A STUDY OF AMERICAN KITCHEN CABINETS, DEVELOPED BY THE BUREAU OF HOME ECONOMICS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE, EDUCATORS AND COMMERCIAL AGENCIES IN ORDER TO DISCOVER STORAGE FEATURES, WHICH MAY BE INCORPORATED IN DANISH KITCHEN UNITS

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By

Inger Nielsen

AN ABSTRACT

Submitted to the College of Home Economics of Michigan State University in Partial fulfillment of the requirements for the degree of

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INTRODUCTION

Both in the United States and in Denmark research has been carried out by architects, home economists, educators and commercial agencies to improve kitchen facilities. This study is based on a review of literature of studies made in both countries, and on visits to several American kitchen displays. The purpose is to select such features of Modern American kitchen units, which may be incorporated into or added to Danish cabinets. Features, which serve to reduce time and energy consumption, or appear to improve utilization of space for specific articles, have been selected. Special study has been made of storage features.

Through the Danish Government Home Economics Council it will be possible to disseminate to Danish home economists, professionals and homemakers the information here gathered. This council sponsors a current kitchen exhibition in its building, which is open to the public. The main purpose of the exhibition is to show homemakers, how they can improve existing kitchens by changing or adding storage features. Some of these features may eventually be incorporated into standard cabinets, manufactured by organizations and commercial companies.

Differences between Danish and American Kitchen Functions.

It was found through research at Cornell University,[1]

1. Beyer, G.H., Weise, F.; The Cornell Kitchen, Cornell Univ. 1952, p. 14.

that the functions of the kitchen vary from family to family, depending on the emphasis put on: "a) family - centered living, b) social standard, c) physical convenience, d) aesthetics." Sometimes the kitchen is used primarily for food preparations; sometimes food preparation is combined with activities such as dining, laundering and hobby work, but the same kitchen units may still be used for the actual kitchen plans.[2]

Due to national, social and economic reasons the functions of the average American kitchen and the functions of the average Danish kitchen probably vary to a certain extent. One of the factors, that influences kitchen planning most is whether dining facilities are within the kitchen or in another room. When there is a dining area in the kitchen, it is found that other activities also tend to be carried out here, such as sewing, children's play and homework. Although surveys, carried out in Denmark[3] in 1956, show that since the last war there has been a tendency to include the dining area in the kitchen, this tendency seems to be better established in the United States. The surveys showed, that 75 percent of the households interviewed

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2. Small Homes Council, Handbook of Kitchen Design., Univ. of Illinois., 1950, p. 1.

3. Petersen, F. Vedel., Plan Køkkenet, Statens Byggeforskningsinstitute., 1959., pp. 16.

wanted dining facilities in the kitchen; however, only ~~in~~ 25 percent of these were found to have them there. The telephone, the radio, and the television set in the kitchen indicate that the American kitchen is a "frame for family activities". These would rarely be located in a Danish kitchen.

Especially in newer, Danish, one - family houses is a dining area planned in the kitchen. Besides, for this type of house, there has been a great deal of experimenting in combining the dining area with the hall, the hall being as necessary a room of a Danish house as any other room.[4] The size of the hall is then enlarged, and from it doors lead to various rooms of the house. The most prevailing type of Danish city dwelling is still the apartment house. Common sizes of modern apartments are one, two or three rooms, besides the kitchen, hall and bathroom. The value of including the dining area in the kitchen in such small apartments is doubtful because it usually is desirable to increase the living areas as much as possible. But the value of a "secondary" eating area is emphasized for all kitchens, even if it be only a pull-out board. An American kitchen will often have a back door entrance, especially when the hall has been eliminated. In Danish kitchens, and

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4. Petersen, Op. Cit., p. 16

again particularly in apartment buildings, the hall offers the only entrance to the kitchen. These are factors, which influence the use and arrangement of kitchen storage.

One of the main differences in the use and function of the kitchen in the two countries may be caused by the differences in kind and amount of equipment and food supplies.[5] Machines such as a dishwasher, home freezer, electric mixer and food-waste disposer are rare articles in the average Danish home. On the other hand, the bread slicing machine is very common in the Danish kitchen. Although the Danish food industry has changed food buying patterns to some extent, the majority of homemakers still take home unprocessed food.

More similarity may be found between American and Danish farm kitchens, where the dining area and family gathering center often are the kitchen. More over, facilities for freezing food are more common on Danish farms than in the towns and cities. In 1955, 72 percent of the rural homemakers had access to a home freezer, either that of a cooperative locker, or her own home freezer.[6]

Large machines such as an electric mixer and dishwasher are also more apt to be found on the average Danish farm

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5. Lindgren, G., Kök, Hemmens Forskningsinstitut., 1952., p. 5.
6. FAO Report: Rural Welfare in Denmark., 1956, p. 17.

than in the average city kitchen. The breadslicing machine, machine, being typical standard equipment, needs to be mentioned, because it is given a central place in Danish storage cabinets, and may influence the requirements of the cabinet design. As homegrown products are used in both countries, many of the food preparation features will be the same in farm homes of both nations.

Due to several reasons the urban American and Danish food buying habits differ. Small shops in every street in Danish cities make it easy for the homemaker to buy immediately needed goods frequently; whereas availability of more and larger refrigerators in America make it possible to shop at large, more distant shopping centers. The result is, that in America women purchase larger quantities of food at less frequent intervals. Home economics educators in Denmark recommend that in the interest of saving time the homemakers combine their purchases as much as possible. But the storage facilities of the apartments are often limited. Furthermore, the transportation of goods from the shopping center to the home by private car is common in America. Danish city shopping patterns include far fewer cars. Finally, the load which a woman can carry is limited, especially when high staircases lead to the apartment. Consequently, the requirements for storage facilities become somewhat different. But a trend toward larger storage

space, larger and more refrigerators and home freezers has already been observed in the newer suburban quarters, where shopping centers are being built in increasing numbers.

Procedure of the Study.

In the following study a description has been given of the origin of the Danish kitchen cabinet units. The organizations in Copenhagen which initiated the research underlying the present units, and the later research and surveys of the Farmers' Organizations, which led to kitchen units, particularly adapted for farm kitchens, have been cited.

As modern kitchen design is based on measurements of energy and time consumption, and space requirements for household work, some important research studies both from America and Scandinavia are reviewed and summarized.

In order to design suitable storage, it is necessary to know the number of articles generally stored in an area. It may be presumed that both type and number of items stored differ between the United States and Denmark. Hence, lists of essential articles for American and Danish kitchens respectively have been included in the appendix.

Features and dimensions of the most prevailing types of Danish kitchen cabinets are described. These are the

"Danish Kitchen Set", designed by the Joint Organization of Danish Housing, and "Jutland Farmers' Organization's Kitchenset", designed by this organization. Furthermore, a few cabinet features from commercial companies are presented.

Storage features, which differ from the Danish design, and which in some way promote work simplification or increase usable storage space are selected from American research and American commercial manufacturing companies. The selected features are presented in relation to the three main work centers: The mix center, the sink center and the range center. The sources of information for these selections include: The findings of research data from The Bureau of Home Economics of the Department of Agriculture at Beltsville, the Small Homes Council - University of Illinois, publications of New York State College of Home Economics in association with Cornell University Housing Research Center, various publications of the Experimental Stations or Cooperative Extension Services of many states, publications of the American Heart Association, articles from architectural magazines, and leaflets of various commercial companies.

Omissions.

Special emphasis has been placed on storage facilities. The planning of work areas and floor space has been excluded

from this study because the division of the kitchen into main work centers is a well accepted design guide in both countries, and floor space must usually be adapted to the prevailing type of houses and kitchens. Materials, which may differ in the United States and Denmark, are not discussed. Laundry facilities and facilities for cleaning are also omitted as these are not directly related to the primary kitchen activities.

RESEARCH STUDIES

Danish Organizations that have made Contributions in the Field of Kitchen Units.

Joint Organization of Danish Housing.

On the Danish market there are several types of kitchen "units". The development of these is based on surveys and research work. The studies, which resulted in one prevailing design of kitchen cabinets, were started in 1943. In that year a Joint Board of Housing Research was established by the Copenhagen Community Council, the Danish Art and Craft Association and the Joint Organization of Danish Housing.

This organization is a cooperative one. Its purpose is to promote building, and to raise its standard.

In 1949 this Board published a report of kitchen surveys and research, and in 1950 the leading architects of the Board published a book, "Planning Kitchens". Soon afterwards architects, carpenters and commercial companies were invited to enter a contest of kitchen design. The purpose of the contest was to gather ideas to develop a pattern set of cabinets.

However, none of the plans received was found adequate.

Hence the architects of the joint organization of Danish Housing started to design kitchen cabinets, based on the book "Planning Kitchens" and on some Swedish studies. The contributions from Sweden were studies of space allowances in relation to time and energy expenditure, carried out by the Swedish Consumers' Institute. During the development of the cabinet designs, the Danish Government Home Economics Council was invited to join the work. They participated by giving advice concerning amounts and types of items to be stored in cabinets, and concerning storage areas.

The first set of the cabinets so developed was displayed at an exhibition in 1953, and was named "Danish Kitchen Set". There are no patent rights on these plans, so that any company or individual is allowed to produce a "Danish Kitchen Set". Presently the Joint Cooperative Danish Consumers' Organization is producing the greatest number of this kitchen set.

Until 1960 government support was given to new kitchens, furnished with "Danish Kitchenset". But this year, 1960, government support for most types of building has been stopped, including support to kitchens.

Later research has been carried out by the government institute for Building Research and the Academy of Architecture. The results of this research were published, and they are currently influencing kitchen design, even if they

have not been applied to one certain type of cabinet as the "Danish Kitchenset". Commercial companies also are doing some kitchen research, and show interest in promoting better standards.

Although the "Danish Kitchenset" was not designed for any particular type of kitchen, its design was based on surveys of city areas, and its main application has been in urban kitchens.

Jutland Farmers' Organization.

Kitchen plans particularly suited to farm conditions have also been developed.

Local farmers' organizations in Jutland are cooperating and are represented in a Joint Organization. The home economics section of this organization outlines the work to be done by local extension workers through meetings and publications and conferences on various topics. In 1959, 719 local organizations were members of the Joint Home Economics Organization, with a total membership of 56,130 homemakers. In 1950 the number of persons engaged in agriculture in Denmark was recorded as 907,000 out of a total population of 4,281,000; but it is agreed, that there has been a continuous downward trend in the number of persons working in agriculture. Several interrelated reasons may account for this trend. First there has been a rise in

the general standard of living, which among other things brought mechanization to the farms. This has influenced the movement of people from country to town. However this migration to the towns has had a somewhat unfortunate effect on the composition of the remaining rural population. The number of young women has declined so that in rural districts they number 11 percent less than the number of young men.[1] Previously, farm families, even on small farms, engaged female help, but because of the decline in the number of young women and also because the present households are smaller, many farm homemakers now are obliged to do their own household tasks. In 1954, 45,000 young girls were employed on farms as domestic help; in 1958, only 29,000 were thus employed.[2]

Futhermore, because the employment of hired help for the farm work proper has equally decreased, the homemaker often participates in farm work. A study made in 1955[3] found, that 47 percent of farm women participated in such

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1. FAO Report. Rural Welfare in Denmark., 1956, p. 7.

2. 36. Beretning fra Foreningen af Jydske Landboforeningers Husholdningsudvalg., 1960., p.22.

3. Foreningen of Jydske Landboforeninger. Stuehusundersøgelser pa Landert., 1956.

work daily, nine percent participated frequently, and 23 percent did so during peak seasons. Ninety three percent took care of poultry andgarden. A few women with specialized education continue other types of work outside the home. It is obvious, that these factors have emphasized the need for improved rural kitchens.

