EQUIPMENT SELECTION AND LAYOUT DESIGNS FOR FOOD SERVICE AT PUNAHOU SCHOOL, HONOLULU

by

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INTRODUCTION

This study was conducted to formulate criteria and make recommendations for the application of these criteria in selecting equipment and planning layout designs for the proposed food service building at Punahou School, Honolulu, Territory of Hawaii. It was hoped that the findings would be of use to those concerned with organizing school food service departments in the Territory of Hawaii and in similar subtropical areas.

Punahou School occupies a unique position in the educational and civic life of Honolulu; its influence is felt throughout the Territory. Punahou is the largest private college preparatory school, other than parochial, in America (23). It has an enrollment of approximately two thousand students, ranging in age from five to eighteen years. The food service department caters to one thousand day students, grades three through twelve, at the noon meal and one hundred fifty boarding students and faculty for all meals.

Social, educational, and physical needs of students, faculty, and employees were prime considerations in developing criteria for equipment selection and layout designs as presented in this study. Criteria were based on objectives of quality food service, nutritional adequacy, optimum efficiency, sanitation, safety, and most economical use of financial and labor resources.

Consideration was given to food service problems which are related to sub-tropical climates in general and to the Territory of Hawaii in particular, located as it is twenty-four hundred miles from the American mainland and largely dependent upon it for supplies.

Problems arising from the widely variant and predominantly Oriental population were discussed in relation to institution food service employees in the Territory of Hawaii. Special consideration was given to the need for modifying certain equipment specifications because of cultural patterns and anthropometric measurements of Oriental food service employees in the Territory of Hawaii.

Data were collected to:

1. Set up criteria for layout designs and equipment selection based on recommendations of food service authorities.
2. Gain pertinent information from certain members of the American Dietetic Association, regarding specific equipment and layout needs for food service institutions in the Territory of Hawaii.
3. Secure specific information about the architectural limitations and new equipment requirements for the proposed food service building at Punahou School.
4. Plan layout and arrangement of equipment for the proposed food service building at Punahou School.

REVIEW OF LITERATURE

Educational Implications for School Food Service

The philosophy of school food service has undergone many changes in recent years. In early American education, little attention was given to problems of nutrition and health. Today, there is increasing evidence that the school is assuming responsibility for factors which affect the physical well-being of the child as well as for factors which concern his mental development. The Interagency Committee on School Lunches reported that (29, p. 17):

> The most persistent trend in school lunch programs at the present time includes the serving of school lunches as a regular part of the educational services to children.

A corollary development in connection with this trend appears to be an acceptance of the concept that the school food service is an integral part of the total school program, and as such should provide facilities and opportunities for learning experiences. Engelhardt et al. (13) stated that in the modern school, the cafeteria is no longer simply a food service but an instructional service as well, offering as it does a variety of opportunities for educational growth.

According to these writers, if the school is to be a place in which young people and adults live and work together harmoniously, the food service department must be planned so as to make its greatest possible contribution to this program

of harmonious living. The consuming of food and the development of ideas often go hand in hand. Activities which promote school and community interests are frequently launched in the school cafeteria (13).

The school food service department should be designed for multiple use to insure maximal utilization of space and to provide opportunities for certain kinds of social learning and participation that are not always feasible in other phases of school work. The facilities of the department thus should be adaptable to general educational purposes such as forum discussions, school social functions, and other activities which are held concurrently with the regular school program. Such educational specifications for the modern school cafeteria present significant implications which must be considered in the planning of food service units (13).

Approaches to Planning

The ultimate aim of all food service is the preparation and service of food of excellent quality and nutritional adequacy, using the most effective and economical methods. It is, therefore, of prime importance that the layout and the equipment be planned so that these goals may be achieved (12, 39).

"Kitchen designing is a science, but it is not an exact science (6, p. 18)." Individual problems develop with each area; it is therefore impossible to design a kitchen by the

rule-of-thumb method.

Thomas (27), West and Wood (39), and Gillam (14) each emphasized the importance of consulting the food production expert or dietitian before plans are drawn. Too frequently inefficient and inadequate food services result because the suggestions of the dietitian are disregarded. While the dietitian is not expected to be an authority on construction features, she should be thoroughly familiar with the problems of the specific situation.

West and Wood (39) recommended that the architect, the food director, the business manager or administrative officer, the engineer, and other qualified persons work together to formulate the detailed plans after the building allowance has been approved. The pooled knowledge, interest, and opinions of such a group will minimize the chances for error in developing the plans for an efficient and functional food service. According to Bryan (7, p. 118):

> The experience of architects who plan dormitory food services and dietitians who operate these services indicates the importance of early and frequent conferences at all stages of planning and construction.

Wall (32) in a report on layout and design of equipment for hospital installations stated that experience and a thorough knowledge of the basic requirements for the specific situation are essential for intelligent kitchen planning. The many variable factors such as the size and shape of the

available space, the extent and type of service desired, the geographical location of the project, and the budget allowance for the installation, all influence the final design.

The professional advice of food service consultants can save the architect many times the fee for such service. Any rule-of-thumb space allocation is dangerous when attempted by an inexperienced designer since the actual space needed for the translation of the progress may vary several hundred per cent because of special requirements, need for flexibility, location, shape of available space, or other factors. The space needed can be determined only by an actual layout with the required equipment spotted (26).

