, he points out, is sometimes called methods design and part 3, work measurement. The techniques used for part 1, commonly known as motion-study techniques, are familiar to many home economists because they have often been applied to the work of the home.

There is a wide range in the details recorded and the complexity of the analysis in the different techniques used for the study of motion. There are relatively overall and informal studies as in simple questioning, requiring no equipment but an inquiring frame of mind. On the other end of the scale are simo charts which can be done only by an extremely detailed analysis of motion-picture film.

Some of the less formal and less detailed motion-study techniques can reasonably be used for work-methods improvement in the home. The more complex, detailed, and expensive techniques have very little application to the work of the home for several reasons. In industry, the use of any motion-study technique is justified by the possibility for savings. In the home, appreciable savings either of time or effort are not often a possible result of a study of motions by untrained and unskilled persons. The work of the home provides few areas where formal motion study can reasonably be applied except as a research technique.

Questioning

One of the standard, less technical motion-study techniques which may be applied informally to work problems of the home is called simply "questioning." It is often used as an aid in analyzing process charts and other more formal motion-study records; it is also useful by itself.

We may use the questions either to survey the overall job of homemaking or specific aspects of it.

Barnes (1963:60) asks the questions in the following way for the industrial situation and suggests that they be asked of every item on the flow diagram or process chart.

"1. *What* is done? What is the purpose of the operation? *Why* should it be done? What would happen if it were not done? . . .

"2. *Who* does the work? *Why* does this person do it? Who could do it better? Can changes be made to permit a person with less skill and training to do the work?

"3. *Where* is the work done? *Why* is it done there? Could it be done somewhere else more economically?

"4. *When* is the work done? *Why* should it be done then? Would it be better to do it at some other time?

"5. *How* is the work done? *Why* is it done this way? . . ."

The questions can be stimulating if they are directed either toward task areas or toward a specific task. One phase of laundering, such as handling clothes after they finish in the dryer, might be selected for study, one method of handling outlined and then subjected to questioning. The questions can also be useful for a general, overall questioning of housework practices.

When we begin to focus on an aspect of the work of the home with a questioning mind, asking such questions as Why? or Where? or When? the results are usually rewarding. Tasks that were previously thought to be necessary may seem less important. The questions serve to guide the thinking of a homemaker who has need to reduce the workload.

Questioning the How of a task may be approached by way of the concept of classes of change. Mundel (1960) proposed that simplification could be classified into five groups according to the origin of the change. Gross and Crandall (1963) condensed these into three: Class I, change originating in the activity of the worker; Class II, change originating in work space and tools; Class III, change originating in the product. These classes of change can serve as the basis for study and simplification of a task of narrow definition, having hot rolls for a meal, or of a task of broad definition, cleaning a room.

Task Breakdown

Another motion-study technique which was developed for industry provides a nontechnical approach to work-methods improvement in the home. The technique consists of listing in order the steps by which a task is now done. Each step is then examined by applying these 4 precepts commonly found in textbooks of industrial engineering.

1. Eliminate all unnecessary work.
2. Combine the operations or elements.
3. Change the sequence of operations.
4. Simplify the necessary operations.

This could be a useful way of considering how to simplify tasks in conjunction with the questioning technique. It is applicable to those tasks that are made up of a series of motions, some of them repetitive, such as dishwashing by hand or by machine. The tasks or series of tasks involved in caring for laundered articles after they are dry, including folding, ironing, and putting away, might be simplified by application of these guides. Possibilities for an improved work method come to mind as we look at the entire series of motions for the task with the purpose of trying to eliminate, combine, change sequence, and simplify.

Process Charts

A process chart is a method of recording all of the steps in a process in order to study how it is being done and to reveal possible ways to develop a better method. The object is to study the chart made of the present practice to find unnecessary elements; then to chart a proposed new method to evaluate how well the unnecessary elements have been eliminated. Concise description of the steps of the process is a requirement. Suppose we wish to study the method of clearing the table after a meal. It is necessary to set limits to the task to be charted; we cannot chart "table clearing" in general but for specific situations such as "clearing the table, breakfast for four." During new trials we must use the same dishes; that is, keep the materials used constant for all trials.

A process chart for even this brief task can become quite lengthy and difficult to analyze. The Gilbreths originated a series of symbols to help in analyzing and categorizing the steps in the process chart in order to more quickly reveal weaknesses in the method and needs for improvement. The 5 categories are: operation, transportation, inspection, delay, and storage. The present set of 5 symbols accepted as standard by the American Society of Mechanical Engineers was abbreviated from the original longer set of the Gilbreths. A form can be set up and duplicated in quantity to facilitate the recording. Templates may be purchased for making the symbols.

Evaluation of Process Charts

Process charting can serve as an effective device for focusing attention on the process and for stimulating ideas for simplifying it. For the tasks of the home the chief value of the process chart is that it focuses on motion so that we can apply some of the work simplification questions to work methods and can become beneficially "motion-conscious."

Beyond that, we soon discover that making a process chart is lengthy and time-consuming. The amount of detail is too great to serve the purposes of the homemaker. The device has often been used in a research study to good advantage but not often by individual homemakers to simplify their work.

If several untrained people observe a task performance and individually make process charts of it, the charts may be found to differ widely. There is much room for judgment in setting down the elements of the process, and the results obtained by untrained and unskilled chart makers are not likely to agree.

Trip-Frequency Diagram or Pathway Chart

Another common motion study technique that is useful where "travel" or "trips" are of practical concern is the trip-frequency diagram or pathway chart, called in industry "flow diagram." As the name implies this is a chart used for the purpose of studying the transportation elements of the process chart.

The first step is to make a floor plan of the area under study. This should be drawn to scale or at least with reasonably true proportions. This may be done with paper and pencil, on a chalk board, or prepared for a flannel board. The usual method or present practice for the activity is then observed and all transportations or trips drawn as lines on the diagram or followed with the string and pin method on the flannel board or tack board. As the recording of trips progresses, unnecessary ones show up quickly and ways to eliminate many of them occur to any group. Alternate methods of performing the activity may then be suggested and plotted on the duplicate drawing of the floor plan for comparison with the original pathway chart.