One aspect of the extension work is giving advice about kitchen planning. There has been a growing interest during the postwar years in modernizing the farm kitchen. Until 1959 extension workers each year helped in planning a great number of individual kitchens. However, the members of the home economics organizations, the field workers, the local architects and craftsmen all agreed, that there was need to produce standard kitchen units, adaptable for farm houses. So in 1959 the "Kitchenset of Jutland Farmers' Organization" was first developed. The design of the cabinets is based on experience gained by home economists through years of kitchen planning. The designers also used the earlier research, mentioned previously, p. 10, and the surveys made of farm conditions in 1955.[4] The cabinet units were designed by architects, experienced

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4. Foreningen af Jydske Landboforeninger. Stuehusundersøgelser pa Landet., 1956.

in kitchen planning, and are now being produced by two craftmen companies, instead of being factory - made.

Need for Improved Kitchens.

It is estimated,[5] that between 20,000 and 25,000 new kitchens have been built annually during recent years, but out of the total number of approximately 1,000,000 kitchens in Denmark, most of these are still unsatisfactory. The main reason for this may be the recent war-time conditions, when all building and modernization was stopped. Also after the war there were inhibiting restrictions, due to lack of material. Hence it is obvious, that there is an urgent need for improvement of kitchen facilities, both in modernizing the existing kitchens and in the planning of the new ones.

Besides, an increasing number of married women are having employment outside the home; this makes it even more desirable that the time spent in housework should be limited by convenient work conditions.

In 1958, in Denmark, 262,786 married women were gainfully employed. The total number of employed women

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5. Petersen, F. Vedel., Planlægning af køkkenet., Statens Byggeforskningsinstitut., 1959., p.1.

was 550,567. The total number of homemakers was 634,283; thus about 41 percent of the homemakers had paid work outside the home.

Review of Some Research, Concerning Expenditure of Time and Energy, and Space Allowances.

Research to improve kitchen cabinets, has been carried out by various American agencies for several years.

These agencies can be classified into the following main groups: Institute of Home Economics, United States Department of Agriculture, Beltsville, Maryland, The Agricultural Research Service, University housing research centers, University home economics departments, University agricultural experiment stations, University agricultural extension services.

Companies, manufacturing kitchen equipment, home appliances and other materials for household use carry out independent research, and even offer financial support to universities for conducting such studies.

The purpose of the studies is to gain knowledge about factors to be taken into consideration in kitchen design through laboratory research, surveys and subjective appraisals from homemakers.

Energy Expenditure for Household Tasks.

Researchers felt, that it is important first of all to know, how much energy is expended in various household tasks. How is the posture of the worker effected by work areas, and by different types of equipment? C. F. Langworthy and H. G. Barott[6] found, that back bending in diswashing required more energy than reaching by arms in dishwashing. A table height of 25.6 inches required 30.0 calories spent per hour; a table 39.4 inches high only 24.4 calories, and a table of 33.5 inches lowered the energy consumption to 20.3 calories.

In another study[7], the task of kneading at a medium high table increased the energy cost to 119.0 percent, as compared to energy consumed during rest. Kneading at a low table increased the energy cost to 133.0 percent. In one study[8] oxygen consumption was used as a measure of energy spent in reaching to different heights, bending by trunk bends and knee bending; a step up and a body pivot

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6. Langworthy, C.F., Barott, H.G., Energy-Expenditure in Household Tasks. The American Journal of Physiology, Vol. Lll., 1920., p. 405.

7. Schwarz, V.W., Human Energy Cost of Certain Household Tasks. Washington State Agriculture Experment Station Bulletin 282., 1933.

8. Bratton, E.C., Oxygen Consumed in Household Tasks., Cornell University., Agr. Exp. Station, Bulletin 873., 1951, p. 36.

combined with arm reaching.

Oxygen consumption per minute was measured as increased over standing. The following chart is taken from this study:

	c.c. oxygen consumption per minute
Reach to 46 inches	28
Reach to 56 inches	54
Pivot combined with arm reach to 36 inches	96
Reaching up to 72 inches	110
Trunk bend to 22 inches above the floor	130
Step up of 7 inches	291
Trunk bend to 3 inches above the floor	312
Knee bend to 3 inches above the floor	547

Even if the trunk bend consumes less energy, it causes more strain on the body than the knee bend, because the leg muscles are stronger and larger than the back muscles. The smaller muscles of the back become more quickly fatigued than the larger, due to fixation of them.

In the development of kitchen cabinets during a project at Cornell University, completed 1952[9], body strain and

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9. Beyer, G.H., Weise, F.; The Cornell Kitchen, Cornell University., 1952., pp. 74.

"relative effort" were measured to determine desirable storage for each item stored within cabinets.

Memomotion films were used for the study, along with consultation with a worker, who was 5 feet 4 inches tall, about the average height for the American women.

Strain occurred, when the angle of back bend was greater than "positive" 15 degrees, or less than "negative" 5 degrees. A negative angle exists, when the worker straightens up and leans backward, for example, in avoiding an opening door from a wall cabinet. The researchers found that reaching into drawers directly below counter level did not cause strain, but that many reaches farther below the counter did.

"The spaces, which were found to be easiest to use, lay between 30 and 60 inches from the floor. Excessive strain was felt when spaces less than 20 inches from the floor were used." Storing items above 64 inches was not recommended.

In reaches between 10 to 68 inches from the floor, the worker used about twice the effort for every inch nearer the floor than for every inch she reached higher than her elbow, in which case only arm motion was necessary.

In a study carried out at Wayne University,[10] overwork

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10. La Francs, E, Simplified Housework., Wayne Univ., 1955, pp.4.

in the kitchen is reported as often being the result of some of the following causes:

1. Work surfaces, shelves and appliances either too high or too low for comfortable working.
2. Haphazard storage distribution of household equipment and supplies.
3. Shelves and drawers cluttered with too much hardware and china, too many utensils and kitchen tools.
4. Use of muscles instead of wheels to carry heavy loads.
5. Refusal to sit while ironing, dishwashing, preparing vegetables, and doing other jobs, that allow sitting.
6. Insufficient, if any, planning of chores.
7. Poor lighting of work areas.

In the same study it was found, that reaching for an object on a shelf, level with the elbow, increases the energy consumption 12 percent, if standing with the arms relaxed is taken as zero. Reaching an object at eye level rises the energy expenditure to 24 percent. Reaching above the level of the head means an increase of 50 percent. Standing on tiptoe for reaching increases the energy expenditure 50 percent, plus the energy it takes to lift the body.

Bending to get something 3 inches above the floor uses nineteen times the energy used in standing still.

An interesting experiment concerning energy expenditure in the storage of four frying pans was reported in 1959,[11] by Dr. Earl McCracken. One pan was hung on a perforated hardboard on the wall, 56 inches above the floor; a second pan was placed on a fixed shelf in a base cabinet, a third on on a pull-out shelf in a base cabinet, and the fourth one was placed on a rotating shelf in the cabinet. All the shelves were located 20 and three eighths inches above floor level. Least energy was consumed when storing the pan on the wall; storage on the rotating shelf proved to be next in energy consumption; the fixed shelf was next; most energy was used in storing the pan on the pull-out shelf.

Mrs. Mary Koll Heiner and Miss Helen E. McCullough found, after a survey of existing kitchen types in 1945[12], "that the design often starts with the tool instead of the user, the gadget instead of the housewife".

They formulated the following basic criteria, which

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11. McCracken, E.C., Richardson, M., Human Energy Expenditures as Criteria for the Design of Household Storage Facilities., Journal of Home Economics., March 1959, p. 198.

12. Heiner, M.K., McCullough, H.E., Products and Practice, Architechtural Forum., Feb. 1946, Vol. 84, p. 158.

they recommend be observed, before initiating any kitchen design:

1. The physical limitations of the homemaker -- her capacity for stooping, reaching and lifting.
2. Organization of all storage in terms of first -- use.
3. Clear visibility for all items.
4. Easy accessibility for all items.

These are some of the studies that have been made concerning the expenditure of energy for household tasks.

Time Studies

One of the many time studies which have been made in connection with household tasks is the Cornell Kitchen Research study 1952[13].

The principle of storage at the point of first use led to the conception of major kitchen centers of activity:

a. Sink center
b. Mix or food preparation center, including refrigerator; or the refrigerator may be termed as a separate center.
c. Range center, including serving space, which also may be considered as a separate center.

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13. Beyer, G.H., Weise, F., The Cornell Kitchen, Cornell Univ., 1952, pp. 54.

In the Cornell study[14] observations were made of time spent at each area.

During the preparation[15] of a meal to serve four persons, 17 jobs were performed at the mix center, but the time spent on each was relatively short, for half of the jobs took less than one minute. The length of time spent at the sink area was greater than the time at any other area during the entire meal preparation, and also during the cleaning up. Time spent at the mix center ranged next; the range center showed the shortest period of time. The time spent at each station should be a guide for providing adequate space for work, and for sitting.

Space Allowances

There have also been studies concerning space needs. The number of steps, a worker travels between the work centers also effects the arrangement of storage units. The Cornell study[16] reports the following data, concerning

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14. Op. cit., pp. 77.

15. The meal was a dinner, consisting of beef patties, gravy, mashed potatoes, vegetables, bread and butter, chocolate milk, water, cake with frosting and coffee.

16. Cornell University, p. 79.

the number of trips taken during meal preparation[17], serving and cleaning up:

	Number of trips
From table to refrigerator or cupboard above it.	2
From table to mix center.	7
From table to sink center.	15
From table to range center.	5
From table to serve center.	11
From range right counter and serve center to refrigerator	2
Serve center to mix center.	4
Serve center to sink center.	13
Serve center to sink storage near range and range center.	12
From sink storage near range and range center to oven.	1
Range center to mix center.	8
Range center to sink center.	21
From sink center to refrigerator or cupboard above it.	11

17. The same meal as mentioned pp. 22.

	Number of trips
From sink center to oven.	4
From sink center to mix center.	60
From mix center to refrigerator and cupboard above it.	10
From mix center to oven.	6

The conclusion of this study was, "that the sink center and the counters to the left and right of it were included in more trips than any other kitchen work stations."

A study by Washington Agricultural Experiment Station[18] in 1950 had found, that more trips were made between range and sink than between range and any other unit. The researchers found that "the saving of motion lies with the arrangement of equipment within each unit rather than in the relation of the units to each other." Furthermore, it was found that "the rearrangement of small equipment in each center was about two thirds as effective as the addition of new equipment in saving time and steps." Addition of a wheeled tray accounted for over one fourth of the step saving.

Although the various measurements of energy, time and space are guides in setting standards for design of kitchen

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18. Wiley, E.W., A motion Study of Kitchen Arrangements, Wash. Agr. Exp. Stat. Bull. 518, 1950.

cabinets, several studies[19] point out, that "there still is a need for flexibility, because each family differs in its kitchen requirements, and the differences in homes dictate differences in arrangement". This finding has been repeatedly verified.[20] But on the other hand it was also found, that in spite of the differences, the amount of storage space used was so similar, that it is possible to suggest standard measurements for liberal and limited spaces, which will suit most families.