In reviewing the literature related to the function of the food service department, it was found that frequent reference was made to the present trend of applying principles of industrial plant methods to kitchen planning. Thomas stated (27, p. 14):

> The ultimate aim of management is to control production so that the required product shall be of the required quality, shall be produced by the best and least expensive method, and that it shall be produced at the required time. Industry has transferred the responsibility for this planning from the workers to a planning department. It is the duty of this planning or production department to arrange for the execution of the work to meet the schedules of requirement and to prevent difficulties from occurring. Food service establishments could employ this method of control to excellent advantage.

The institution kitchen is essentially a factory for the production of food. The problem of arranging equipment within

the kitchen is closely related to that of arranging the production machinery within a factory. The factory and the institution kitchen differ in one respect. The factory is usually concerned with the production of a single item or possibly a series of closely related items. The institution kitchen, on the other hand, is concerned with the preparation of a wide variety of products which are being prepared in varying quantities. Timing of these products is of further importance. To assure optimum quality at serving time, the food products must be completed at the correct time (24).

Thomas (27) developed criteria for ascertaining the equipment needed for institution kitchens and the arrangement of the equipment which will result in maximum output with a minimum amount of labor. The scope of the menu must be determined before such a study can be conducted. Each menu item is traced through the various pieces of equipment in which it is processed. As each particular item progresses from storage through preparation and cooking to the service area, a record is kept of the equipment used, its capacity, the time used, and the total preparation time. After this information is collected, process charts of products through equipment may be prepared which portray the steps involved in the preparation of a menu item. From these charts, it is possible to determine the total equipment needs of an institution kitchen. By this method, the arrangement of the equipment is based on the

flow of material in direct routes from one stage of processing to another, with the movement continuously directed toward the serving counter for the majority of the products.

Dana (12) suggested that the problem of institution kitchen planning be approached according to the menu pattern, the type of food service and the character of the clientele, the size of the establishment, and the production quantities.

A project to establish standards for space allowances and routing in institution food service departments was initiated by the American Dietetic Association in 1944. The study was continued during 1945 and 1946 by a committee of the Food Administration Section* and became known as Project #4, Planning the Postwar Kitchen. The Committee stated that (1, p. 34):

> The essence of modern architectural planning is based on function . . . . Simplified building must be preceded by simplified thinking, which in turn depends on an understanding of fundamental requirements.

According to The Committee, there are two stages in an architect's approach to a design. The first of these is the preliminary stage when the overall areas should be determined for which space should be provided. There is no detailed planning at this stage; however, estimates of gross square footage and general locations are required. Detailed study is a part of the second stage of planning.

The Committee (1) recommended the use of flow charts in

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*Hereinafter to be referred to as The Committee.

planning the institution kitchen. As the first step in planning, a flow chart is made which shows the steps that the work must take, their sequence, and the relations of the various working units to each other. This chart graphically portrays how the work proceeds from receiving area to storage, thence to pre-preparation, preparation, service, consumption, and disposal of waste. It further shows which units of the department need contact with each other, which with the rest of the institution, and which with the out-of-doors.

After the basic flow chart is made, the second step is to orientate the general plan to the building. Certain units need to be accessible to others. These proximity requirements include (1, p. 35):

> (a) Accessibility of main corridors, stairways, and elevators to dining rooms, offices, and locker rooms;
>
> (b) Accessibility of service elevators to . . . , garbage and trash storage, and storerooms;
>
> . . . . . .
>
> (d) Outside windows desirable in preparation and production areas, dining rooms, dishwashing units, and offices;
>
> (e) Outside exits needed for receiving area and garbage and trash storage.

This group of writers pointed out that the necessary partitions within the food service department should be shown on the flow chart. If the number of partitions is kept at a minimum, problems of light and ventilation will be less,

supervision will be easier, space will be saved, and there will be fewer walls to wash and corners to clean. It was recommended that the following areas be enclosed: receiving; refrigeration and storage; preparation; processing; cafeterias and dining areas; dishwashing; offices; employee facilities; and garbage and trash (1).

In the third step, the relationship of the units within the department are planned in such a way that work may proceed without back-tracking and with a minimum of cross-traffic and effort. The fourth step is to allot space so that working units will be separated to avoid confusion and so that each unit will have sufficient working space. To accomplish this, the requirements of each individual area must be studied (1).

West and Wood (39), Dana (12), and Segeler and Setchell (24) agreed that the use of templates is helpful in planning kitchen arrangements. A plan of the available space is drawn to scale usually one-fourth inch to the foot. Pieces of cardboard cut to scale represent the various items of kitchen equipment. By arranging these templates on the floor plan, it is possible to visualize the layout. The templates may be shifted until the most desirable arrangement is found. By this method, one can clearly observe whether aisle space is adequate, and how much interference is likely to occur among personnel.

Architectural Features

Ventilation, acoustical treatment, and lighting as well as the fundamental factors of shape and size should be considered when planning the architectural features of a food service unit. In addition, there are other essential features which will not be discussed in this study.

Ventilation

All rooms in which food is stored, prepared, or served, or in which utensils are washed shall be well ventilated according to the United States Public Health Service Ordinance and Code Regulating Eating and Drinking Establishments. The reason given for good ventilation was (30, p. 21):

> Proper ventilation reduces bacterial concentration in the air, odors, condensation upon interior surfaces which may drop into food or utensils, smudging of walls and ceilings, excessive heat, and the concentration of toxic gases produced as a by-product of combustion or otherwise. Moisture promotes mold development.

In a food service department with adequate outside windows in all areas, and in a mild climate, a hood and a pull-out fan over the heated equipment may suffice. In most establishments, however, partial or complete air-conditioning is usually advisable (1).