Evaluation of Trip-Frequency Charts

When travel in the form of movement by walking comprises a large part of a task, then the pathway chart may be a useful tool for simplifying it. Trips that are excessive in number and unorganized as to purpose often represent unnecessary time and confusion costs of work. Pathway charts can help to reduce travel from room to room as in housecleaning, back and forth across the kitchen in meal preparation, or around the bed for bedmaking.

A study of bedmaking by Muse (1949) illustrates a situation where the number of trips and the distance traveled are excessive and can be reduced by focusing on the method of work. This study illustrates another important point, that a method with the minimum amount of walking and time spent is not satisfactory if it involves loss of some ease and convenience in the operations aspect of the task. Of the methods devised to reduce the excessive walking in the bedmaking study, the one that was satisfactory to all three of the Muse subjects was not the lowest in the distance walked or time required. One method that was near the lowest in distance and time was unsatisfactory to two of the three women. The reason for dissatisfaction was the difficulty in handling the bottom sheet with other covers on top.

This observation from the Muse study illustrates that the focus on trips should not eliminate attention to other elements of the task. In view of the complexity of household work and the presence of the family, other factors may outweigh walking as a cost of household work. Other costs may be substituted as we reduce the walking. It is often suggested that we reduce the number of trips by remembering to get several items instead of one on one trip. This is a good principle if it does not require too close attention to the task as a substitute cost of work. If the job is one that goes on with small children playing near or during conversation with another member of the family, thinking too closely about the task may not be a feasible or desirable alternative to walking. Even the homemaker who has a great need to reduce the physical costs of work may not readily substitute close attention to the task for extra walking.

When the trip-frequency chart can be used to help develop an improved permanent arrangement, then it can be of practical use and an interesting project. But even here, there is danger of over simplification. An entire kitchen cannot justifiably be rearranged on the basis of charting an observation of baking a cake or even of preparing an entire menu. If the results of trip-frequency charts are to be used in determining permanent arrangement of a kitchen, they must be based on a wide range of activities in the kitchen. Even then they serve as guides, not rules. The trip-frequency chart, applicable in industry where a manufacturing process repeatedly follows a pathway, is less applicable in the home. Even though some operations are repeated often, the variability of menus and other uses of the work area must be taken into account. The pathway chart does, however, give a graphic presentation of unnecessary trips and can help to improve organization for a work method.

Activity Analysis: Worker-Equipment Chart

A further refinement of the process chart for the industrial work situation is the activity analysis which is the process chart plotted against a time scale. This has been used to advantage when men and machinery interact, resulting in a motion-study technique called the man and machine chart which we call "worker-equipment chart." This permits an analysis of the productive and the idle phases of both the man and the machine.

With this technique, operations are analyzed into three main steps: get ready, do, and put away or clean up. This kind of analysis has proved useful for the work of the home in giving a clearer picture of a complex task such as meal preparation. In a simplified form, the technique is useful to homemakers either for pointing to simplified use of major equipment or in evaluating the use of small tools. Knowledge of the proportion of time or motion that goes into the get ready and the put away, in one sense the unproductive steps in any task, can lead to a satisfactory simplification of a task using major equipment.

The technique can be used also to help evaluate small tools that take up drawer and cupboard space. Does the time and effort involved in get ready and cleanup for an onion chopper indicate that a knife is a more useful tool for chopping one onion? Or does the rubber spatula appear to be as easy to use as the electric beater for some brief mixing jobs, such as prepared-mix brownies, when the get ready and the cleanup are compared to the do for using both types of equipment?

Operation Analysis: Right-Hand and Left-Hand Chart

A further refinement of the process chart is the operation analysis or right-hand and left-hand chart. The application of this technique to the work of the home is even more limited than the ones previously discussed. Since this involves the study of both hands performing a manual operation, it will probably be a detailed study of a part of a larger operation. The number of women who would benefit from performing such a detailed study is limited. Since the part of a task subjected to right-hand and left-hand analysis would have to be a stationary one, performed on a specific surface, and would need to be a short-cycle repetitive task, the number of applications to housework are extremely limited. If the chart is made by simple observation of a worker it is subject to the same inaccuracy and variations in judgment as the process chart.

RESEARCH TECHNIQUES FOR ANALYZING WORK METHOD

Micromotion and memomotion study provide a means for detailed and accurate analysis of work using the motion-picture camera. Both are too detailed and too expensive to be of use in an educational program for homemakers. Both have had some use in research in home economics.

Micromotion

The record of an activity is made by a motion-picture camera and is therefore subject to analysis by more than one person and to rechecking. It provides a method for accurate timing of an activity.

Both the filming of the activity and the analysis of the film are time-consuming and expensive. Because there are so few household tasks that warrant or even lend themselves to this kind of detailed study, it is not a useful technique for work study in the home.

It was for this kind of analysis that the Gilbreths developed their method of classifying fundamental hand motions into therbligs. Analysis of an activity by means of therbligs results in describing the detailed motions of both hands into 17 categories such as grasp, search, select, hold, and transport empty. For a fuller explanation of this technique and its terminology the reader should refer to a textbook in industrial engineering.

A simultaneous motion chart or simo chart is a right-hand and left-hand chart plotted against a time scale and made from micromotion filming. An example of this chart made of a household activity, "transferring eggs from box to tray" may be seen in Gilbreth, Thomas, and Clymer (1954, 1959).

Memomotion

Mundel adapted the motion-picture technique to the study of larger operations for which fine analysis is not needed. He developed a drive for the motion-picture camera which can be adjusted to expose the film at 60 or 100 frames per minute instead of 960 (Mundel, 1960). This permits a coarser analysis of the activity than can be made by micromotion, with a saving on film used and on time for analysis. After the motion pictures have been made with the memomotion drive, the film can be analyzed according to the purposes of the research. This form of motion study has been used in home economics research for complex tasks such as meal preparation.*

SIGNIFICANCE OF MOTION STUDY FOR THE WORK IN THE HOME

Motion study, as the name implies, is limited to the study of motions during work. The special techniques were devised to aid in categorizing and counting motions. The outcome of a motion study is usually evaluated on the basis of the degree of success in reducing the number of motions required for the task. The assumption that a method of work

* Description and evaluation of the use of memomotion for home economics research is given in Steidl (1963c). Other references to the use of this technique in home economics research may be found in Bennion et al. (1956); Bland et al. (1959); Bratton (1958, 1959b); Grady (1962, 1964); Johnston et al. (1957); Mize (1952); Mize et al. (1957); Steidl (1957, 1960, 1961a, 1961b, 1961d).

requiring fewer motions is the easier method, or even that it is the faster method, is probably not always valid. Evidence is accumulating that the assumption may not be valid in regard to industrial work and is probably even less valid for homemaking tasks. The reader will find the evidence in the next chapter.