With the aim of increasing convenience and service, and minimizing reaching, stooping and walking, the following basic measurements for features of kitchen design were worked out during the Cornell study[21] (adapted for a woman 5'3" - 5'5" tall):

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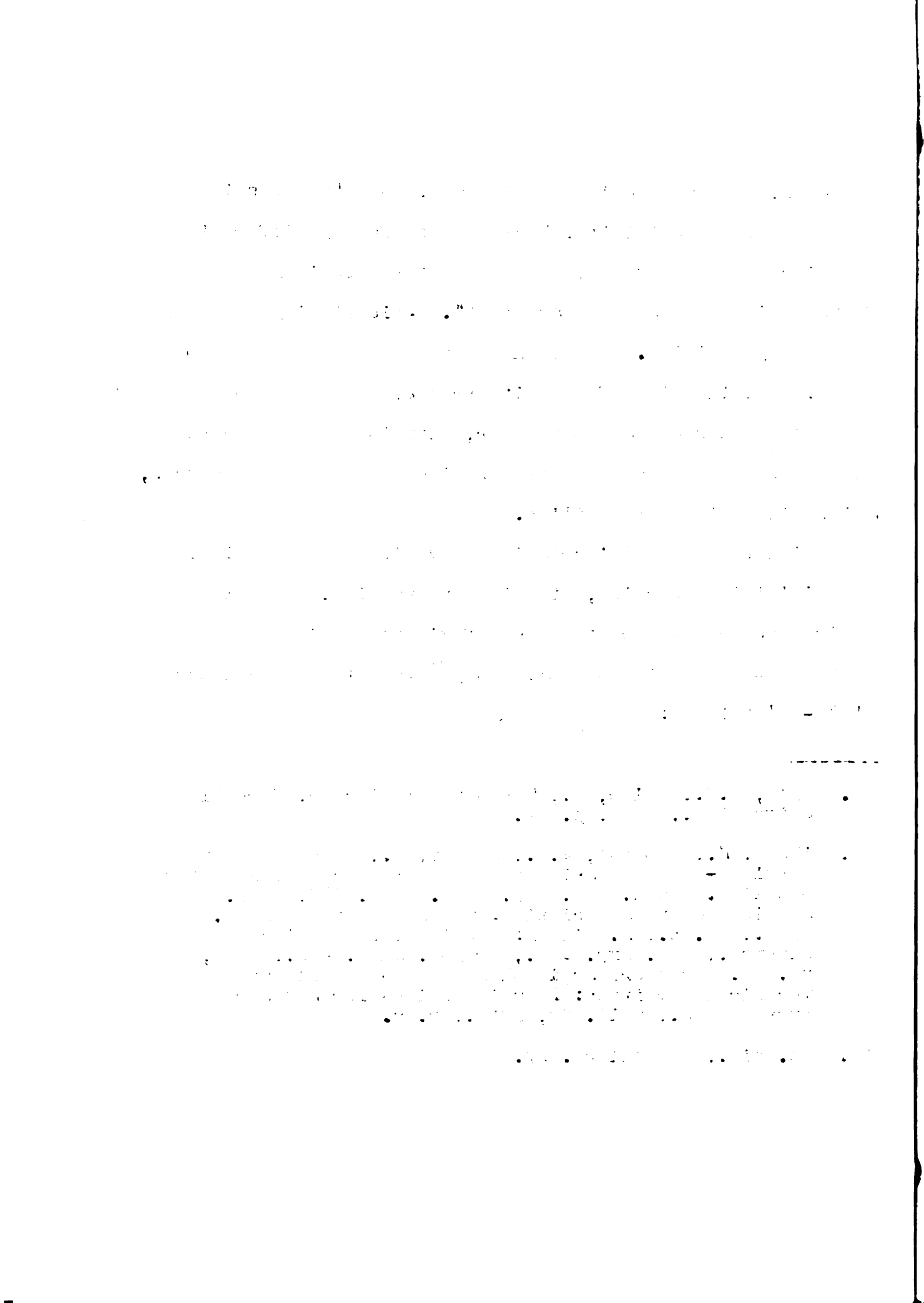
19. Beyer, G.H., Weise, F., The Cornell Kitchen, Cornell University., 1952, p. 24.

20. Wilson, M., Roberts, E.H., Thayer, R., Standards for Working - Surface Heights and other Space Units of the Dwelling. Wash. Agr. Exp. Stat. Bull. 345, 1937. American Heart Association: The Heart of the Home. 1948., pp. 5., M. Wilson: A Guide for the Kitchen Planner., Agr. Exp. Sta., Oregon. Bull. 482., 1950, pp. 26. Southern Regional Housing(58) Research Technical Committee: Planning Guides for Southern Rural Homes., Bull. 58, 1958., p. 9.

21. Op. cit., Cornell pp. 27.



Suggested heights of working surfaces:

Floor of sink	32" inches
Mixing table	32"
Pull-out pastry board	33 1/2"
Kitchen planning desk	28"
Mixing table for seated worker	24"

Minimum toe space:

Width (front to back)	4"
Height	3"

Maximum heights of shelves:

Articles in frequent use:	
No counter obstruction	72"
Obstruction 20 inches wide	68"
Articles visible throughout the entire depth of the shelf	61"
Maximum height of drawer	59"

Lowest reach recommended:

Fingertip level from floor	25"

Minimum dimensions of cabinets:

Width of any working surface	14 - 20"
Length of sink bowl	30"
Length of counter to the left of sink	32"

Length of counter to the right of sink	36" inches
Width of surface adjacent to range	21"
Width of mixing surface, adjacent to to another unit	28"
Width of serving counter, free-standing	28--36"
Surface near open side of refrigerator	15"

In several studies[22] a counter height of 36 inches for tasks such as vegetable preparation, other food preparations and dishwashing is listed as the most common and convenient, if it is possible to achieve only one counter height. Thirty - six inches is also the standard height for a free standing range.

The height for the installation of built - in ovens has also been studied by the Home Economics Institute and others[23]. The findings from USDA suggest, that the lowest rack position of a gas oven should be 37 inches

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22. American Heart Assn.: The Heart of the Home., 1948 p. 12.
Holbrook, H.S., Your Farmhouse, Planning the Kitchen and Workroom., USDA Bull. 12, 1951, p. 27.

23. Style, E., Built - in ovens. Cornell University., Bull. 945., 1955. USDA. Agr. Research Service. Institute of Home Economics. Installation Heights of Separate Ovens. Research Report No. 2, 1956.
McCracken, E. Richardson, M., Human Energy Expenditure in using built - in ovens at different elevations. Stove and Appliance Builder 21, 1956, p. 36.

from the floor; the bottom of the interior of the oven 34 inches, and the lowest broiler rack 28 inches above the floor. In electric ovens the normal broiler rack position is most conveniently located 40 inches from the floor, the lowest rack 35 inches, and the bottom of the interior of the oven 32 inches above the floor.

The American Heart Association[24] suggests, that maximum counter depth should not exceed 20 inches for easy reaching. Mrs. Koll Heiner and Miss McCullough[25] hold 16 inches to be maximum for this.

They have also determined desirable widths and depths for certain storage units.

	Suggested Widths of Storage Shelves
Packaged supplies, all types	24" inches
Utensil storage at range	16 - 24"
Utensil Storage at sink	24 - 28"
China and glassware (according to size of family)	36 - 48"

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24. Am. Heart Assn., The Heart of the Home., 1948, p. 12.

25. Heiner, M. Koll., McCullough, H. E., Products and Practice., Architectural Forum., February 1946m p. 158.

	Suggested Depths of Storage Shelves
Packaged supplies	4 - 6 - 8"
Utensil storage at range	14"
Utensil storage at sink	16 - 18"
China and glassware	6 - 8 - 12"

It was observed, that the greatest work economy was achieved by shallower depths.

The floor space in front of the kitchen units also influences convenience of work.

A clearance of 4'0" between cabinets opposite each other is sufficient for 2 workers[26].

Clearances between cabinets at right angles to each other, but separated by a door or work area, should be at least 3' 0".

In the Cornell study[27] it is said, that 30 inches of clearance are adequate to give free circulation for one worker, when the space is free of doors and drawers, which are likely to be left open.

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26. Handbook of Kitchen Design., Small Homes Council., University of Illinois., 1950, p. 14.

27. Op. cit., Cornell, p. 77.

It was found, that a worker took up 3 1/2 feet of floor space, when she had to crouch to use storage space.

Danish and Swedish Research.

Studies of Energy

Research, concerning time and energy expenditure, and standard measurements for kitchen units, which parallels American research, has been carried out by the Swedish Consumers' Institute, a government Institution. This was done in cooperation with similar Swedish organizations.

The studies done in Sweden concerning time and energy consumption have been the basis for the design of kitchen cabinets in all Scandinavia. However, the cabinets vary to some extent in the different countries, due to national variations, and to individual research carried out in the various countries.

In Denmark the Academy of Architecture, the government Building Research Institute, and the government Home Economics Council have developed standard measurements for work areas.

The Joint Organization of Jutland Farmers has studied the use of time in farm kitchens, and the frequency of trips

in regard to location of work areas as well as in regard to the location of the kitchen in relation to other rooms of the house.

Swedish research[28] found, that the greatest strain from doing house work was experienced in legs, feet, back and shoulders.

It was found, that bending for dishwashing requires one third more energy than standing straight. Most kitchen work, it was observed, is done in a forward bending position. The muscles of the back do heavy work in holding the weight of the body, when it is bent; this in the long run may cause permanent back injury.

Injury to the shoulder muscles can also result, if the worker during a long period works at a surface, which is too high for her.

Standing too much or walking incorrectly will effect the muscles of legs and feet.

In order to avoid excessive strain while standing at work, it was found that the table height should be about four inches lower than the elbow, when the upper arm is straight to the body, and the lower arm bent forward.

The highest shelf, which a woman of average height is

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28. Gunnar Lindgren - Kok., Hemmens Forskningsinstitut. 1952., p. 10.

able to reach, without standing on tiptoe, was found to be 76 to 80 inches. The average height of a Scandinavian woman is calculated to be 5'5 1/2". Items, which are used frequently, therefore, should not be placed on shelves higher than 64 inches, and heavy items should be on a level with or close to the counter top.

Time Studies.

Surveys by the joint organization of Danish Housing discovered in 1945,[29] that a homemaker in a city family of three to six members spends on an average 4-1/2 hours in kitchen work. When time spent in eating, playing and doing hobby work in the kitchen is added, it becomes evident, that the arrangement of work areas should be as convenient as possible.

However, studies in Sweden[30] revealed, that only one tenth of the single jobs in one location or position lasted more than two minutes. What helped to make the work flow more smoothly, was the collection of small items at

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29. Petersen, F. Vedel., Plan i køkkenet., Statens Bygge forskningsinstitut., 1959., p. 4.

30. Lindgren, G., Kok. Hemmens Forskningsinstitut., 1952, p. 6.

the point of first use into the three main work centers (mix, sink and range center). Sufficient space also aided proper work sequence.

In order to suggest good work sequence, the traffic lines between the main kitchen units were studied during two days of kitchen work with food preparation and cleaning up. The trips taken between the kitchen units and storage areas were rated in the following order:

	Trips
Between sink center and mix center	520
Between mix center and range center	245
Between range center and serving space at the range	75
Between mix center and serving space at the range	60
Between sink center and range	45

The findings showed that the greatest number of trips were taken between the sink and the mix center; next, between the mix center and the range; fewest trips were made between the range and sink center.

Space Studies

Recommendations for standard measurements for work areas and units have been worked out by the Danish Government Building Research Institute[31], and are suggested as minimum and optimum measurements for a family of three to six persons.

Recommendations:

	Width	
	Minimum	Optimum
Cleaning of vegetables	28 inches	32 inches
Mixing counter	32"	40"
Serving of hot food	24"	32"
Preparation of cold food	32"	32"
Baking	32"	40"
Space next to refrigerator and cabinet for unrefrigerated foods	16 "	16"
Sink, single bowl	20" x 16"	22" x 16"
Sink, double bowl	26"	26"
Space for stacking unwashed dishes	30"	36"

31. Boligen., No. 8., 1951.

	Width	
	Minimum	Optimum
Space for drying washed dishes	24 inches	28 inches
Elbow room at range	8 "	12 "
All base cabinets, including drawers and pull-out board over kneespace	140 "	172 "

Dimensions of Shelves:

	Width	Depth
Wall cabinet for dinnerware and glasses	160 inches	12 inches
Wall cabinet for food preparation and serving dishes	140" - 160"	12"
Wall cabinet for groceries and packages	140"	8 - 12"
Ventilated cabinet for foods	160"	24"
Storage for jars and bottles	72" - 96"	24"
Width of countertops	160" - 200"	

34 to 35 inches are recommended as the height of tabletop for most kitchen tasks.