Air-conditioning implies more than the popularly used term "air cooled". It includes heating, control of humidity, and the circulation, cleaning, and cooling of air. Systems

have been perfected whereby the controls for all factors are established in one central unit. The system may be regulated to filter, heat, humidify, and circulate the air in winter and, with the addition of cooling coils and refrigeration, maintain a desirable temperature in summer. Dehumidification may be necessary in certain climates. Since air-conditioning systems are in the experimental stage, it is essential to seek the aid of a heating and ventilating engineer in selecting an air-conditioning system (39).

Acoustical treatment

Reducing disturbing and undesirable noises, beyond what may be accomplished through control of personnel, may be achieved through the use of noise-absorbing surfaces and furnishings and by the use of certain types of construction which tend to break the transmission of sound. The use of acoustical plaster or other sound-absorbing materials for wall and ceiling finishes will help minimize noises. Ample space, furniture glides, composition rather than metal trays, tablecloths, and table pads all contribute toward the lessening of noises (39).

The use in the kitchen of sound-proof materials in wall, ceiling, and floor construction and finish will aid further in reducing noise. Sound-proof motors, automatic lubrication of the so-called noiseless power equipment which maintains it in quiet working condition, rubber tired trucks, rubber collars

on openings in dish-scraping tables, garbage cans on rubber casters, and ball-bearing glide table drawers diminish noise in the kitchen (39). In addition, a three-sixteenth inch coat of acoustical paint applied to the under surface of metal tables will aid in reducing noise. Acoustical treatment is an essential factor in achieving customer comfort and employee efficiency (1).

Lighting

Adequate natural as well as artificial illumination is essential for the food service department. Ample light promotes cleanliness and efficient performance of duties by employees (30).

West and Wood (39) attributed fatigue and general debility of employees to improper amount and kind of light. The lighting should be planned to insure glareless white light. Glaring light reduces efficiency, impairs vision, and increases the possibility of accidents. Twenty to thirty foot-candle intensity is recommended for general lighting in food preparation and display units with an increase up to fifty foot-candles in intensity on working surfaces. Supplementary lights installed above or near the working areas will supply the increased amount of lighting.

Wiring is an important consideration in the planning of illumination. West and Wood (39) advised installation of

wiring which is adequate to provide for an economical distribution of electrical energy for future requirements. Should wiring be too light to carry the specified wattage, energy is lost between meter and light, light generation is lower than rated, and cost is higher. Installation of wiring, panel boards, and switches should be in accordance with the National Electrical Code requirements.

Fundamental factors of shape and size

Theoretically, the ideal kitchen layout would be circular. This arrangement is ideal from the standpoint of reducing walking and interference. However, this is obviously impractical as no appliances are made to fit circular designs. The square is the nearest practical approach to the theoretical ideal because it has the greatest area for the distance enclosing it of any common shape (24). If a kitchen is rectangular, its length should be no more than twice its width. It is desirable to have the doorways between the kitchen and dining room on the longer rather than the shorter side of the rectangular kitchen. Having the doorways on the shorter side increases the distance employees must travel within the kitchen and slows up service (24, 39).

Early in the planning procedure, adequate space must be estimated for the preparation and service of meals for the number of people to be served (39). Since each food service

area has specific requirements, it is evident that space allotments must be worked out for each individual problem. There are basic principles and figures available which will be valuable in estimating space allowances. Each expression of opinion, however, is qualified by references to physical differences, varying needs, and individual ideas (12).

In many institutions, the kitchen area is approximately one-fourth to one-third as large as the dining area. This space relationship is usually estimated exclusive of the area required for dishwashing, the receiving and storage of food, and for employees' rest rooms and locker rooms (39).

Table 1 shows a number of space allowances as cited by West and Wood.

According to Gillam (14), Wells, a kitchen equipment engineer, expressed the total area, exclusive of storage and employee facilities, in terms of 100 per cent. He suggested 40 per cent allocation for the kitchen area and 60 per cent for the dining room.

The variety of types of food service offered in institutions makes it impossible to set up standard measurements for the units within the department. The fundamental areas for which space must be provided are: receiving, storage, preparation, processing, service, clean-up, linen service, office space, and employee facilities (1).

Percentage allocations developed by Wells serve as a

Table I*

Space Requirements per Seat

Types of food service	Square feet per seat	
	Dining room	Kitchen
Commercial restaurants	14	3½ - 4½
Commercial and university cafeterias (including service area)	15	3½ - 4½
Commercial lunchrooms (counter service only)	18	3½ - 4½
Residence halls	15	3 - 4
School lunchrooms	9	1 for 500 or more. 1½ for smaller units with a minimum of 300.
Hospitals	12 to 15	18 to 20 (per bed)

*Table reproduced from West, Bessie Brooks, and Wood, Levelle. Food service in institutions. 2d ed., p. 453. New York. John Wiley and Sons, Inc. 1945.

guide in determining the proportions needed for various units. He recommended that the kitchen area be divided on a percentage basis as follows: preparation area, 18 per cent; pantry or salad and cold service, 10 per cent; cooking area, 18 per cent; service and pickup, 20 per cent; dishwashing, 10 per cent; pastry shop, 10 per cent; and halls and passageways, 14 per cent. In cafeteria service, 15 per cent of the dining area is required for the service unit (14).

Receiving and Storage Areas

Consideration of receiving and storage areas is essential for efficient and economical food service operation. Proper storage of food is necessary to protect the health of clientele, conserve food values, and prevent waste. Furthermore, well-planned storage facilities in relation to work centers result in saving time and energy of employees which in turn reduces labor costs (28).