It is possible that the study of the number of motions can sometimes be productive for improving work methods for household work. Excessive motions, whether in operations or transportations, are likely to cause confusion and disorganization. A certain amount of reduction of both of these categories of motion may help to relieve confusion and smooth the organization of the work. But it is important in home management that we do not focus on counting motions to the point of neglecting other significant costs of work. Often, especially in the home, not fewer motions but easier motions may constitute an improved method. A shorter work cycle does not necessarily mean an easier or more comfortable work method, an objective more likely to be desired by homemakers than speed.

Even in the industrial situation, the use of the motion-study charts and diagrams to analyze problems is questioned by some engineers. In the opinion of Krick (1962:115), "The special diagrammatic techniques and associated symbolic language . . . are sometimes useful in analysis of methods problems, but not as often and not as useful as textbooks in this field have traditionally led readers to believe." Motion study can be allowed to assume too much importance in the analysis of work problems. The view is then too narrow and may result in overlooking the crucial aspects of the problem.

Sometimes, instead of depending on motion study even in the industrial situation, Krick suggests that it may be better to begin with a verbal statement of the present situation, the kind of situation that is desired to replace it, and a listing of the limitations or restrictions imposed by economic or other considerations.

This is certainly true concerning the work of the home. Assume that a homemaker has a laundry problem which she states in these terms: "I am annoyed with having piles of soiled and clean laundry taking up space in the kitchen all day when I wash clothes. The washer and dryer are located in the kitchen. The house is an open plan, with the kitchen clearly visible from the dining room. I prefer to let laundry accumulate and wash 4 or 5 loads in one day rather than to scatter 1 or 2 loads a day through the week. With small children at home and interruptions from many other sources, the piles of soiled or clean laundry are sometimes in the way and causing unsightly clutter even into the dinner hour. This annoys my husband." She would have had to be aware of the problem in some such terms as this before she would have asked for help or have set herself the project of improving the work method.

The solution to this kind of a problem is not to be found by means of motion study. Rather, the homemaker would need to list the limitations and restrictions, such as whether or not she could change her preference for several loads in one day, whether or not the laundry area could be moved, if any money or how much would be available for making changes. With such a statement of the problems and limitations, it could then be determined if any motion analysis chart or diagram would contribute to a further understanding of the problem and testing of alternative solutions. Motion study might be found to make no contribution at all to this kind of problem.

The value of motion-study techniques in our field is mainly as a means of graphic presentation of alternative methods and of stimulating creativity in work-methods improvement. In the class room or with a group of homemakers, where the task to be studied is of necessity simple and brief, the charting serves largely as a device to focus thinking on the method of work. The weakness in "present practice" and suggestions for improvements come immediately from any alert group without the work of analyzing the chart and adding up results. Seldom is formal motion study used in an individual's home to analyze problems and solutions as it has been used in factories.

Considering the nature of work in the modern home and its significant human costs, improved body mechanics is more to be worked for and educated for than the elimination of small units of motions. The quality or kind of motion can be more significant for fatigue reduction than the number of motions.

The informal techniques of questioning and task breakdown can provide an approach that stimulates ideas for simplifying work method. A process chart, while more detailed and time-consuming than the first two, can quickly provide insights into weaknesses in work method based on common sense. It can show ways to bring order out of chaos when chaos is the problem.

In short, motion study has a place in work study for the home, but it must not occupy too large a part of the study or be depended upon for the miracles that have sometimes been ascribed to it.

CHAPTER 16

A Critique of Motion-Economy Principles

In conjunction with the methods for study of motion described in the previous chapter, industrial engineers have commonly used a set of suggestions for improving motion, usually called principles of motion economy. These have served both as criteria for evaluating the elements of the original method of work and as guides for designing an improved method. Often these principles have been depended upon as guides for the improvement of work methods in the home, with or without the use of formal motion study techniques such as process charts.

TRADITIONAL MOTION-ECONOMY PRINCIPLES

A statement of the principles of motion economy in Table 16-1 is presented here in the version from Barnes (1958:214). A thoughtful reading of this partial list of principles will suggest a number of possibilities for improving homemakers' work methods. In introducing his list of principles, Barnes says that not all the principles presented are of equal importance nor does his discussion of them include all the factors which enter into the determination of better methods for doing work.

Use Both Hands

Statements 1, 2, and 3 in Barnes' list are often condensed for homemakers simply to "make both hands work for you." It it true that balanced use of both hands promotes good body mechanics and reduces strain, but the application to the work in the home is limited. The stationary workplace for short-cycle, repetitive tasks, for which these 3 principles are most effective, is not often found in a home.

To "make both hands work" effectively means to work productively

Table 16-1. Principles of Motion Economy: A Check Sheet for Motion Economy and Fatigue Reduction

Use of the Human Body

1. The two hands should begin as well as complete their motions at the same time.
2. The two hands should not be idle at the same time except during rest periods.
3. Motions of the arms should be made in opposite and symmetrical directions, and should be made simultaneously.
4. Hand motions should be confined to the lowest classification with which it is possible to perform the work satisfactorily.
5. Momentum should be employed to assist the worker wherever possible, and it should be reduced to a minimum if it must be overcome by muscular effort.
6. Smooth continuous motions of the hands are preferable to zigzag motions or straight-line motions involving sudden and sharp changes in direction.
7. Ballistic movements are faster, easier, and more accurate than restricted (fixation) or "controlled" movements.
8. Rhythm is essential to the smooth and automatic performance of an operation, and the work should be arranged to permit easy and natural rhythm wherever possible.