If different heights in the same kitchen are possible, the heights of the following various surfaces should be:

	Height
Cleaning vegetables	34" - 35"
Serving counter for hot food	32" - 34"
Serving counter for cold food (sandwiches)	34" - 34 1/2"
Range	32" - 34"
Mixing of batter etc.	28" - 31"
Kneading doughs	31" - 32 1/2"
Rolling out dough	34"
Sink counter with built - in sink bowl	34" - 38"

A pull - out board for a seated worker should be adjustable in height. It is recommended, that there be four positions for this: just under the counter top, and 24, 26 and 28 inches above the floor. Toe spaces 3 - 4" high are recommended for base cabinets. To provide convenient passage way in front of the main work areas: sink, range, food storage cabinets and refrigerator, a free space of at least 3'4", preferably 4' is suggested. Space between countertop and wall cabinet of 20 inches can provide room for a drip tray with two rows of plates or a large kitchen machine, such as an electric mixer.

A test was carried out by the Swedish Consumers' Institute[32], with dishwashing in a kitchen withpoor work facilities, and in a kitchen with good work sequence, and proper table height. In the inconvenient kitchen the counter was too narrow, especially on one side of the sink, so that the dishes had to be handled several times, and the height of the countertop was too low.

In the inconvenient kitchen dishwashing following a standard meal for five persons required 14 minutes; whereas it required only 8 minutes in the better kitchen.

But even with continuing work sequence and well arranged equipment, it was found in Sweden, that sitting during dishwashing saved neither time nor energy. Moreover, the workers reported, that sitting obstructed their motions, and that the dishes seemed to be heavier in handling.

MINIMUM ESSENTIAL EQUIPMENT IN A KITCHEN

American Kitchen.

Information about items stored in kitchen cabinets is of importance before initiating a design for these. It may be anticipated, that there is a great variation in storage

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32. Lindgren, G., Kok. Hemmens Forskningsinstitut., 1952., p.7.

patterns due to size of household, social standards and values, and cultural background.

In order to get information to solve these problems cooperative studies were carried out by California -, Nebraska -, and Rode Island Agricultural Experiment Stations[33], and The Bureau of Human Nutrituion and Home Economics, U.S.D.A. Identical methods were employed in the three states, where the actual use of equipment by 645 homemakers was observed during a three weeks period. Family sizes of 2 - 7 members were represented, all from the medium economic income level. Most of the homemakers were less than 50 years old, and in 73 percent of the families there were children. Most of the families were home - owners, and all the houses were equipped with electricity and running water. Electricity, gas, kerosene and wood or coal fuels were used for cooking.

The results obtained in the three different states appear to be quite similar. More than 70 utensils were generally used by the homemakers. Variations which occurred, seemed to be influenced by:

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33. Woolrich, A., Barager, A., Kuschke, B., Warren, J., Phipard, E.F., Fincher, L. J., Cooking Utensils Based on Meal Patterns., Journal of Home Economics, Vol. 40, No. 6, June 1948.

1. The individual homemaker's personal working habits or desires.
2. The menus prepared.
3. The utensils available in the household.

Based on the articles, generally used by the homemakers, test sets of utensils were worked out, and supplied to the homemakers to use for three weeks, while their own equipment was removed. From the women's records made during this period, essential items, which would satisfy the needs of the homemakers were picked out. The number and type of utensils did not seem to be considerably influenced by family size; only the capacity of each utensil was so influenced.

This list of utensils was augmented, and then employed in designing the Cornell kitchen. Besides, lists of food, supplies, tableware and equipment were taken from a regional study "Farm Housing in the Northeast", by Cornell University 1949[34].

The items which were included, were stored by 20 percent or more of the observed families. Some revisions were made during the Cornell research, when it was felt, that certain changes might be better suited to New York State.

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34. Beyer, G.H., Weise, F., The Cornell Kitchen., Cornell University., 1952, p. 28.

In Appendix 1 is found this list of equipment, tools, supplies and food as compiled by the Cornell Study.

ESSENTIAL ARTICLES FOR STORAGE

Danish Kitchens

The Danish Government Home Economics Council has also prepared lists of minimum household equipment. Surveys were made of existing equipment in 100 urban, medium income level homes in 1949. The results of these surveys were tested in the Council's research kitchens. These lists are available without charge to any homemaker.

In the appendix is found the recommended list for a minimum number of articles for a city household of 2 - 4 persons. These utensils are exhibited at the current kitchen display at the Home Economics Council building in Copenhagen.

DESCRIPTION OF DANISH KITCHEN CABINETS

Several organizations and companies have based their designs of kitchen cabinets on the research. which has been explanined earlier, page 10 and page 13. In the following paragraphs is given a short description first of the units, belonging to "Danish Kitchenset," secondly of the kitchenset designed by Jutland Farmers' Organization, and finally some special features of cabinets, manufactured by cooperative and commercial companies.

The main use of the "Danish Kitchenset"[1] has been in urban kitchen planning, especially in apartment houses. For builders and technicians, who intend to furnish a kitchen with "Danish Kitchenset" there are available printed guides and drawings of 130 kitchen variations of cabinets.In these the units are arranged in various ways, but all arrangements exemplify the principles of good work sequence.

The cabinets are constructed either ready - made to be placed on a base, or as sections, which are to be assembled in the kitchen. The latter are less expensive. All these cabinets can be furnished with drawers with dividers and stops, adjustable shelves and trays on rollers.

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1. Petersen, F. Vedel., Plan; Køkkenet. Statens Byggeforskningsinstitute., 1959, p. 34.

In order to insure good and uniform materials and methods of construction, quality control of the production of these cabinets is achieved by periodic inspection.

The complete "Danish Kitchenset" consists of 23 units. Some of the units are available in different sizes.

The features of these units are described in terms of size and design characteristics. The cabinets are described in the following order: Those belonging to the mix center, to the sink center, and to the range center.

For the mix center the following cabinets are designed: A cabinet for a built-in refrigerator can be 24 or 28 inches wide; 91 1/5 inches high, and 24 inches deep. This cabinet has an upper cupboard with one shelf, the space for the refrigerator, and a cupboard beneath with one shelf. The cabinets are available for different heights of refrigerators, as well as in the two widths, 24 and 28 inches.

The food storage cabinet, which is made in the same heights and depth is available in the 24 inch width. It has two full-depth shelves at the top, two shallower, cut-back shelves beneath these, one full-depth shelf with two drawers (for bread) below, a pull-out board for the bread-slicing machine, and one to four drawers for vegetables and bottles.

Base cabinets for the mix center are usually 28.8 inches high. The height, 28.8 inches, of all the base cabinets is exclusive of countertop and foundation base, which can be adapted to the height of the individual homemaker.

Widths of these cabinets may be 16 or 24 inches. The depth also varies. A 24 inch depth is most common, but the base cabinets can be obtained in 21.6 inch depth.

In each cabinet are two shallow drawers, and a cupboard with three pull-out trays behind a hinged door.

The base cabinets for the mix center are also built with only three pull-out trays within the cupboard.

There are cabinets, of the same deths and heights, as the other base cabinets, which are equipped entirely with drawers. These cabinets are all 16 inches wide. There are five drawers in each: two four inch drawers, two six inch drawers, and an eight inch one.

Wall cabinets for storage of groceries are all 39 inches high. The width and depth vary. The available widths are 24, 32 and 40 inches. The available depths are: 8 and 12 inches. There are one fixed shelf at the top, and three adjustable shelves beneath, of which the lower one is cut-back. There are wire spice racks on the doors. The doors of the wall cabinets are either of the sliding

type, where a lower door is pushed up under the upper one, and vice versa; or they are double hinged doors. These latter are the more common. The hinged doors open independantly of each other, and there is no middle post to interfere with reaching.

The following cabinets are designed for the sink center:

The sink units are built to accomodate sinks of varying sizes: 32, 38, 48 and 56 inches in width, the larger sizes may be used to fill a corner space. The height of the sink units is usually 28.8 inches, but a unit 30.8 inches can be obtained. The usual depth is 24 inches, but a shallower, 21.6 is provided. The units are planned for double sink bowls or for one small sink bowl besides a regular sized one. Under the sink is a small half shelf. There are towel racks, and holders for waste containers. The doors have grills for ventilation.

Cabinets to the left of the sink are of the same height and depth as the sink unit, but they are either 16 or 24 inches wide. They are equipped with two shallow drawers with removable dividers at the top, and a cupboard beneath with a shelf and a narrow space for trays.

In a Danish kitchen a pull-out board is often placed to the right of the sink. The height of the board can be adjusted: just under the counter top and at heights of 28,

26 and 24 inches above the floor. The widths of the lap boards are 20 or 28 inches, and they are about 24 inches deep. Under the board is open space to allow the worker to sit.

Wall cabinets for china and glassware are 39 inches high, 32 or 40 inches wide, and 12 inches deep. The upper shelf is fixed, and the three lower ones are adjustable behind sliding or hinged doors.

The range center includes cabinets for cooking utensils. The base cabinets are available 16 and 24 inches wide. The height is 28.8 inches, and the depth is 24 inches. In the upper part, the cabinets contain four shallow, cut-back wire shelves. Beneath, are two pull-out trays. The doors are equipped with racks for lids.

The kitchenset designed by the Jutland Farmers' Organization,[2] which is described below, was suggested mainly for the activities carried out in a farm kitchen. The units may be used in a new kitchen or as supplements in a rebuilt kitchen.

The drawers of the Jutland cabinets are provided with stops and dividers. Shelves and trays in the cupboards slide out, and are adjustable in height. All inside corners

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2. 36. Beretning fra Foreningen of Jydske Landboforehingers Husholdringsudvalg. 1960. p. 85.

are rounded and plastic clad. Hinged double doors are usually used for the base cabinets. They open independantly. The complete set consists of 26 units, including variations in sizes. Besides, extra cabinets to be placed between the ceiling and the wall cabinets, can be obtained.

The following cabinets are designed for the mix center:

The cabinet for a built-in refrigerator is similar to the one provided by "Danish Kitchenset." The only difference is that it is to be placed on top of a base cabinet.

The food storage cabinet is also designed to be placed on top of a work counter. It is closed by an accordion door, folding horizontally. It contains four cut-away shelves, which decrease in depth from upper to lower. In this way the counter top at the same time may function as a shelf and a working space. Usually the cabinet has two vents to the outside of the house.

The upper part of a freestanding food storage cabinet is designed as the one described above. The base cabinet is equipped with two drawers, side by side, and a cabinet with shelves.

Thirty four inches is the standard height of all the base cabinets, inclusive of counter top and base. However, it is possible to obtain bases of varying heights. The base cabinet for groceries is made as a pull-out panel with one upper stepped shelf, attached to the front panel,

and two lower shelves also so attached.

A base cabinet with wire shelves, closed with hinged doors, is designed for mixing utensils.

Units with drawers, made by Jutland Farmers' Organization, are similar to the units with drawers from "Danish Kitchenset."

A corner cabinet is equipped with two or three revolving shelves with raised edges. The upper shelf is spaced for small utensils or packages. The back wall is rounded to follow the circle of the shelves. A wall cabinet for groceries is also available. The accordion door folds horisontally. The cupboard contains four adjustable shelves of alternating width.