Receiving area

The receiving area, where goods are examined and invoices checked, should be adjacent to or near to the storeroom and refrigerators. The receiving area should be large enough for weighing, counting, and inspecting the maximum amount of goods likely to be on the floor at one time. Space should be provided for a freight scale near the entrance. Doors to the

receiving room and corridors leading to the storeroom should be of sufficient width for two food trucks to pass (1, 11).

The receiving platform, with a height from the driveway equal to that of the floor of a standard truck, should be sufficiently long to allow for simultaneous unloading of several trucks. The platform should be covered and should be separate from the receiving room so that the temperature of the room may be controlled (1).

Types of storage space required

Different kinds of food, supplies, and equipment used in food service call for various storage conditions.

Storage space is needed for "dry stores", a term used to indicate non-perishable items. Refrigerated storage is essential for perishable items. Paper goods and miscellaneous supplies may be kept in the "dry stores" area, but there is less likelihood of damage by mice and insects if these articles are stored away from food supplies. In addition, plans should include space for storage of cleaning equipment and supplies, kitchen utensils, linen, personal belongings of employees, and garbage and trash (28).

The amount of storage space needed varies with individual institutions depending on the frequency of deliveries (39). Space should be calculated on the basis of amounts of merchandise to be stored at any one time. This is usually influenced by the following factors: the location of the institution;

the purchasing policy; the number of departments to be served by the storeroom and their requirements; and plans for expansion (1).

New food processes, such as deep freezing and dehydration, affect the nature and types of storage facilities required (24).

Central storeroom

The main storeroom should be located near the receiving center and in a logical line of routing to the kitchen storage and preparation centers. This route should be as short and direct as possible (1).

Basic requirements of dry storage areas as listed by The Committee were: cool, dry room without overhead pipes; artificial ventilation or cross-ventilation from properly located windows or louvres; double doors opening into a wide corridor; windows guarded with heavy screens; and good lighting. The Committee (1) was in agreement with Dahl (11) that ceilings should be twelve feet, and the number of doorways should be kept at a minimum.

The modern storeroom should have shelves, tables, bins, and doors of steel. If adjustable shelving of heavy steel is arranged to store a specific number of each item in a section, it is possible to determine the amount of each article on hand (11). A U-shaped arrangement with shelves open on both sides facilitates placing new goods at the back (1).

Dana (12) recommended that the width (front to back) of upper shelves should be eighteen inches so that three (double height) No. 10 cans or four (triple height) No. 2½ cans may be stored. The width of shelves at and below counter level may be increased to twenty-four inches. Where shelf units are opposite each other, two and one-half to three feet should be allowed for aisles.

It is preferable to store merchandise in case lots on platforms, approximately ten to twelve inches high, to minimize dirt accumulation and lessen opportunities for vermin or rat breeding.

Separate rooms for the storage of cereal products and for the storage of root and other vegetables and fruits which do not require refrigeration are recommended. The root cellar should be well-ventilated, dry, and cool but unlike other storage areas, it should be dark. In each of these rooms, sufficient space should be allowed for cross-stacking of bags and for circulation of air (1).

Refrigerated storage

Refrigerators may be located within the food service department, or in the central storage area. The storage refrigerators within the food service department should be accessible to the various food service units (1).

Sharp boxes (refrigerators held at temperatures below

freezing) should, wherever possible, be planned to open into refrigerated areas with as many of their sides as possible flanked by other refrigerators. These anterooms should be large enough for hand trucks to enter. Insulation should always be depressed in the floor construction so that the floor of the box will be level with the floor outside to permit the entrance of trucks (1).

In figuring the amount of refrigeration space needed, it should be remembered that in small walk-in refrigerators, the aisle space will almost equal the storage area of the refrigerator. For a given amount of refrigeration space, the longer (back to front) the refrigerators, the smaller the proportion of space needed for exterior aisles. Six feet or more is desirable for the exterior aisles in front of refrigerator doors (12).

The number and size of walk-in storage boxes required will depend on the scope of the menu, the number of persons to be served, the purchasing policy, and the community resources. Each must be considered before building. Refrigeration should be adequate to avoid crowding of supplies and to permit a shelf-arrangement which facilitates placing new stock at the back (1). West and Wood (39) reported that a space of two cubic feet per person served per day is recommended as a basis for estimating the refrigeration needs of an institution. They further stated that the geographical location greatly influences the amount of space required.

Garbage and refuse storage

A necessary adjunct to the efficient modern kitchen is an adequate storage unit for garbage and refuse. This area should be located near the service entrance or near an outside exit on a driveway so that refuse cans may be easily removed. An adjacent cement floor area with hot and cold water connections and steam jets should be provided for washing and sterilizing cans (1).

The area necessary for the storage of garbage and refuse will depend on the method and regularity of collections, the effectiveness of supervision in keeping left-overs and plate waste at a minimum, and the community garbage disposal practices (17).

Modern kitchens should provide refrigerated areas for garbage storage to improve sanitation conditions and eliminate unpleasant odors. If it is not feasible to construct a refrigerated unit for this purpose, a screened outdoor area should be provided (1).

Linen storage

The type and quantity of linen used and the proportion of the total linen supply to be stored at one time will have an effect on the space required for linen storage. The amount of reserve and new linen kept in storage and the frequency of laundry service will determine the total amount of linen to

be kept in storage at one time (1).

Clean linen is usually stored on shelves one and one-half or two feet wide. It is wise to estimate the size and numbers of each item to be stored and to calculate the capacity of each shelf before building. Work tables three feet by eight feet are recommended for counting and sorting linen (1).