Arrangement of the Work Place

9. There should be a definite and fixed place for all tools and materials.
10. Tools, materials, and controls should be located close in and directly in front of the operator.
11. Gravity feed bins and containers should be used to deliver material close to the point of use.
12. Drop deliveries should be used wherever possible.
13. Materials and tools should be located to permit the best sequence of motions.
14. Provisions should be made for adequate conditions for seeing. Good illumination is the first requirement for satisfactory visual perception.
15. The height of the work place and the chair should preferably be arranged so that alternate sitting and standing at work are easily possible.
16. A chair of the type and height to permit good posture should be provided for every worker.

not unproductively at such work as *holding*. To use two hands to dust, for example, means to use two dust cloths or mitts so that both hands are actively dusting. One difficulty is that small items cannot be moved safely with mitts. A second dust cloth may get left behind when it is necessary to hold or to move items, which is usually a part of the job. If the items dusted were more standardized the two-hand method would be more satisfactory. Even in the kitchen where some work stations are more or less permanent, but often have multiple uses, the homemaker must have previously provided for the *hold* in order to use both hands productively.

In some cases a task that can utilize both hands is too short term to be worth the forethought required to have eliminated the need for holding with one hand. The two-hand principle may be logically applied when cycles of action are repeated and the duration and the quantity of work at one spot make the time for special arrangement worthwhile.

The claims that have been made for two-hand work even in industry may at times have been too extravagant. Studies that have been made in both industrial and marketing work indicate that the time for the total work cycle is longer for a two-hand operation than for a one-hand operation. Barnes (1963) reports that total cycle time was shortest for right hand only, next for left hand only, and longest when both hands were used—30 to 40 percent more time than for the right hand only. He points out, however, that since two cycles were performed simultaneously, more work was accomplished with the two hands in a given time period.

Smith and Smith (1962:50) report studies made by Block to analyze the effects of two hands used simultaneously. "Careful measurement showed that symmetrical two-handed cycles of motion required more time per cycle (not necessarily more time per unit of work output) than an equivalent one-handed cycle. Also, the percentage increase in time of two-handed cycles was dependent on the complexity of the motions." Smith and Smith (p. 51) conclude that "the rule that two-handed motions are more efficient cannot be accepted as generally true, but must be tested for each different task and each situation."

For several reasons the use of two hands together is not often effective for homemaking tasks. The homemaker seldom concentrates on one highly patterned operation for hours at a time or even for quarter hours at a time. The work of the home is extremely varied and generally less structured than work in industry or marketing. For most of the homemaking tasks the visual field is both wide and complex and so the therbligs "search" and "select" are too important to permit sufficient attention to both hands simultaneously. For tasks that are characteristically of short duration, the positioning of the two hands seldom becomes automatic. The result is that trying to position both hands causes a break in the rhythm of the work that may wipe out possible gains from two-hand work.

Confine Hand Motions to Lowest Classification Possible

The fourth motion-economy principle in Barnes' listing, to the effect that hand motions should be confined to the lowest classification possible, is weakened by all of the necessary qualifications. The classification of hand motions as given by Barnes (1963:235) is:

"1. Finger motions.
"2. Motions involving fingers and wrist.
"3. Motions involving fingers, wrist, and forearm.
"4. Motions involving fingers, wrist, forearm, and upper arm.
"5. Motions involving fingers, wrist, forearm, upper arm, and shoulder."

In introducing this classification, Barnes says, "The lowest classification, which is shown first, usually requires the least amount of time and effort and probably produces the least fatigue." He also points out that "As desirable as it may be to keep hand motions as short as possible, it is incorrect to assume that finger motions are less fatiguing than motions of the forearm." These two statements seem contradictory and cast doubt on the validity of the principle.

In discussing this so-called principle, Ryan and Smith (1954) question its validity since studies have shown that finger motions are not likely to be superior in speed or ease to forearm movements in rapid tapping. They point out, however, that if a movement is not repeated often it is better to perform it with a flick of the finger if that is sufficient.

With all the need to hedge this statement with qualifications the wonder is that it continues to be carried along in its position of importance in the basic principles. Even in industry it appears to be better ignored than practiced. In the work of the home the whole range of the classifications hardly applies. The choice between motions involving fingers, wrist, and forearm (No. 3) and those involving fingers, wrist, forearm, and upper arm (No. 4) appears to have some value in the application of the normal work curve to storage and counter areas.

In his discussion of this fourth principle, Barnes (p. 237) concludes: "All evidence seems to show that the forearm is the most desirable member to use for light work, and that in highly repetitive work motions about the wrist and elbow are in all respects superior to those of the fingers or shoulders." Then why do we continue to list this principle in terms of the lowest classification of motions? Why not just drop the old statement and simply say, "The forearm is the most desirable member to use for light work"?

Principles Concerned with Quality of Motion

Principles 5, 6, 7, and 8 in the Barnes listing, having to do with the quality of motion, are important aspects of good body mechanics and have a direct relation to the cost of work to the worker. The use of momentum and smooth, continuous motion, ballistic movements where practical, and the values of rhythmic work are all applicable to the work of the home as well as of industry. These are discussed in Part I.

Location of Tools and Materials

Principle 9 regarding a definite and fixed place for all tools and materials does have widespread application to the work of the homemaker. It is basic to the concept of activity centers and to the design of the workplace. Widespread and consistent application of this principle would contribute to improving the organization for work and to smooth performance of family nonwork activities. Its chief limitation is the fact that families are made up of people. The definite and fixed place for tools can be provided but there remains the training to inform all family members of all fixed places for all the tools for all the activities and cooperation in the replacement of all tools to their places after use. This tends to reduce the extent to which this principle is applied in some families. The degree of detailed application must be keyed to the inclination to orderliness not only of the homemaker but of all the helpers. The principle is a good one but it sometimes works out to less than perfection if the home is to remain a home.

Principle 10, the location of tools, materials, and controls, has contributed to successful design for functional storage and at times could be more thoughtfully applied to the design of major appliances. Suggestions are in Part III.