The sink center can be furnished with units of varying dimensions. The space under the sink is open. At one side is a sliding rack for towels and brushes. Beneath this rack there is a metal shelf.

A base cabinet withpull-out panel can be placed next to the sink. At the top is a divided drawer. Beneath the drawer the cabinet is vertically divided. Shelves, facing both sides, are attached to the vertical divider. Another cabinet of standard dimensions is closed with a hinged door. The shelves in this cabinet are designed as serving trays; removable dividers for the trays are available.

A similar cabinet of the same dimensions is furnished with three sliding metal baskets instead of trays.

Jutland's Kitchenset provides a pull-out board similar to the pull-out board of "Danish Kitchenset". It has an additional shallow shelf.

Wall cabinets for china and glassware are all of standard dimensions, and are closed by horizontally folding doors. In one type the left side is equipped with four adjustable shelves, of which the lower one is cut-back. The right side has only one shelf. The bottom of this section is designed for the accomodation of a drip-tray in order to make it possible to store the washed dishes.

For the range center two types of base cabinets of standard dimensions are designed. One type contains shelves, which alternate in depth. The other type has a drawer at the top. Beneath the drawer is a pull-out panel with vertical dividers.

Besides the "Danish Kitchenset" and the cabinets designed by Jutland Farmers' Organization there are about 15 other plans for kitchens, developed by cooperative consumers' organizations and commercial companies. Although these units are similar to these that have been described, some of the features vary from company to company. The following are selected from some of these differing features.

There is one base cabinet at a mix center, which has a pull-out shelf, which provides a constant location for the electric mixer. Beneath is a drawer for attachments belonging to the mixer. A food storage cabinet is equipped with cut-away shelves throughout the cabinet. The cut-away section is on different sides for alternate shelves. This makes it possible to store taller articles. Shallow tip bins for flour and sugar attached to the bottom of a wall cabinet are also provided.

Some sink units have doors hinged at the bottom, provided with trash containers. In another sink unit the trash container is constructed as a tip-bin, which fits into an opening in the cabinetdoor.

The bin has a handle on the cabinet panel, so that it can be removed for emptying and cleaning without the door being opened. A wall cabinet near the sink is furnished with a ladder - like rackfor towels. The rack can fold back behind the closed door, or it may be pulled down to horizontal position, when desired.

At the range center a ventilation hood is sometimes built into the bottom of a wall cabinet.

To utilize narrow intermediary space various base panels are available. One panel carries towel racks. One has a perforated partition with hooks, and another one is provided with vertical dividers.

SELECTION OF STORAGE FEATURES, DEVELOPED THROUGH AMERICAN RESEARCH

The concept of specialized work areas: mix -, sink -, and range centers, is well established both in the U. S. of America and in Denmark. Both the countries emphasize the idea of the storage of small items at those specific centers, where they are most frequently used. Hence kitchen lay-out is not included in this discussion of cabinet features.

Furthermore a discussion of materials will be excluded, as the availability of them differs to a certain extent. In Denmark the most commonly used woods for kitchen cabinets are teak and beech. Thus different kinds of wood are apt to be used in the two countries. Neither are laundry facilities or facilities for cleaning equipment included, as these in some cases may better be located outside of the kitchen.

Dimensions of the cabinets are mentioned only when they are necessary in order to visualize the cabinet features. When they are omitted, it is because the purpose of this study is to select such features as will be adaptable to present Danish standard dimensions.

Only such cabinet features of the three main work areas are selected for discussion, which because of special construction contribute to worksimplification, satisfaction

and more useable storage space. The selection is based on studies of American research and visits to several commercial kitchen displays.

Features suggested for the Mix Center.

The Small Homes Council[1] defines work centers as "areas of activity: mix, sink , range and serve area, which represent the major work processes involved in preparing a meal. Whether or not the kitchen is deliberately planned to provide these centers, they always exist."

But to achieve efficiency, it is desirable "that none of the supplies belonging to it are separated and assigned to cabinets in another part of the kitchen."

The mix center should provide storage for mixing bowls and spoons, knives, measuring cups, sifter, beater, grinder, rolling pin, baking pans and casserole dishes, basic foods such as sugar, flour, shortening, and spices. The refrigerator is located at this center. If much baking is done, it is convenient to have the oven also located near this center. This is possible, particularly when the oven is a built-in type.

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1. Small Homes Council., Handbook of Kitchen Design., Univ. of Illinois., 1950, p. 6.

In the Beltsville Kitchen, Design number 1[2] is a number of interesting features. Knee space is provided under part of the mix counter. A pull-out board can be adjusted to three different heights. Immediately above the counter level against the wall there are small tip-out bins for flour and sugar. Above these are built-in holders for waxed paper and aluminum foil. To the left of the bins is a compartment for the electric mixer, from which it can easily be rolled out on the counter.

A piece of perforated hardboard, attached to the wall above the counter, provides additional and easy storage for small utensils. A tall corner cabinet with rotating shelves is also used for utensils and food supplies. The shelves are sized and spaced for visibility, and the fixed door of the cabinet rotates with the shelves.

In the second Beltsville Kitchen[3] there are other interesting features. Flour and sugar canisters are fastened on caster-equipped platforms, so that they can be pulled into any position on the counter. The supply cabinet in this kitchen is a wall cabinet extending down to counter level.

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2. Howard, M.S., Thye, L.S., Taylor, G.K., : The Beltsville Kitchen-Workroom. USDA Home and Garden Bull. No. 60, 1958, p.3.

3. Beltsville Energy - Saving Kitchen, Design No. 2., USDA, Leaflet No. 463, 1959.

It has double vertical folding doors. Some of the shelves are cut-back and stepped to accomodate flavorings, condiments and different sized packages. The top shelf has vertical dividers for baking pans and similar articles. The base of the supply cabinet is equipped with half-circle revolving shelves. This makes it possible for the worker, seated to the right of these shelves, where knee space is provided, to reach items on the shelves, while remaining seated.

In a Home Economics Institute recommendation for farm kitchens[4] emphasis for storage arrangement is put on frequency of use of stored articles. Articles are divided into those used daily, weekly or occasionally. They are also listed according to shape, weight, bulk and fragility. Frequently used, heavy and fragile items are also stored near counter level on shelves or in drawers. Mixing bowls, measuring cups and spoons are stored separately, so that they can be grasped individually. Knives are placed in a slotted rack in a shallow top drawer. Spices and similar small articles are stored in a revolving pan, attached to a shelf at the bottom of the wall cabinet.

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4. Holbrook, H.S., Your Farmhouse, Planning the Kitchen and Workroom. USDA. Home and Garden Bull. 12, 1951, p. 14.

In "A Step - Saving U - Kitchen",[5] which was designed particularly for farmhouses, shallow metal tip-out bins for flour, sugar and meal are attached to the bottom of a wall cabinet. To replenish the small flour container, there is in the wall cabinet above a large bin. This holds about 40 lbs. of flour. When a shutter in the large bin is pulled out through the front panel of the cabinet, the small bin is filled. Also the large tip-out bin is easily filled, as it is attached to the front panel of the cabinet.

Michigan State University, Cooperative Extension Service[5¹] in an Extension Bulletin suggests among other things, that articles be stored one row deep on shelves, an idea, which earlier had been developed by other research workers. This can be achieved by putting one row in the cupboard and one row on the door shelves or by step shelves within the cupboard.

Workers at Cornell University have conducted research in kitchen planning, which was finished in 1952.[6]

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5. Thye, L.S., A Step - Saving U - Kitchen. USDA., Home and Garden Bull. 4. 1951.

5¹. Morris, C.K., Pardee, E., Improve Your Kitchen Storage. Michigan State University. Coop. Ex. Service. Bull. 365. 1959, p.5.

6. Beyer, G.H., Weise, F., The Cornell Kitchen., Cornell Univ. 1952, p. 58.

The cabinets for the Cornell Kitchen are designed for complete assembly or to be added separately to other types of cabinets. The most important features concerning these cabinets are: shallower shelving, space for interchangeable drawers and trays, adjustable counter heights, and special cabinet doors.

The basic construction features of the storage cabinets are identical. The shelves are of two widths: 6 and 12 inches, in the upper cabinets, and are adjustable and interchangeable, as are the sliding doors. Within the base cabinets, the bread board, lap-board and bread box are adapted to the same mechanism that slides trays and drawers. The counter height[7] of these cabinets is adjustable by means of vertical metal spacers. The height can be adjusted over an interval of six inches by parallel grooves in the metal spacers, which are located at the back wall at each side of a base cabinet. The counter tops are slid into the grooves at the desired height.

There is a special type of drawer, which combines a sliding mechanism with the drawer itself. The drawer is a tray type, fitted into the cabinet by pins, which are attached to stationary bushings, and snap into slotted louvres on the side of the cabinet.

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7. Cornell, op. cit., p. 67.

The doors of some of the base cabinets also have a special construction. A narrow central space (cartridge) both supports the cabinet counter top and contains the doors, when the cabinets are open. The doors slide out of the cartridge on grooved guides, until stopped at the front edge. Then they are swung sideways to close the cabinet. Each cartridge contains two doors.

The wall cabinet at the mix center in its lower half, contains molded plastic bins for flour and sugar. The flour compartment holds 25 pounds. At the bottom of the compartment is a flour sifter, whereby flour is sifted directly into a bowl on the table. The sugar compartment can hold 10 pounds. Both tilt forward. Beside this construction are three shallow shelves for small articles. In the upper half of the cabinet are stored packages and cookbooks in files.

The base cabinet has on one side a bread and cake box, that slides out under a small tools tray. The box is divided by vertical and horizontal movable partitions. The other side section of the base cabinet has at the top a slide-out tray for bowls, a lap-board, and at the bottom, a slide-out shelf with vertical dividers for pans and baking sheets. The bottom shelf has at the front a triangular wire handle, projecting upward, which makes it possible for the worker to pull the shelf out, and grasp the pans without stooping.

Maud Wilson wrote[8] that vertical pull-out panels in base cabinets generally are more convenient than shelves, provided they move easily when loaded. They can be built for specific purposes, with shelves, hooks or racks. Mrs. Wilson recommends one or two sets of vertical slots for a kitchen, two - four inches wide; one set could be 14 inches high by 12 inches deep; the other one, 20 inches high by 16 inches deep. The slots may be placed between shelves in a floor-to-ceiling cabinet or as a back section of an end base cabinet, with the opening of the slots at the side of the cabinet. Back ends of a wall cabinet may also be utilized for slots. In both the latter cases stored trays and pans will be parallel with the front panel of the cabinet.

In "Space Design for Household Storage," 1952,[9] Helen McCullough suggests that "all kitchen supplies, except for large canning equipment and a large roaster can be stored in cupboards of 12 inches depth."

Slanting files are used for trays, baking sheets and serving dishes. Whenever possible, according to the character

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8. Wilson, M.: A Guide for the Kitchen Planner., Agr. Exp. Station., Oregon State College, Bull. 482, 1950, p. 13.

9. McCullough, H.: Space Design for Household Storage. Univ. of Illinois Agr. Exp. Station, Bull. 557, 1952, p. 46.

of an article, the cabinets, designed at the University of Illinois, were built with shelves, which curve back and are adjustable. The doors were often equipped with racks, hooks or shelves.

A cabinet for packaged foods might have the door shelves 3 inches deep. These hold packages stored broadside, while the cupboard shelves, cut back to 8 inches, permit most packages to be stored with the narrow end out, and provide space for canned goods.

In Architectural Forum, 1946,[10] Miss McCullough and Mrs. Heiner also emphasize the value of shallow, cut-back shelves, vertical, slanting, and horizontal files.