The linen storage area should be located where it will be conveniently accessible to the food preparation and service units and the dishwashing area. Space should be provided for the collection, sorting, and counting of soiled linen. Such space should be well-ventilated and convenient to outside loading platforms (1).

Pre-preparation Areas

Pre-preparation units for meats and vegetables are usually found only in larger institutions. Handling carcass meats necessitates a pre-preparation area; whereas establishments purchasing fabricated meat often plan for the pre-preparation of meat in conjunction with its cooking. Preliminary cleaning of fruits and vegetables in a separate area reduces the amount of dirt and debris in the preparation areas.

The meat pre-preparation unit should be located between the refrigerators and the meat and vegetable cooking unit. In addition, it should be near the receiving area (1). Heavy equipment for meat cutting should include part or all of the

following: sink flanked by drain boards; electric meat saw; electric slicer; utility tables; meat block; scales; electric meat grinder; and hand sink (12).

The fruit and vegetable unit should be located near refrigerated and dry storage areas. Allowance should be made for the direct flow of fruits and vegetables from storage areas to each piece of equipment in logical sequence and out to the meat and vegetable cooking and salad and sandwich areas. Routing should be planned to avoid cross-traffic. The size and shape of the fruit and vegetable pre-preparation area will be influenced by the shape of the building, the scope of the menu, and the equipment required. Straight line, L-shaped, and parallel are three of the many equipment arrangements which may be used in this area (1).

In some modern installations, fruits and vegetables are prepared for final finishing before being stored in refrigerators. Refrigeration space is saved and double handling of materials is avoided if this plan is followed (7). The fruit and vegetable pre-preparation center must provide all or part of the following equipment: electric vegetable peeler; compartment sinks; raised platforms for bags and crates of fruits and vegetables; utility tables; and hand sink (12). The vegetable chopper and slicer should be located in an area that will be conveniently accessible to all units (1).

Navigation space for hand trucks, excellent lighting, and good ventilation are essential in these areas (7).

Preparation Units

Meat and vegetable cooking, bakery, and salad and sandwich units are considered the most vital zones of the food service department.

Meat and vegetable cooking unit

The meat and vegetable cooking area is usually located in the center of the main kitchen on the long axis of the room with other preparation areas around it. The logical work route then follows either a clockwise or counter-clockwise direction. This unit should be contiguous to the pre-preparation units, the pot and pan washing unit, the service units, and a hand washing sink. Carefully routed lines of travel will avoid waste of time, confusion in service, and friction between employees (1).

Factors affecting the space required for the meat and vegetable cooking areas are: complexity of menu; largest number of persons served at one meal; and the number and size of ranges, ovens, work tables, steamers, steam kettles, fryers, and mixers. All meat and vegetable units should be approximately ten feet in width, consisting of a table two and one-half to three feet wide, a space of four feet between the table and range, and a range approximately three and one-half feet wide. An additional two feet should be allowed for adequate cleaning if the unit is placed against a wall or back-to-back

with other equipment. The length of the unit varies with the size of the establishment, the menu pattern, and the consequent amount of equipment. Both the proportionate size of the unit and the amount of floor space per person served decrease as the size of the establishment increases (1).

The four methods of arranging equipment suggested by both Dana (12) and The Committee (1) were: (1) straight-line; (2) L-shaped; (3) parallel, back-to-back; and (4) parallel, facing. Parallel or L-shaped arrangements limit unnecessary steps and are preferred for institutions that require a great deal of large equipment. In each arrangement, sufficient space should be allowed for easy cleaning.

Work areas should be carefully planned to provide efficient and comfortable conditions for employees. For each preparation employee, at least four linear feet of work table space should be provided. This allowance should be increased to at least six feet per employee where three or four roasting ovens are used. Time and energy of employees will be saved if work tables are located near the cooking equipment (12).

Sufficient aisle space should be provided between cooking or other equipment and work tables to permit cooks to withdraw large roasting pans and turn to place them on work tables. For other work areas, a minimum of three feet aisle clearance is preferred unless portable trucks are used, when an aisle space of four feet is recommended. Where two work tables are

parallel to each other, the desirable clearance between tables is four feet or four feet, six inches. In large kitchens, main traffic aisles must be clearly defined. Work aisles in each department should be at right angles or parallel with main traffic aisles but separated from them. The cook, baker, salad maker, and pot washer should have working aisles that are not traversed by workers in other departments of the kitchen. Accidents will be avoided if this principle is observed (12).

Proper lighting and good ventilation are essential in the meat and vegetable cooking unit. Vented hoods hung from the ceiling over all cooking surfaces and steam units aid in ventilating the kitchen. Provision is thus made for controlling odors, smoke, moisture, and gas fumes (39). Six thousand two hundred eighty cubic feet of air exchange per minute per square foot of hood was recommended by Bryan (7). Hoods facilitate the installation of direct lighting fixtures by which cooking surfaces and work areas may be properly illuminated (39).

Bakery

The size of the bakery will depend on the extensiveness and variety of baked goods offered on the menu. The maintenance of quality food standards and good sanitation is possible only if adequate space is allowed to permit easy cleaning and efficient arrangement of essential equipment. Sufficient turn-around space should be allowed for the baker to remove products from the oven and place them on cooling racks. Space

is required for garbage containers and portable trucks (1).

The shape of the bakery will depend on the equipment to be used and on the relation of the bakery to other kitchen units. In some kitchens, the equipment is shared by various units. In such a case, the common equipment should be adjacent to these units. The bakery may be rectangular, L-, U-, or irregular shaped (1).