Principle 13, relative to location of tools to permit the best sequence of motions, implies a fixed and relatively unchanging work station and task. This principle, too, has been one of the guides in the development of functional storage design. It can serve also as a guide when setting up the method for routine tasks, such as dishwashing and ironing.

Other Motion-Economy Principles

Principles 11 and 12, concerning gravity feed bins and drop deliveries, has application to the work in the home which is limited largely to clothes chutes and flour bins. These principles have not been fruitful much beyond this in contributing ideas for improving work methods in the home.

Principles 14, 15, and 16 are quite broad and are treated elsewhere in this book. The body of knowledge on heights of workplaces and chairs is extensive and requires a grasp of background information if it is to be applied successfully. The admonition to provide suitable work heights requires the study of available information to the point of understanding. Information relating to the design of the workplace for sitting and standing to work is discussed in Part I.

The third category of principles from Barnes, concerning design of tools and equipment, applies almost exclusively to industrial work and is not discussed here.)

THE NEED FOR RESEARCH

Adherence to the principles of motion economy for so many years by industrial engineers provides an example of the strength of tradition and its blinding effects. The originators of tradition are often creatively filling a need. Following tradition without questioning shows a lack of creativity in the followers. The Gilbreths and Frederick Taylor originated a point of view and methods for implementing it at a time when there was little to build on. The Gilbreths' early work was in the first two decades of this century; the degree of innovation was great and their success in bringing about improvements in work methods was unquestionable. The need for a healthy criticism of the techniques was not apparent to the industrial engineers in those days. Thus the motion-study techniques and the motion-economy principles became firmly entrenched. Their contribution to the progress of American industry is undeniable. Their success in filling a need, along with the almost unnoticed commonsense exceptions made by practitioners over the years, operated to obscure the need for research to test the value of the principles and precepts.

Barnes (1963:221), one of the influential and respected motion and time study engineers, pointed out this need: "Additional research which will enlarge our knowledge of the inherent capacities of the various members of the human body is greatly needed. There is much yet to be done in determining the fundamental laws which permit the maximum amount of productive effort with a minimum of fatigue." Industrial engineers for the most part have not been leaders in subjecting the principles to the test of controlled research. Even when their experience and common sense has shown a given principle to be greater in its limitations than in its application there has been a hesitation to tamper with the time-honored statement of the principles. (Witness the instruction to confine hand motions to the lowest classification.)

Even though research studies have been all too few, nevertheless there have been some significant contributions from the field of industrial engineering, from applied psychology, and from the newer interdisciplinary field of ergonomics, some of which have been mentioned in the preceding pages.

OTHER STATEMENTS OF MOTION-ECONOMY PRINCIPLES

Most authors of motion and time study books have their own way of stating and of grouping motion-economy principles such as those quoted from Barnes in the preceding section. Some of the differences are superficial only, some are real. Some are based on the experience of the individual author, some take into account the results of available research.

Shaw (1960:122) proposed that instead of principles of motion economy, characteristics of easy movement seemed to her more appropriate. She made a thorough revision of the "maxims" given by the Gilbreths and other authors and reduced the material to these five statements:

"1. Movements should be simultaneous.
"2. Movements should be symmetrical.
"3. Movements should be natural.
"4. The path of the movement should be rhythmical.
"5. The path of the movement should be habitual."

She suggests that the longer lists of the Gilbreths and of Barnes do not contradict this list but are elaborations of it. Of this short list, she says, "characteristics are few enough to be considered at once and sufficiently general to be applicable in all circumstances" (p. 122). It seems, too, that here there is something of a change away from the emphasis on mechanical classification and counting of motions and toward the emphasis on an individual's feeling of ease. Ease of work and the comfort of habitual motions are also likely to be important in the home where the worker and the one who designs the work method are one and the same person.

Krick (1962:133) gives his own set of principles which serves as guides to achieving the best work methods. These principles he gives in three groupings similar to those for the Barnes list. The categories are (a) preferred work procedure, (b) preferred workstation layout, and (c) preferred equipment design.

Under category (a), preferred work procedure, two principles should be mentioned as incorporating new thought that is useful for our purposes. The first is his statement, "The sequence of motions should facilitate learning and rhythm . . ." (p. 133). To speed up the learning of a process, to acquire skill to perform smoothly, may be one of the most direct routes to reducing the human costs of housework that should result from a focus on motion.

A second principle in Krick's list is of interest because it bypasses the old admonition to confine hand motions to the lowest classification and says flatly "Transports should be performed by natural forearm motion, with a minimum of upper arm movement" (p. 134).

It has usually been the practice in home management to restate and condense the motion-economy principles of the industrial engineer in order to simplify them for the use of homemakers. The validity of the statements in the context in which they are presented in industrial engineering often has not been questioned. In recent years, serious questions are arising about the validity of the principles, even to the extent of questioning the theoretical assumptions on which the field of motion study has been based.

FALLACIES IN THE ASSUMPTIONS UNDERLYING MOTION STUDY

The basic assumptions underlying the analysis of "fundamental hand motions" are now seriously open to question. It is well to mention this here, even though the detailed analysis into therbligs is seldom used to study the work of the home. The one assumption, basic to all others in motion-study theory, is that therbligs represent truly elemental units of hand motions and can be separated, reshuffled, and put together at will, in order to design what the Gilbreths called the "one best way." This leads to the assumption that when the elements (therbligs) are put together in the optimum way, this will be the fastest way. Information from controlled studies, especially from the field of applied psychology, is beginning to accumulate to indicate that the various elements are not independent, but are interacting, and that the method requiring the fewest motions is not necessarily the fastest or easiest, even for industrial work.

Smith and Smith (1962:42) review one study which was planned to test "whether travel time varied as a function of the pattern of manipulation." The experiment was set up to vary the pattern of manipulative motions but to keep constant the travel distances. They found that there was a variation in travel time, even though the distance remained the same, when the manipulative movements were varied. Smith and Smith conclude that "The variation in travel time was due to interaction of the travel movement with other components of the pattern . . ." (p. 43).