For the mix center they suggest a unit, consisting of upper open shelves, four inches deep, below which commonly used utensils are hung on the wall. The height between counter and wall shelves is 15 inches. One half section of the mix center base cabinet consists of a shelf for the electric mixer, which swings out and up to almost counter level like a typewriter desk. The other half of this cabinet is a pull-out panel.

They also have designed a "Swing Storage Cabinet" to store food supplies. The height is 78 inches; width 24 inches, and depth 14 inches. The upper part is divided

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10. McCullough, H., Heiner, M., Products and Practice.,Arch. Forum., February 1946, p. 155.

into"leaves", which means that there are four vertical surfaces, hinged at one side. They thus provide four storage sections instead of the usual two. To prevent tipping of foods, edges are provided on the shelves of the leaves.

Special features, which have been adopted by the American Heart Association,[11] for a wall cabinet above the mix counter are open shelves and "gravity - feed" bins. The lower shelf is six inches deep, the upper one deeper with vertical files. To the bottom of the shelf are attached the gravity bins for flour and sugar. They glide out for filling. Rolling pin, spoons, whisk and other small articles are hung on a perforated wall board beneath the wall cabinet. Mixing bowls are placed on revolving shelves, attached to the door of a base cabinet.

Companies that manufacture kitchen cabinets are indebted to all of this research work, part of which has been reviewed. The companies have incorporated in their new designs many of these storage features.

Several companies offer base and also wall cabinets with curved ends, with open or closed shelves. When floor space is scarce, the handicap of protruding sharp edges is diminished.

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11. American Heart Assn., The Heart of the Home., 1948, p. 17.

A corner base cabinet arrangement, which differs from the more common circular revolving shelf arrangement has semicircular shelves, attached to one of the doors, adjacent to the corner. The doors, are hinged at the inside edge. Sometimes the shelves are detachable for cleaning.

The commercial cabinets also feature: sliding trays with bottle racks; flour and sugar bins with hinged covers in deep drawers; a bread box with sliding cover, built into a deep drawer; a wire rack for various sized cans shaped so that three rows of cans are placed in a slanting position on the sliding tray, and movable, vertical files. Corner wall cabinets may be utilized as mentioned under base cabinets, or may be equipped with circular rotating trays, attached to the shelves with or without a center post.

Midway units, 10 inches high and 8 1/4 inches deep, or less, with sliding doors provide extra storage between counter and bottom of the wall cabinet. One company has attached a "condiment nook" beneath a wall cabinet. It slides out as a drawer, and then tilts down to a stop in a slanting position, for easy reach. It is spaced for small items. A "knife nook" is constructed in the same way, but has a rack for knives.

Features Suggested for the Sink Center.

The Small Homes Council[12] defines the Sink Center in the following way:

"The sink center is used for dishwashing and for the preparation of foods, which first require water. At this center there should be storage space for foods needing soaking, washing or the addition of water, fruits and vegetables not requiring refrigeration, saucepans, coffee pot, tea pot, double boiler, kettles and strainers, knives and brushes, dishwashing and cleaning supplies; provision for waste disposal". Dinnerware may be stored near the sink, preferably near both the sink and dining areas. For a right handed person it is generally accepted, that the work moves most efficiently from right to left. This places the dish cupboard to the left of the sink.

The sink center in the first Beltsville Kitchen[13] has a double bowl sink. The left bowl is only 3 1/2 inches deep, and is intended for washing vegetables and other foods. There is open knee space under the left bowl, so that the worker may sit. Storage compartments are at

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12. Small Homes Council. Handbook of Kitchen Design. University of Illinois. 1950, p. 7.

13. Howard, M.S., Thye, L.S., Taylor, G.K., The Beltsville Kitchen - Workroom. USDA. Home and Garden Bull. No. 60, 1958, p. 4.

counter level (below a window). Onions and potatoes are stored in ventilated tip-out bins to the left of the counter. On the end wall of a dish cabinet on perforated hardboard saucepans are hung.

Back of the sink above counter height in a compartment with sliding doors are dishwashing supplies. In an open compartment, back of the sink are can openers and paper towels. To the right of this is a narrow rack for knives, one placed above the other. There is a food waste disposer in the left sink bowl; other trash is thrown into a trash chute through an opening, which can be closed by a horizontally hinged door. The trash container is a deep drawer at the bottom of the base cabinet under the right sink bowl. It rolls out on casters for emptying. It has a removable metal lining. If possible the trash chute may be connected with a basement container.

Below the left sink counter is a drawer section. To the left of this is a full-length storage cabinet with an accordion - folding door. The base part of the cabinet is of counter depth, and deeper thanthe upper part. When the door of the upper part is open, the counter becomes at the same time a shelf and working space. Beneath are drawers for silver, pull-out shelves for linen, vertical files for large dishes and trays, and shelves for small table

appliances. The upper part of the cabinet has adjustable shelves for china and glassware. The top shelf, which is deeper, holds packaged foods.

In the Beltsville Kitchen, Design No. 2[14] the sink center is much the same. The main difference between the two kitchens is, that in the sink center in kitchen no. 2 the mid-way wall cabinets are hung on the wall instead of being built-in compartments at the back of the sink. These cabinets are 11 1/2 inches high and 5 inches deep, and hang beneath the window. The sliding doors are perforated to allow ventilation. The top of the cabinet may be used for placing small, frequently used items.

The sink center, planned for farm kitchens by Bureau of Home Economics[15] is placed beneath a window. To the left of the window is the cabinet for glass and dinnerware, at the end of which is attached a small dish towel rack.

The cabinet under the sink offers room for dishpan, supplies and a wastebasket, attached to the door. It can be reached quickly through a swinging closure in the door. Immediately to the right of the sink cabinet is a 12 inch

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14. USDA. Beltsville Energy - Saving Kitchen. Design No. 2 leaflet No. 463., 1959, pp. 3-4.

15. Holbrook, H.S., Your Farmhouse., Planning the Kitchen and Workroom., USDA Home and Garden Bull. No. 12, 1951, p. 16.

wide pull-out panel. Its open side faces toward the sink. Behind the panel is a full-width shelf at the bottom, while the upper shelves become narrower. Hooks for brushes etc. are provided.

The corner cabinet has been made into a garbage and trash disposal unit. It is divided into sections for cans, for paper, and for garbage. The three openings are beneath a lift-up lid, well lined and set flush into the counter. As the lid is operated by a foot pedal, no handle interferes with work on the counter. All sections are opened by means of doors in the outside wall for removal of the contents.

In "A Step - Saving U - Kitchen"[16] it is said, that the counter for preparing vegetables and stacking dishes need not be as deep front to back as the mixing counter. Hence four bins are built below a window for vegetables and fruit to the right and the left of the sink. Behind the sink is a compartment for cleaning supplies. Immediately to the right of the sink is an oblong opening in the counter for garbage. The garbage container, the opening and counter lid are metal-lined. As this kitchen is designed for farm homes, the garbage pail is meant for

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16. Thye, L.S., A Step - Saving U - Kitchen., USDA, Home and Garden Bull. No. 14, 1951, p. 7.

vegetable peel and food waste to be given to hogs. It can be removed from the outside or the inside. Below this compartment are two drawers. The other base cabinets are designed in the traditional way. To the left of the sink is a floor - to - ceiling cupboard with revolving shelves for dishes and cereals. The revolving shelves below the counter level hold large utensils, also used at the range.

A Michigan State University Extension Bulletin[17] recommends that use be made of the space under the sink by installing pull-out towel bars, door racks to hold supplies, Removable shelves to fit available space is also suggested.

The Cornell Kitchen[18] has a one piece sink counter top, sloping slightly toward the double bowl sink. At the back is a continuous line of small storage bins for fruits, vegetables, soaps, canned and packaged foods, paper towels and small utensils, closed with sliding doors.

The space under half of the sink is open, except for the base, which serves as a foot rest for a seated worker.

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17. Morris, C.K., Pardee, E., Improve your Kitchen Storage. Michigan State University. Cooperative Extension Service. Ex. Bull. 365, 1959, p.8.

18. Beyer, G.H., Weise, F., The Cornell Kitchen, Cornell Univ., 1952, p. 61.

To the left of the open space is a swing-out compartment for garbage. It is operated by a "spring-release" catch and swings completely out through the open space under the sink. The handle is easily reached, when the compartment swings out in this way. It contains three separate and removable receptables for paper, for garbage and for cans. To the right of the open space is a cabinet with sliding trays. Next to that is a section for storing and drying towels and dishcloths on sliding racks. Beneath the dish pans are stored.

Mrs. Wilson[19] offers the following general recommendations for the sink center. The front rim of the sink bowl should be as narrow as possible, and so should the apron. It is necessary that the space under the sink be adequately ventilated. The doors should be heavy enough to permit installation of racks. A feature, which may make more use of the space under the sink, is a movable separate filing section. It is located on a shelf, and can be pushed from one side to the other. This eliminates the necessity of moving individual items to get something. Overall dimensions for drawers used as utensil drawers near the sink, or for the average kitchen are 16 inches

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19. Wilson, M., A Guide for the Kitchen Planner. Agr. Exp. Station. Oregon State College, Bull. 482, 1950, p. 27.

wide by 4 inches high by 22 inches deep. A desirable height for insets of the drawer is 1 1/2 inches to give freedom of hand action.

In "Space Design for Household Storage"[20] a simple storage cabinet for range and sink utensils is shown, to be used where a combination may be desirable. The cabinet is designed as a double panel cabinet with racks and shelves on each panel, respectively for utensils used at the sink and at the range. One panel swings open as a usual cabinet door does.

In the Architectural Forum[21] Mrs. Heiner and Miss McCullough accept the combination sink-range panel as a convenient storage method at this center. One of their suggestions for a sink unit includes a shallow sink bowl (if the counter height is 36 inches). They found that a desirable "depth"of counter from front to back is 18 inches, and that a horizontal tool panel immediately over the sink splashboard offers great conveniences. The under-sink cabinet is designed with a pull-out panel for half of the cabinet. It holds dishpan and two shelves for cleaning

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20. McCullough, H.E., Space Design for Household Storage., University of Illinois., 1952, p. 47.

21. McCullough, H.E., Heiner, M.K., Products and Practice, Architectural Forum, March 1946, p. 187.

supplies. The other half part contains a pull-out shelf, and a shelf for garbage receptacle fixed on the door.

Mrs. Heiner and Miss McCullough found that on an average, 16 small tools were used at the sink. Space was provided for these on the back panel.

They suggest a free standing dish cabinet for a small kitchen, where counter space is inadequate. It is 76 inches high, 36 inches wide and 12 inches deep. Upper doors, 18inches high, hold files for trays and platters. Below is a drop-front, 12 inches high. The upper cabinet is occupied by shelves for glass and china. Beneath the drop-front are drawers for silver, linen and towels. The lower shelves are designed for larger bowls and appliances and are open.

The kitchen of the American Heart Association[22] has a solution to the problem of waste disposal similar to that of the "Step - Saving U - Kitchen." To the right of the sink is a hole in the counter top. The top of the metal container beneath is flush to the counter. It is placed on a shelf, attached to the door, and thus swings out for removal. The cabinet under the sink holds dish-towel racks and pans placed on door shelves. The most

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22. American Heart Association., The Heart of the Home. 1948, p. 15.

frequently used pans and small tools are hung on racks on the wall within easy reach. Soaps and measuring cups are placed on a shallow shelf. Open upper shelves are used for storage of everyday dishes and glassware.