According to Dana (12), the location of the bakery in relation to the kitchen is elastic. Since baked goods do not deteriorate so rapidly as do hot foods, they may be more easily transported. It was the opinion of The Committee (1), however, that the bakery should have easy access to the storage areas and other kitchen units. Proximity to the service unit is considered essential.

Salad and sandwich unit

The location of the salad and sandwich unit should provide for direct routing of ingredients from their source of supply. Supplies are drawn from storage areas, both dry and refrigerated, and the fruit and vegetable prepreparation and cooking areas. The most essential factor to consider in the placement of the salad and sandwich section is its location in relation to the service areas. It is desirable to have salad refrigerators placed as close to the point of service as possible. A compact unit with a left to right work route and

the use of a refrigerator placed in the wall between the salad and sandwich preparation department and the service area with doors on either side is an ideal arrangement for the salad and sandwich preparation center (1).

Parallel, straight, L-, or U-shape may be used for the salad and sandwich unit. A minimum space allowance of four feet on the exposed work sides of a work table should be allowed to provide comfortable working conditions for employees and ample space for the use of large movable mixing bowls, carts, and other large equipment (1).

Tables, sinks, and refrigerators are the essential equipment of the salad and sandwich area. The salad preparation table should be large enough for the preparation and arrangement of salads on trays of chilled dishes. The mixer and food chopper should be easily accessible to this unit. Refrigerator space is necessary for storing salad ingredients and dressings, chilling dishes, and holding trays of arranged salads (1).

Dining and Service Areas

Dining and service areas located on first floor levels are frequently preferred. The dining room, however, may be located on any level, provided adequate service facilities are available. Light, airy, attractively decorated rooms are desirable for dining areas (1). According to Engelhardt et al. (13), a dining room that can be closed off from the service

area is desirable. Dining rooms that are separated from the activities and noises of the kitchen and service area can be used for various educational and community activities.

The cafeteria serving counter may be in a service room located between the kitchen and dining room, at the end or side of the dining room, or in an alcove adjacent to the dining area (39). The Committee (1) stated that the cafeteria service area should be one-fifth to one-seventh the size of the dining area. Approximately one and one-third square feet per seat should be allowed for the cafeteria service area in universities and hospitals, and seven-tenths square foot for school lunchrooms. The service area, nine to ten feet in overall width, runs parallel with the cafeteria line. The tray slide is twelve inches wide; the cafeteria counter is at least twenty-four inches wide; the space from the counter to the back bar is four feet wide; and the back bar is twenty-four to thirty inches wide.

Cafeteria counter

One of the prime considerations in planning a cafeteria is rapid service. All aspects of the counter service should be carefully studied to eliminate possible bottlenecks (24).

Service counters vary in length and arrangement depending on the menu pattern, the number of persons to be served, the time allowed for serving, and the necessary speed of service. The counter space must be sufficient for comfortable service

without crowding, and at the same time not so great as to demand more employees (1).

According to Bryan (8), West and Wood (39), and The Committee (1), the average school lunchroom cafeteria counter (fifteen to twenty feet) can serve from twelve to fifteen persons per minute. The average university cafeteria counter is thirty to thirty-two feet in length and serves an average of five persons per minute. The type of service used, whether continuous or intermittent, affects the number of persons that can be served during a given time. The number served per minute will decrease if continuous service exceeds thirty minutes as employees become fatigued and confusion in the kitchen and dining room increases (1).

There is a general trend toward the use of short counters as these are more easily supervised and require fewer employees. By limiting the number of hot foods served each day and supplying the counter with small pans of fresh hot foods at frequent intervals, less space is required for the hot food unit (8, 39).

A recent space-saving development is the use of only square or rectangular counter insets. This innovation in insets further affords maximum flexibility in the arrangement of several foods and makes it possible to control the quantities of foods to be held at any one time. At the same time, a wider variety of foods within the reach of each employee permits him to serve a maximum number of plates (39).

School cafeterias often maintain a separate cold table to sell milk and ice creams to children who wish to supplement their lunches from home. This lessens the space required for milk and ice creams on the main counter and thereby reduces the length required (1).

Cafeteria counters may be arranged in any of the following ways: straight line; two parallel lines with two steam tables, and two cash desks; two lines, two cash desks, but only one steam table; or two lines with one cash desk (1).

In addition to the hot food unit, space should be provided on each cafeteria counter for trays, silver, napkins, salads, breads and sandwiches, desserts, beverages, ice creams, and cash registers. It is desirable to have the salad display counter directly in front of the salad refrigerator which has two doors--one opening into the salad preparation department and the other into the salad counter area. The hot food unit should be nearest the kitchen entrance. In determining space allowances for various foods on the counter, it was found that the three groups: hot meats and vegetables; salads and cold plates; and desserts and beverages require approximately equal display space. The hot food unit should be purchased for the exact size and number of openings needed for the menu (1).

Clean-Up Areas

The clean-up areas include dishwashing facilities, storage of cleaning equipment and supplies, and pot and pan washing.

Dishwashing area

The function of the dishwashing department is the washing, sterilization, drying, and returning of all china, glassware, and silverware to its proper place. Careful planning is required to provide speed and efficiency at a low operating cost (24).

The dishwashing area should be located in a soundproofed, well-ventilated, and adequately illuminated room. Acoustical treatment for walls as well as ceilings is recommended because the dishwashing process is usually very noisy. Special attention should be given to construction, surfacing materials, and equipment to insure maximum sanitation (1).