Hall (1956) studied internal relations of elemental motions within a task for the time required for various therbligs of an industrial type task. He found both positive and negative correlations between times for the various therbligs; 11 of the coefficients out of 66 possible pairings equalled or exceeded the 5 percent level of significance. Hall concluded that his results provided evidence that elements within the task are related and that the removal of one may be reflected in other elements.

Simon (1956) studied the duration of movement components as a function of the focus of a perceptual cue. The procedure for the repetitive task involved distinguishing silver from copper pins to be inserted into a plate. He concluded that "The present results show conclusively that variations in the perceptual requirements of one part of the work cycle significantly affect the durations of other parts of the cycle" (p. 300).

Ryan and Smith (1954:329) raise the question of work movements being independent elements of the work pattern. They doubt the assumption that:

". . . a movement which proves very rapid as part of the long, sweeping curved motion path which one worker uses will combine satisfactorily with a succeeding motion which also proved fast, but as a part of a series of short, jerky, rhythmical motions which another worker has adopted. . . . The synthetic combinations, in fact, sometimes proved awkward and workers preferred to modify them into more natural patterns."

Smith and Smith (1962:51) review a study for which an experiment was set up to test the assumption that time per movement is less after the therblig pattern has been improved by simplifying the motion patterns. They conclude that "the duration of a movement is not necessarily decreased by reducing the number of possible movements in the overall task pattern."

With such serious questions regarding the use of traditional motion study and motion economy principles for industrial work for which they were designed, their use for the work in the home is doubtful indeed.

CHAPTER 17

The Design of Work Methods

A broad concept of design of work, going beyond the design of physical equipment and space, is possible if we look at all kinds of work cost and at the entire job of the homemaker. It is true that the costs of work to the worker are influenced greatly by the physical equipment and the arrangement of the workplace. There is also a part of the work that is relatively independent of a stationary workplace and partially independent of manufactured appliances. But whether the work is closely dependent on a place or is relatively independent of specific areas, the method of work deserves attention. Work method, as well as the equipment and the workplace, can be designed consciously to avoid or to minimize those costs which are known to be significant. This will require less emphasis on reducing the number and distance of motions and on energy expenditure than has sometimes prevailed.

If we deemphasize motion study and energy expenditure and broaden the concept of the costs of work, criteria for work-methods design are more difficult to formulate. We are in the position of trying to substitute criteria which are somewhat nebulous for the specific, the subjective for the objective, the complex for the simple, and perhaps the essential for the superficial. But home economists, whose task it is to apply knowledge from many fields to the needs of the family, cannot afford to ignore so much that is relevant to the work of the home.

No adequate system of principles for reducing the costs of work can be tied up in a neat package to be applied quickly as criteria for evaluating and as guides for improving work methods. Such a system would need to take account of factors in all four of the components of work cost discussed in this book. The traditional principles of motion economy are not adequate for this function.

A concise statement of comprehensive guides to work-methods improvement is needed. Such a statement is proposed here to serve as an aid in evaluating work methods and in suggesting improvements. The factors included do not all permit objective measurement at present; the statement is admittedly tentative and incomplete. The framework for the statement is based on one by Ryan and Smith (1954:330–344), in which they reorganized and restated the traditional principles of motion economy. A similar grouping of principles is found also in Chapanis, Garner, and Morgan (1949). The presentation of the principles by these authors is relevant to a concern for the costs of work from the worker's viewpoint. We borrowed this outline from Ryan and Smith, adapting and enlarging it to serve as a practical summary of information presented in this book.

PROCEDURES FOR DESIGNING METHODS OF WORK

Reduction of Effort: Preferences and Satisfactions

The worker's preferences in choice of methods, equipment, environment, and materials for work influence the costs of work.

1. Principle of optimal duration of the work period. The optimal duration of the work period uninterrupted by rest or change of activity differs among individuals.

Criteria

The worker's handling of controllable interruptions is balanced against the uncontrollable interruptions.

The worker is aware of the effect of stops and starts on her own sense of accomplishment and satisfaction.

The worker recognizes when the fatigue from the long duration of a work period overbalances the sense of satisfaction from avoidance of stops and starts.

The worker accepts a longer time allowance for tasks that are enjoyed.

2. Principle of optimal activity level. Overactivity in work performance is physically costly and may reduce accomplishment; overrestriction in number and distance of movements may increase the affective cost of work and interfere with a sense of satisfaction from physical exertion.

Criteria

The worker is aware of the need to move freely according to preference.

The worker controls the unnecessarily frequent movements and those involving sharp changes of direction.

3. The principle of satisfying standards of work. Homemakers and families differ in standards of quality that are required for their satisfaction in the process and the results of work in different task areas.

Criterion

Short cuts, omissions, and quality acceptable in work determined by individual standards.

Reduction of Effort: Strain and Attention

Planning, thinking, and attention required by the conditions of work may add strain and enter into the costs of work.

1. Principle of minimizing frequency of decisions and judgments. The work method as well as the equipment and the workplace is designed to permit the formation of habits for routine work.

Criteria

A natural sequence permitting ease of motion consciously determined in the learning stage of a new operation.

Arrangement of the workplace to reduce decisions in work performance.

New, unlearned tasks begun when workloads and attention demands are lighter.

Frequently performed mechanical tasks learned to the point of skilled performance.

Standing rules used to reduce amount of planning.

The use of routines to add to the structure of time.

Objective measures used to determine quantity and quality.

2. Principle of reducing search. Materials, tools, equipment, or items previously worked on are readily available to prevent delay and the frustration of search.

Criteria

Frequently used tools and materials permanently positioned for easy accessibility and visibility.

Habit of returning permanently positioned tools and materials to their place immediately after use.

Work surface large enough to permit convenient temporary storage during an operation.

3. Principle of facilitating rhythm. Sequence of motion and workplace arrangement for short-cycle repetitive tasks are planned to encourage rhythmic movements.

Criteria

Alternating use of muscle groups.

A motion of longer duration preferred over one of shorter duration that interferes with the rhythmic pattern.

A movement of greater travel distance placed in a pattern of motion among several of shorter travel distance.

4. *Principle of reducing the number of items to be attended to at one time.* This principle is controlled by planning and organization of the work but is also concerned with family interaction.