Some commercial companies offer cabinet doors of grill work to substitute for solid doors, when ventilation is needed, for example, for sink cabinets, cabinets where towels are dried and for vegetable cabinets. The 3 1/2 inch deep sink bowl is shown by many companies. One of the purposes of this shallow sink is to facilitate work for which the worker is seated. Hence a recessed sink front is featured below the front rail, formed by the sink. With a food disposal unit the front may be recessed 8 1/2 inches, when the total depth is 25 inches. Without a food disposer a recession of 9 5/8 inches is acceptable to permit space for drain tubes. Sliding towel racks cannot be used in this case. Towel racks are offered by most companies. Usually there are three metal or plastic tipped rods, which slide on a bracket by means of nylon rollers. Some companies have furnished the special towel cabinet with a small electric heating element.

One unit for the food-waste container is designed as a deep drawer, 18 3/4 inches high in the upper part of a base cabinet. The drawer is furnished with two plastic waste baskets. The drawer has stops and is fully accessible.

There is a vegetable storage unit with three sliding, ventilated trays of metal mesh. Another type of vegetable storage has three wire baskets, that fit on a sliding tray.

Another company features a special linen storage base cabinet containing 9 sliding shelves, one inch deep, equally spaced.

In order to utilize empty space in dish cabinets or similar wall cabinets, a wire cup - and - glass rack may be inserted by means of shelf clips. The width of each rack is 4 1/2 inches. The cups slide in, with the handles down between two metal wires. Another methods of utilizing the underside of shelves in wall cabinets, is to use suspended metal wire shelves. Racks for cups or other small items are likewise suspended.

Besides, cup hooks may be attached to the underside of a shelf. Intermediate space between base cabinets may be used for two narrow, tall vegetable bins of wire, one above the other. They are constructed so that they slide out. Other possibilities for using intermediate space are vertical tray dividers, towel racks, and a sliding rack for pots and pans.

A base cabinet may function as a pull-out panel with sliding racks or both sides of the cabinet furnished with wire cradles; for example, three shelves above each other. This construction may be used in a sink cabinet for pans and cleaning agents, instead of the traditional shelves.

Features Suggested for the Range Center.

The Small Homes Council[23] defines the range center as "the place concerned with actual cooking processes. It has storage space for skillets, lids and saucepans used directly at the range as well as for the smaller utensils used here. Canned vegetables and other foods used first with boiling water also belong to this center. The serve center has no specific appliance, but is part of, or closely related to the range, and sometimes to the refrigerator. There is storage for electric equipment, for trays and for ready - to - eat foods".

As the separate oven and cooking surface gained popularity, Small Homes Council[24] in 1956 carried out research in regard to the location of the oven. Often the built-in features necessitate certain adjustments in standard kitchen arrangement.

The advantages of this installation are that the oven needs not be installed in the main cooking area; moreover, it may be installed at a height, convenient for the homemaker. Storage space becomes available underneath both

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23. Small Homes Council., Handbook of Kitchen Design., University of Illinois., 1950, p. 8.

24. Small Homes Council., Separate Ovens., University of Illinois., C. 5.33. 1956.

the oven and the cooking surfaces. Also more flexibility is gained in regard to number, kind and placement of the burners or units of the cooking surface, as well as the placement of the controls. The oven can be built into a wood or metal cabinet or into a masonry wall.

The Small Homes Council suggests, that these considerations should be taken into account: all surface cooking units or burners should have a heat-proof area adjacent to them. The lowest rack of the oven is best located at counter height, and counter space should be provided adjacent to the oven. From this it follows, that more floor area is necessary for built-in features. Floor space should be adequate in order not to sacrifice needed counterspace. In order to prevent heat damage to the cabinet above the oven, the cabinet can be set back a few inches; but this space does not offer convenient storage facilities. If two ovens are installed, it is suggested that they be placed side by side instead of one above the other.

One conclusion of this research was that the oven should be closely related to the mix center. Good suggested locations for built-in ovens are:

1. Opposite mix and sink centers.
2. At extreme end of cooking sequence next to the serve center.

3. As part of any center, that is isolated from the other centers.

4. In a corner between two centers.

The Beltsville Kitchen No. 1[25] is furnished with a surface cooking top and a separate oven. The three top units are staggered so, that is is not necessary to reach over the front ones to use those at the rear.

Utensils used daily are hung on perforated hardboard at each end of the cooking top. Under the cooking top is a unit with drawers and a cupboard with pull-out shelves.

The oven is placed to the right of the surface cooking top. Under the oven are three drawers for oven accessories, paper sacks and tall beverage bottles. Above the oven is a cabinet with vertical dividers for serving dishes. The back half of this upper cabinet is separated from the front. It opens toward the end, thus providing space for extra large platters and trays.

In the Beltsville Kitchen, Design No. 2[26] the base cabinet under the top cooking surface has revolving, half-circle shelves. In one plan the range unit with cabinets

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25. Howard, M.S., Thye, L.S., Taylor, G.K., The Beltsville Kitchen - Workroom., USDA Home and Garden Bull., No. 60, 1958, p. 7.

26. USDA Beltsville Energy - Saving Kitchen., Leaflet No. 463, 1959.

is an island arrangement. The alternate plan shows the oven with cabinets and refrigerator as an island arrangement.

In "Planning the Kitchen and Workroom"[27] there is mention of a pull-out panel on one side of the range. Its open side faces toward the range. The shelves are graduated in width. Vertical dividers are used on the bottom shelf for lids. The base cabinet on the other side of this range has two drawers for small utensils. Cupboard space below the drawers is equipped with removable vertical dividers for roasters, racks, platters and trays. Above the range is an 8 inch wide, low shelf.

A "Step - Saving U - Kitchen"[28] pictures shallow, open shelves above the range. They are lined with asbestos. The lower shelf is designed for such supplies as flour, sugar, salt, pepper, coffee and tea; the upper - for cereals. A wall cabinet with double fold, hinged doors, which fold back flat, is shown 24 inches above the range. The lower shelf is used for platters. The second shelf has vertical files, whereas the top shelf is meant for

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27. Holbrook, H.S., "Your Farmhouse. Planning the Kitchen and Workroom., USDA Home and Garden Bull., No. 12, 1951, p. 18.

28. Thye, L.S., A Step - Saving U - Kitchen., USDA Home and Garden Bulletin, No. 14, 1951, p. 11.

extra packages. Next to the range is a serving counter with drawers and base cabinet. The wall cabinet above the serving counter opens into both the dining room and the kitchen. At the back of the serving counter, beneath the wall cabinet are sliding doors, which provide a passway for food from kitchen to dining room.

The cooking center of the Cornell Kitchen[29] has the cooking units set into the counter top. The base cabinet beneath the counter is closed by doors, which recede in the same way, as described on page 56. The cabinet contains adjustable pull-out shelves for pans, skillets and kettles. A wall cabinet is placed above the range. Its shelves are adjustable, interchangeable and of varying depth. The doors are of the sliding type. The cupboard above the built-in oven is for linen and towels. Below the oven is a cupboard vertically divided. The bottom shelf pulls out by means of a triangular wire handle, attached to the front edge of the shelf at each side. This eliminates stooping by the worker.

Miss McCullough suggests in "Space Design for Household storage"[30] a free standing cupboard for the range

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29. Beyer, H.G., Weise, F., The Cornell Kitchen., Cornell University, 1952, p. 62.

30. McCullough, H.E., Space Design for Household Storage., University of Illinois., 1952, p. 46.

center. The cupboard might be 78 inches high, 14 inches deep and 16 inches wide. It is designed to accomodate all items required at the range center, including about 20 packaged foods, which ordinarily are first used at the range, as well as serving dishes.

All the shelves in this cupboard are cut-back and adjustable. The top shelves are for packaged foods and light weight articles. Next, are shallow shelves for bowls and platters. The design makes it possible to store bowls and dishes individually. Frequently used pans, skillets and griddle can be stored on shallow shelves nearest counter level. The bottom shelves accomodate less frequently used and large articles. At one side on the bottom of the cabinet is a vertically divided tray section. The door is furnished with racks for stirring, turning and measuring tools and other small utensils used first at the range. Below these racks on the door is a holder for pot covers.

Miss McCullough recommends a combination range-sink cabinet when floor space is limited. It has been described under the sink center.

Miss McCullough and Mrs. Heiner write in the Architectural Forum,[31] that the conventionel range has "been broken into

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31. McCullough, H.E., Heiner, M.K., Products and Practice., Architectural Forum, Vol. 84, 1946, p. 187.

many pieces, and in the interest of saving effort, and in regard to safety standards, it should never be reassembled again". Accordingly they have designed a surface cooking cabinet, only 16 inches in depth, to reduce the reaching over pans. Under the cooking surface are two counter - balanced tip-out bins, vertically divided. One of the bins holds five surface cooking utensils. A divided drawer above the other bin holds stirring and turning utensils. The bin below is for pan covers. A variation of this cabinet has a tip-out bin for cooking utensils; but the other section is a pull-out panel, built for storage of tools on one face of a vertical divider and of lids on the other face.

Peet and Thye[32] recommend a narrow shelf above the range as an aid in saving time and energy. Hooks for saucepans and tools may be attached below the shelf. Knife racks should be nearby.

Many manufacturing companies offer range hoods, which fit beneath or inside of wall cabinet units. They vary in size and shape. The cabinets for built-in ovens are furnished with ventilating assemblies, which usually include

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32. Peet, L.J., Thye, L.S., Household Equipent., 1955, p. 349.

a blower, vent-duct, filter and switch. Besides the oven assemblies, there may be cupboard or drawer space as in standard cabinets. Some commercial companies build a base cabinet for a narrow space next to a range. This may be equipped with a pull-out rod. The rod has a twin set of hooks for pots and pans.

Several companies are offering automatic appliance centers. These may be built into cabinets at the range center or at the mix center. An appliance center may feature five or more individually protected circuits, which can be operated at the same time. Sometimes one or two of the outlets can be operated by an automatic control clock. The appliance center is usually serviced by a double voltage circuit from the fuse box.

General Improvements.

Improvements can be added to already existing cabinets in many different ways.

The University of Massachusetts has found[33], that space is often wasted between shelves in many of the old cabinets. A removable shelf, supported by legs at each

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33. Dale, V. M., Ideas for Extra Storage., University of Massachusetts, Cooperative Extension Service., Publ. No. 324, p. 6.

end, can be placed on the original shelf. It is usually advisable to make this shelf half the width of the original one. Stepped shelves may also be used. They have two or more levels, and thus raise the articles in the back high enough to be seen, and easily reached. The University of Massachusetts also suggests the use of perforated hardboard, as liners for closets, fastened to walls and doors. With hardboard it is easy to attach adjustable shelves, hooks and special holders. When hooks are used, on the under side of a shelf in a wall cabinet, they should not be too curved, as it may be difficult to hang and remove articles and cup handles may break. Drawers of old cabinets are often too deep for convenience. One way to make use of unemployed space in a too-deep drawer, is to insert a tray in the upper part of the drawer. The tray can be guided on runners and have a smaller area than the lower part. It may then be moved from side to side, when something is needed from the lower part.

Sometimes very high wall cabinets are placed above a base cabinet, to facilitate reaching the high shelves, Oregon Agricultural Experiment Station[34] recommends a step board. The step board may be located about 12 inches

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34. Oregon State College. Patterns for Kitchen Cabinets. Oregon Agricultural Experiment Station. Bull., 446, 1949, p. 26.

from the floor; it can be pulled out between two drawers.

Some old base cabinets are too low. To solve this problem the American Heart Association[35] recommends raising the work counter by adding a section of shallow drawers on top of it.

Sometimes in old kitchens a chimney interferes with proper work conditions. If a chimney is a corner one, it may be covered diagonally with a piece of perforated hardboard.[36] This hides the chimney and gives space to hang frequently wanted utensils. If a chimney protrudes from a wall, the suggestion is to build regular upper and lower cupboards, adjacent on either side of it. Against the face of the chimney shallow shelves are built. The lower section of the chimney is covered by a false front; the counter flows around the chimney in an uninterrupted line.