According to Nordquist, the requirements for a good layout are (22, p. 509):

(a) Enough space. To get the advantage of the full capacity of the machine, there should be enough room for dish tables large enough to permit efficient handling of the tableware.

(b) Good flow. The table arrangement should provide for a good flow of dishes from a convenient point where soiled tableware is deposited on to the point of storage.

(c) A soiled dish table. This table should provide space for convenient depositing of the soiled dishes on the basis of preliminary sorting, a good rack loading zone, and a suitable runway for guiding the racks into the machine with smooth action.

(d) A clean dish table. Enough space for the movement of the racks of clean dishes will be needed so that the operator may wait a full minute after the racks have left the machine before touching the dishes (for air-drying of china).

(e) A rack return. A slide, roller, or belt arrangement is needed for quickly and easily returning empty racks to the loading zone on the soiled dish table.

(f) An unloading space. A shelf or table space will be required for stacking clean dishes, clean silverware, and stacking loaded cup racks (where they are used for washing, transporting, and storage of cups).

In planning the area for the soiled dish table, Dana (12) recommended that space be provided for the following: a preflush device; a soaking sink; dish machine racks; trays, while dishes are being removed; and an area for stacking china. According to The Committee (1), no exact size can be recommended for the soiled dish table. The number of soiled dishes returned at one time, the speed with which they are delivered from the dining area, and the capacity of the machine will affect the amount of space needed. If the machine is operated at maximum capacity, less soiled dish space will be required. If dishes are delivered to the area at a rate faster than they can be sent through the machine, it will be necessary to have more soiled dish space. The most efficient tables are approximately twenty-four to thirty inches wide. The table height is determined by the machine. Sixty per cent of the total space should be allocated to soiled dishes and forty per cent to clean dishes.

Factors that determine the size and type of machine required are: number of people served; time allowed to complete the washing process; type of menu; and type of service.

The clean dish table should be long enough to accommodate at least three dish racks to permit drying and cooling of the china before stacking. Some establishments prefer to unload racks directly to a portable table for transport to the dispensing stations. Approximately five square feet of clean dish table space should be provided for hand toweling silver, if this method of drying is used (12).

In addition to tables and dish machine, space in the dishwashing area is needed for auxiliary pieces of equipment. Provisions should be made for prerinsing dishes and for washing glasses and trays. A glass washer with revolving brushes for washing and a force spray for rinsing requires about two square feet of space. A sink, twenty-four by twenty-four by twelve inches, is necessary for soaking dishes that require special attention. Space should be provided for wheeling one or more dish trucks in and out of the dishwashing area (1).

There are various possibilities for arrangement of the equipment in this department. In the straight-line arrangement, dishes are received, scraped, sent through the machine and on to the clean dish tables, all from the same direction. An aisle, four feet in width, should be allowed on each side of the equipment. If the available space tends to be long and narrow, this is a desirable layout. When more width is available, the square type set-up is satisfactory. The U-shape is another popular arrangement. The soiled dish area should be easily accessible to the dining area (1). Because of the

noise, it is often desirable to have dishwashing away from the dining room. If these areas are not adjacent, mechanical conveyors save time and money in transporting soiled dishes to the washing area. It is of prime importance that the dishwashing department be located in such a way that soiled dishes may be routed to avoid interfering with routing of service and with the least crossing of incoming and outgoing traffic (39, 10).

Pot and pan washing area

Separate pot and pan washing areas for the meat and vegetable cooking unit and the bakery are desirable. In many establishments, it is necessary for both units to share the same pot and pan washing area. In such a case, the sink should be easily accessible to the cooking and bakery areas and located in the main kitchen in an open space that is well-lighted and well-ventilated. One-tenth square foot per person fed is recommended for this area in large kitchens, increasing to three-tenths square foot in small kitchens (1). Dana (12) recommended a three or three and one-half foot work aisle for the pot washer. This aisle should not be a traffic aisle for other kitchen employees.

The sink should be equipped with drain boards, splash back, and grease trap. A three-compartment sink is recommended for the three steps: soaking, washing, and rinsing. A drainboard, adjoining and sloping towards the soaking

compartment, is often used for the soiled pan area. Adequate space should be allowed to prevent placing pots and pans on the floor. Another drainboard should be provided on the opposite side of the sink for placing utensils after they are removed from the rinse water (1).

The clean pan storage area should be located as near the meat and vegetable cooking unit as possible. Utensils may be stored on a rack above the cook's table or on shelves (1). Pan storage shelves should be constructed of non-corrosive metal. Shelves should be removable and constructed of a single sheet of metal. Pans stored up-side-down on pipe or slatted shelving may be contaminated from dirt or floor dust (37).

Straight line and U-shaped arrangements are two popular and efficient methods of locating equipment. The soiled and clean tables or drainboards in the U-shaped arrangement are parallel and opposite each other at right angles to the sink. This arrangement offers the most economical use of space (1).

Cleaning supplies and equipment area

A specific area should be allocated for the storage of cleaning equipment. In large kitchens, it may be necessary to provide two such areas so that equipment will be readily accessible to all employees (1).

Mops and brushes should be washed and dried in a well-ventilated area or in the sun before storing in cleaning

closets (8).

A sink or trough with hot and cold faucets should be located in an unoccupied corner of the kitchen. A waterproofed square or a triangular section of floor with a drain and a three-inch coping will be more convenient than a sink. Racks for mops, brushes, and brooms; shelves for supplies; and space for mop buckets will complete this unit (1).