Criteria

Work, especially difficult work, is relegated to times of low family interaction.

Mechanical, well-learned work is chosen for times of greater family interaction.

Use of mechanical signals or timers to eliminate the need to remember and to estimate time.

Reduction of Effort: Time Expenditure and Timing

The time spent in work performance and timing of action are human costs of work.

1. *Principle of omitting nonessentials.* The omission of tasks or parts of tasks that are not essential to a family is a primary method of reducing time expenditure for household tasks.

Criterion

Essentiality of tasks or parts of tasks consciously determined.

2. *Principle of ordering tasks within time.* Time spent on tasks is more effectively used if the future is anticipated and tasks programmed within a longer time span.

Criteria

Sequencing and dovetailing are done to use time most readily available.

Rhythmic order of events in time is used to aid in sequencing.

3. *Principle of avoiding too close a timing of events.* Excessive strain that results from too close timing of events can be reduced.

Criteria

Time allocation to tasks is made realistically.

Ability to estimate time is developed and used.

Constraints on timing imposed by factors outside the task are recognized.

4. *Principle of learning the task.* Knowing how to do the task is one of the great time savers.

Criteria

Motor skill developed for frequently performed mechanical tasks.
Worker aware that unlearned tasks take longer than familiar tasks.
Understanding the task recognized as worthwhile.

Reduction of Effort: Muscular Exertion

The use of the worker's body in work performance constitutes a cost of work.

1. *Principle of work position.* The major weights of the body are maintained in natural alignment over a stable base whether for sitting, standing, or walking and as much as possible for bending, squatting, or crouching.

Criteria

Low angle of trunk bend.
Low angle of forward bend of the head.
Absence of maintained trunk twist.
Minimal lateral or forward lift of the upper arm.

2. *Principle of minimizing static work.* The dimensions and design of the equipment and workplace permit and encourage a good working position so as to avoid static work in all parts of the muscular system.

Criteria

The height of the worker's elbow (when the body is in natural alignment) above the height of the work surface or the point of application of force.

Stability and firm resistance to the motions of the work provided by feet on the floor or rigid foot rest; feet sufficiently far apart.

Unrestricted movement of legs and thighs needed to balance work movements during seated or standing work.

No part of the body forced out of alignment or into a fixed position in order to use equipment.

3. *Principle of application of force.* The worker exerts the required amount of force with the least possible muscular exertion.

Criteria

Smooth continuous motions rather than jerky motions.
Forearm only for exerting force with the hands when possible.

Force exerted by the hands and forearm originates from a right-angled bend at the elbow.

Force exerted downward from the elbow joint rather than upwards or sidewise.

For moving heavy weights, force exerted at or near the center of gravity of the weight.

For lifting heavy weights, force is exerted as near as possible to the center of gravity of the worker's body.

Force exerted from a stable position of the worker's body.

Force for moving heavy objects exerted by the large, strong muscles of the legs and thighs when straightening out from a crouch rather than by the muscles of a straightened arm or the small muscles of the back.

4. *Principle of movement reduction.* Reduce unnecessary number and distance of movements.

Criteria

Tools and materials in frequent use located as near as possible to the place of use.

Tools and materials for routine tasks located in order of a good sequence of motions for the task.

A good sequence of motions consciously selected and established as habit for frequent and routine tasks.

Separate activities localized at centers when area covered during the work performance is large.

The work of get ready and cleanup is taken into account and reduced as much as possible.

Reduction of Effort: Physical Impairment

Extreme muscular exertion may involve temporary or permanent impairment of parts of the body used in work.

1. *Principle of eliminating severe physical work.* The design of the work method, of the equipment, and of the workplace is planned for the physical well-being of the worker and the avoidance of impairment in any of the body parts or systems.

Criteria

No exertion of force during twisting or bodily distortion.

Avoidance of restriction or compression of bodily parts.

Avoidance of a long-maintained static position.

Avoidance of extreme exertion, whether pushing, pulling, or lifting.

Working position and level of lighting promote good visibility.

The interrelatedness and the overlapping among the sections of the outline above are acknowledged. Many of the so-called principles might more accurately be called commonsense suggestions. It was necessary to include them in order to get the essential breadth. The emphasis required for good balance will differ for different homemakers and at different times for one homemaker.

The design of work methods goes far beyond motion study and is broader than traditional concepts of work simplification. The reasons are found largely in the differences between work in homes and work in industry and in increased knowledge of the human costs of work.

Individual and highly personal preferences as to environment for work, work methods, materials and tools, work to do or to leave undone all have a real effect on the human costs of work. So too, do the family's attitudes toward these matters. When the worker operates under conditions of no monetary pay, in her own home, under her own or family management, these preferences rightfully assume greater importance than when work is performed for pay outside the home. Preferences alone, if followed to extremes, can serve as obstacles to reducing significant costs of work. An individual may need to be helped to recognize this danger but must exercise final judgment as to which costs are more significant to her.

The handicapped, chronically ill, and the elderly homemaker in today's economy and with today's attitudes toward the desirability of independence have need for sound information about the human costs of work and how they may be minimized. The use of such information contributes to a sense of pride in successful work accomplishment in the home. An appreciation of the contribution of the work of homemakers to the gross national product and to the family's real income has been too much neglected. So also has the homemaker's appreciation of her labor as a sizable part of the national labor resource and her responsibility for using it effectively.

Knowledge that increases a homemaker's ability to evaluate her own work methods and to design improved ones can contribute to her sense of satisfaction from measurable work accomplishment. Acquiring such knowledge is not likely to be overemphasized to the detriment of the family if work performance is seen in the context of the family's satisfaction in the home.

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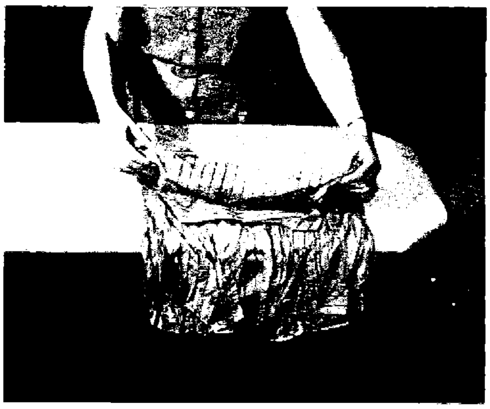
APPENDIX

A Technique for Developing Skill in Shirt Ironing

(Weaver, 1959, pp. 8–12)



1.
Place the rolled, dampened shirt on the far side of the left end of the board. As the shirt is unrolled, the tail will fall over the side of the board and the yoke will be toward you.