Sometimes very large, old type kitchens may have convenience added by installing island or peninsula groups of cabinets. A peninsula may sometimes be added to a small kitchen in order to increase storage and work areas without using too much floorspace.

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35. American Heart Association.,The Heart of the Home., 1948, p. 23.

36. Halderman, E.C., Kitchen Problems, Household Magazine, Jan., 1958, p. 32.

Mention has already been made of making use of the free side of a cabinet by adding perforated hardboard for hanging utensils. Rounded shallow shelves may terminate a base or a wall cabinet.

Some commercial companies offer wheeled base cabinets. These cabinets fit in with the standard cabinets, and it is possible to lock the wheels in a fixed position.

SUMMARY

A number of the selected American storage features may be incorporated into or added to the kitchen plans in the current kitchen exhibition, sponsored by the Danish Home Economics Council. These features may also be used in advising homemakers through the various channels of information, employed by the Council: radio, pamphlets, telephone service, mail correspondance as well as personal conferences in kitchen planning. For the exhibition, the following features are likely to be selected, in the opinion of the writer, as first choice; they are features, which do not require too great changes of the existing Danish kitchens.

The shallow sink bowl for cleaning vegetables is not commonly used in Denmark, but it may be a suggestion for improvement of kitchens.

"Midway" units could be placed between the counter and wall cabinets. They augment storage space. Furthermore, several energy studies found, that a narrowed counter depth is preferable for many tasks. Hence these midway units need not be a sacrifice of usable counterspace.

Food waste disposers are rare in Denmark, mainly because the installation of them requires special permission.

Hence the problem of hygienic and conveniently arranged waste containers is important. The use of a corner cabinet for this purpose may be applicable. An opening in the counter top through which garbage is emptied into a container, relieves the worker from stooping. Also a swinging closure in the cabinet door, which encloses the waste container facilitates waste disposal.

Vertical slots, built into the end of base and upper cabinets provide an unusual storage compartment, which could easily be adopted in many Danish Kitchens. Besides providing extra storage space for large platters and trays, these slots contribute to making space in high and deep cabinets more accessible. Along the same line may be mentioned the vertical dividers, which are more frequently used in American cabinets than in Danish ones. They serve to improve both visibility and reachability of articles in high and low cabinets.

The semicircular shelves in American corner cabinets may easily be installed in old corner cabinets. This can be done with less rebuilding than revolving shelves would need. The latter are more commonly known in Denmark.

Better accessibility to shelves may be achieved by the special handle, designed at Cornell University. It is attached to a sliding bottom shelf; it projects about

12 inches upwards, and so eliminates stooping. To gain easier access to high shelves of cupboards, which are frequently used in farm kitchens, a pull-out step board may be inserted between drawers in a base cabinet. Often in old kitchen cabinets sufficient space is available, but is not made useable. The various recommendations for addition of half shelves, stepped shelves, wire shelves and racks, hooks and drawer insets may be followed in order to accomodate storage for extra articles.

Space may be wasted not only within the cabinets, but also in terms of intermediary space between cabinets or between cabinets and a door or an appliance. Several suggestions were offered to use these spaces. One example is a narrow cabinet with deep sliding vegetable bins; another is a pull-out rod on which saucepans are hung.

Perforated hardboard, which often was demonstrated both in American research studies and by commercial companies is another achievable possibility for extra storage.

The studies concerning height and location of built-in ovens may be of interest to Danish home economists and research workers. The separation of the oven and cooking surfaces is only a recent trend in Denmark. Hence, very little research has been carried out there in regard to time and energy expenditure in the use of the separated parts of the range.

Not all the features, provided in American kitchen cabinets, and selected for this study, may be applicable in Danish cabinets in the near future. However, this comparative study of American and Danish research in regard to time and energy expenditure, space allowances and the actual designs of kitchen cabinets may give suggestions for further research to be carried out in Denmark. For example, the study revealed a difference between accepted counter height, in case only one height is used. The most convenient height was found by American research to be 32 1/2 - 33 inches for the average American woman. However, in practice, the 36 inch height for work counter is used almost exclusively -- mainly because all the ranges are built 36 inches high. In Denmark, the counter height is usually 34 - 35 inches. The average height of a Danish woman, nevertheless, is accepted as slightly more than the average height of the American woman. These findings indicate that more research may be needed to establish the most desirable standard height for work table. In most Danish kitchens the counter height is even lower than the recommended 34 inches. In the older kitchens the conditions can be improved quite inexpensively by placing a shallow section of drawers on top of the counter, as was suggested by the American Heart Association.

Another finding, which showed the differences between American and Danish kitchen functions, is the fact that for regular kitchen work in America most trips were taken between the sink and the range center, whereas in Denmark most trips were made between the sink and the mix center. America uses more processed foods; these often need no preparation at the mix center. This is a fact that influences both the location and the design of the cabinets.

The value of a well considered arrangement of equipment within the proper areas was demonstrated by research, done at the Beltsville Institute. This was found to be more important than the addition of new equipment. Hence the recommendation by the Bureau of Home Economics to rearrange stored articles in order of frequency of use may be a guide to each individual homemaker.

This study also leads to the conclusion that there has been a rapid development in the field of kitchen research during the last twenty years in both the United States and Denmark. Much has been accomplished. However, because of economic considerations, it is not always possible for the homemaker to make full use of all of the present knowledge about kitchen and cabinet design, as it relates to the saving of time and energy. But there are certain guiding principles, which may be followed with little or

no money expenditure. The following principles have been the basis for the research which has been accomplished in this field. The individual homemaker can also apply these principles in the organization of her kitchen:

1. Adaptation of any plan or feature of kitchen cabinet to suit the individual type of household, which is to use them.
2. Arrangement of equipment to provide rational work sequences.
3. Storage of articles nearest the point of first use or of most frequent use.

APPENDIX 1

List of Essential Articles for Storage in a Kitchen.

American Kitchen - Cornell Study. 1952

MIX AREA

Utensils

Baking:

3 baking sheets

12 custard cups

1 casserole and cover

1 square cake pan

1 tube cake pan

2 round layer cake pans

3 loaf pans

2 muffin pans

4 pie pans

3 pudding pans

2 wire cooling racks

Equipment

Mixing:

Bowls: 1 pt., 1 qt., 2 qt.,
4 qt., 6 qt., and
1 electric mixer.

Equipment Continued

Measuring:

1 set measuring cups for dry ingredients

1 measuring cup for liquid ingredients

household scales

1 set measuring spoons

Hand tools:

1 sugar scoop

1 can and bottle opener(hand)

1 biscuit cutter

1 cookie cutter

1 egg beater

2 stainless steel forks

1 bread knife

1 paring knife

1 nut cracker

Hand tools Continued

1 pastry blender

1 rolling pin

1 rubber scraper

1 flour sifter

1 spatula

1 wooden spoon

2 stainless steel tablespoons

2 stainless steel teaspoons

Supplies

Other:

cookbooks

funnel

food grinder

grater set of 3

bread and pastry board

hammer

pliers

screwdriver

paper bags and string

1 roll wax paper

1 knife sharpener

Food

25 packaged goods

9 bottled goods

10 items of baked goods

4 supplies, purchased in bulk.

SINK AREA

Utensils

1 colander

1 colander with mallet

1 double boiler and cover

6 qt. kettle with cover

12 qt. kettle with cover

6 qt. pot (side handles) with cover

1 qt. saucepan

2 qt. saucepan

3 qt. saucepan

4 qt. saucepan and cover

Hand tools:

1 vegetable brush

1 can opener, wall type

1 apple corer

1 French knife (or at mix)

2 paring knives

1 floating blade vegetable knife

1 pair kitchen shears

1 orange squeezer

1 large strainer

1 small strainer

Equipment

Cleaning supplies:

2 boxes cleanser, open

1 rubber plate scraper

1 metal scratcher

1 bar laundry soap

1 bar toilet soap

2 boxes open soap powder

2 rolls paper towels

Linens:

6 aprons

4 clean dish cloths

2 used dish cloths (or sponge)

6 clean scrub cloths

6 clean pot holders

12 clean dish towels (or at serve)

4 used dish towels

5 clean hand towels

1 used hand towel

Dishwashing Equipment

1 dishpan

2 dish drainers

1 metal tray

Garbage and Trash:

3 gal. container for wet garbage, receptacle for empty cans, receptacle for waste paper

Supplies

Other:

1 chopping board (or at mix)

2 empty qt. glass jars

1 cup liquid measure

1 stool (or at mix)

Food:

8 canned goods

Fresh vegetables and fruits

4 packages dried food

RANGE AREA

Utensils:

4 cup drip coffeemaker

12 cup percolator coffeemaker

1 double boiler and cover

8" frying pan

10" frying pan and cover

11 1/2" frying pan and cover

2 griddles

1 tea kettle

1 roasting pan and rack

1 covered roaster

1 tea pot

Equipment:

2 forks, 2 tine

1 ladle

1 butcher knife

1 set meat slicing knife
and fork

1 paring knife

1 potato masher

1 pancake turner

1 perforated mixing spoon

1 nonperforated mixing spoon

1 wooden spoon

1 sharpening steel

1 pair of tongs

Supplies

Measuring:

1 set measuring spoons

1 set measuring cups

1 qt. liquid measure

1 oven thermometer

1 deep fat thermoneter

1 meat thermometer

Food:

11 packaged goods

SERVE AREA

China

Glass

Silverware

Linen

Electrical Equipment:

grill and cord

toaster and cord

Waffle iron and cord

Other:

2 ash trays

1 metal tray

3 hot plate pads

4(2 pr.) salt and pepper shakers

1 pkg. paper napkins

7 packages food

APPENDIX 2

List of Essential Articles for Storage in a Kitchen.

Danish Kitchen - The Danish Home Economics Council. 1949

Utensil	Utensil (Continued)
Pots and saucepans:	1 can opener
4 1/2, 4, and 3-liter, with lids	1 cork opener
1 1 1/2-liter saucepan	1 bottle opener
1 pressure saucepan (desirable)	2 whisk beaters
1 frying pan	2 wood (or plastic) spoons
1 tea kettle	2 kitchen spoons (steel)
1 coffee pot	2 kitchen teaspoons (steel)
1 ceramic teapot	1 perforated spoon
1 meatknife	1 liter measure
1 knife with scalloped edge	1 deciliter measure
1 vegetable knife	3 measuring spoons
1 potato peeler	1 round pudding form
1 butterknife	1 round pan with loose bottom
1 pair of scissors	1 rectangular pan
1 bread-slicing machine	1 strainer
1 turner	1 cutting board
1 shredder	1 plastic funnel
1 parsley grinding mill	

Utensil (Continued)

1 colander

1 reamer

1 nylon scraper

1 pan rack

1 toaster (non-electric)

1 fork

1 rolling pin

1 pastry brush

1 meat thermometer

1 alarmclock

1 kitchen paper rack

1 flour shaker

skewers

1 egg divider for cooked eggs

1 set of mixing bowls

1 meat storage dish

2 plates

1 butter container with cover

1 margarine container with cover

1 coffee box

1 tea box

2 cookie boxes

1 salt box

1 pitcher

Utensil (Continued)

1 shelf with condiments

aluminum foil

1 laminated wood tray

Dishwashing Utensils:

1 dish pan

1 dish tray

1 dish drainer

1 rack for dishcloths

1 dish brush

1 pan scrubbing-brush

1 soap container

1 sink cleaner

1 bottle brush

1 rack for cleaning powders and brushes

1 holder for wastebags

dishcloths

steelwool

China

Glass

Silverware

Linen

Food:

15 packaged goods

15 bottled goods and condiments

20 canned goods and condiments

17 supplies bought in bulk

6 items of baked goods

fresh vegetables and fruit

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