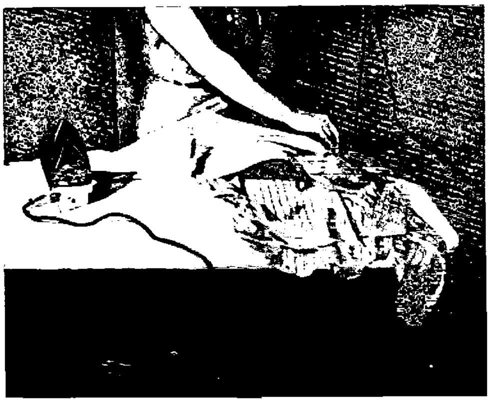
2.
Pick up the right sleeve by the shoulder and cuff and turn it placket side up. Smooth the wrinkles toward the shoulder and the cuff. Start ironing in the center of the sleeve and iron toward the shoulder.

3.
Shift the iron to the left hand and iron into the cuff. Shift the iron back to the right hand, and iron the inside of the cuff. Stretch and iron the seams dry.

Turn the sleeve over and iron in the same manner as the first side was ironed.

4.
While the shirt is in this position, iron the outside of the collar and the inside of the band. When there is extra fullness in the collar, ease the fullness in by ironing from the points toward the center and from the collar edge toward the band.

5.
Pull the shirt slightly toward you, fold the yoke back upon the shirt, and iron the yoke. To prevent ironing a crease in the shirt back, have the back extended over the edge of the board as you iron the yoke.

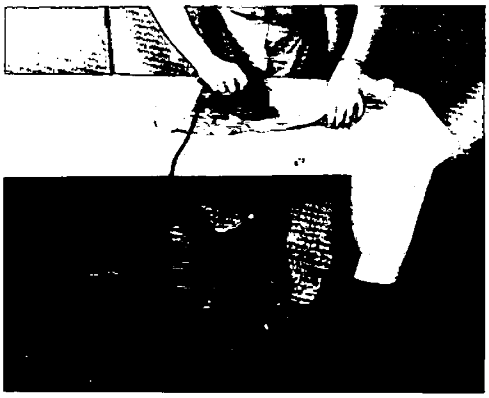


6.
To put the shirt in position for ironing the second sleeve, cross the arms, grasp the shirt at the top of the sleeves and turn the shirt. With this Z turn, there is little handling of the garment.

7.
The right sleeve now hangs free over the end of the board and is away from the rest of the dampened shirt. The placket side of the left sleeve is already on top. Smooth out the wrinkles and start ironing from the center of the sleeve toward the shoulder. Iron into the cuff gathers, using the left hand. Change the iron to the right hand and iron the inside of the cuff. Turn the sleeve over and iron the other side.

Iron the other side of the collar and the band.

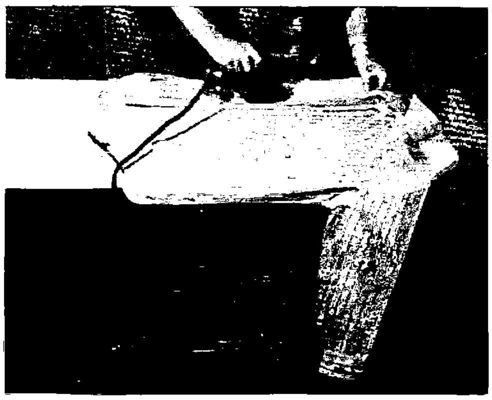
8.
To put the shirt in position for ironing the body part, grasp the shoulders and turn the shirt so that it will be lengthwise on the board with the shirt fronts up, and the collar at the end of the board by your left hand.



9.
Iron the inside left half of the back and yoke. Stretch and iron the underarm seams dry; otherwise, the shirt will be puckered when it is finished. Iron with the grain of the fabric when possible.

10.
Lay the unironed left shirt front over the ironed back. Iron the buttonhole band. Lay a folded Turkish towel on the shirt and fold the band back over on it. Stretch and iron the band on the wrong side, being careful not to iron a crease where the shirt is folded. Turn the band back in place, remove the towel, and finish ironing the left front. Iron the heavy seams to dry them thoroughly. The Turkish towel need not be used if marks from the buttonhole band can be ironed out of the shirt front.

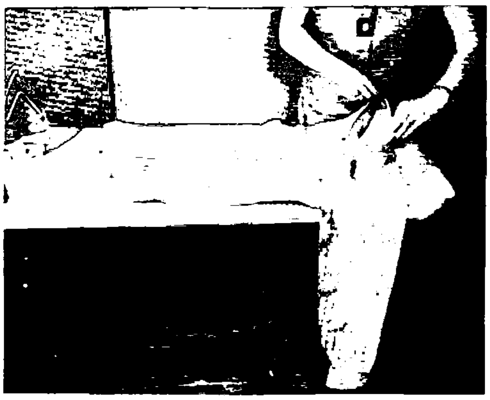
11.
Shift the shirt slightly toward the back of the board. Finish ironing the inside of the back.



12.
Lay the unironed right shirt front over the ironed back. Lay the folded Turkish towel on the right shirt front. Turn the button band back on the towel. Stretch and iron dry. The Turkish towel need not be used if marks from the buttons can be ironed out of the shirt front.

13.
Lay the shirt front flat, remove the towel, and iron the right front. Iron the seams until they are dry.

14.
The shirt is now ironed. Button the bottom and middle buttons.



15.
Fold the collar back, creasing it with the fingers. It is not necessary to iron this crease. Ironing the crease would tend to make the shirt collar wear out faster. Button the collar button. The shirt is now in position for folding without its being moved. The shirt has had only two complete turns during the ironing process. Thus there has been little handling and wrinkling of the shirt.

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