Employee Facilities

Adequate provision for the personal needs of employees is an important requisite. Locker rooms with showers, toilets, dressing space, and individual lockers should be provided. The rest rooms should open off a corridor and not directly off the kitchen or dining area (1).

A comfortable dining area for employees is needed. Provision may be made for serving employees in the main dining room before or after the service is opened to clientele. An employees' dining room is desirable for a food service department that has a large number of employees (39).

Administrative Office

The food service director needs an office for counselling, planning, interviewing, and conducting the business of the department.

The office should be located in or near the kitchen, preferably in an area that is readily accessible to the kitchen

and an outside exit (39). The kitchen-side partition may be of glass above a level of three feet and thus facilitate kitchen supervision from the office (8).

Overall office space requirements will be affected by the number of professional and clerical employees. Ninety square feet is the minimum allowance for an office equipped with a desk, three chairs, a bookcase, and a file (1).

Factors Affecting Selection of Equipment

The efficiency of work units and the quality of service attained in a food service department are largely dependent on the equipment. It is, therefore, essential for the food service administrator to understand the fundamental nature of kitchen equipment (32).

All equipment should be constructed of materials suitable from the standpoint of utility and durability, should be attractive in design, and should afford simplicity in cleaning. Ease and cost of operation, safety devices, and capacity are points to be considered (39).

Food service and kitchen equipment is generally divided into three general classifications: fixed equipment; fabricated equipment; and small labor-saving devices (37).

Materials

West and Wood (39) listed alloys of iron, nickel, and chromium as the most important noncorrosive metals used in

kitchen equipment today. The outstanding characteristics of these metals are permanence, resistance to ordinary stains and corrosion, lack of chemical reaction with food, ease of cleaning and fabrication, and attractive appearance. These are all features of food service equipment where appearance, cleanliness, and sanitation are of prime importance. The high ductibility and wearability of these metals result in permanence of the equipment constructed from them, and thus maintenance costs are reduced to a minimum. The initial cost of equipment constructed from noncorrosive metals is comparatively high, but the actual cost per year of service is considerably lower than that of equipment manufactured from other types of metals. According to Webber (34), depreciation losses are minimized and quality is provided which is of value far in excess of the difference in the original cost.

The increased use of stainless steel and Monel metal for kitchen equipment is due to their noncorrosive properties and their attractive appearance in both dull and polished finishes (22). The stainless steel commonly known on the market as eighteen-eight contains approximately eighteen per cent chromium, eight per cent nickel, and no copper. Monel metal is a natural alloy which contains approximately two-thirds nickel, one-third copper, and a small amount of iron. These alloys have a relatively low carbon content (39). Stainless steels are harder than Monel metal and are more easily cleaned (22). Stainless steel is recommended for use in a damp climate

because it does not oxidize or tarnish as readily as Monel metal which is one-third copper (16).

In specifying stainless steel as a material to be used in the construction of an equipment item, it should be remembered that the standard length of the alloy is ten feet and the standard widths of sheets are twenty-four, thirty, thirty-six, and forty-two inches. Wherever possible, specified dimensions should permit the use of a ten foot sheet. If a table top is to be fabricated with a rolled edge one and one-fourth inches in diameter, the overall length of the table could not exceed nine feet seven inches. In order to be fabricated from a sheet thirty-six inches in width, thirty-one inches is the maximum width that could be specified for the table. If a table ten feet and six inches in length is specified, it would be necessary to purchase an extra sheet of alloy or weld an extra section into the table; thus the cost of the table would be increased (37).

In selecting materials for equipment, consideration should be given to the gauge or thickness of the metal. The gauges most frequently used for noncorrosive metals in the construction of food service equipment are numbers twelve to sixteen. Gauges above sixteen may be used for sides or parts of equipment where the wear is light (39).

Metals may have a dull or bright finish. The surfaces of highly polished metals are more susceptible to scratches. The seven finishes for flat products as listed by West and Wood

are (39, p. 500):

Finish	Description
No. 1	Hot rolled, annealed and pickled
No. 2B	Full finish--bright cold rolled
No. 2D	Full finish--dull
No. 4	Standard polish, one or both sides
No. 6	Standard polish, tampico brushed one or both sides
No. 7	High luster polish on one or both sides
No. 8	Mirror finish on one or both sides

Aluminum is suitable for many types of food service equipment. Because of its light weight, durability, high thermal and electrical conductivity, and corrosion resistant properties, heavy sheet aluminum is used extensively for cooking and baking utensils and steam jacketed kettles. The heavy weight and high porosity of cast aluminum utensils make them less desirable than those made from sheet aluminum (39).

Cast iron is used for braces, castings, pipes and for certain types of fixed equipment. Galvanized steel and iron have long been used for fixed equipment when low initial cost is a necessary and limiting factor. The process of galvanizing refers to a protective coating of zinc which is deposited on the basic metal to protect it to some extent from corrosion. Galvanizing is soon worn and chipped off, however, leaving the base metal exposed. Such equipment corrodes easily and is difficult to keep clean or sanitary. The comparatively low initial cost of equipment constructed from galvanized steel or iron is quickly offset by the rapid rate of depreciation (39).

Fixed Equipment

The term, fixed equipment, refers to equipment manufactured by concerns specializing in the production of such items as ranges, ovens, fryers, steamers, steam jacketed kettles, mixing machines, vegetable peelers, dishwashing machines, and vented hoods (37).

Ranges

Many useful and efficient ranges designed in relation to the fuel to be used - gas, electricity, oil, and coal - are available on the market. Ranges for institution kitchens should be the heavy duty type. Heavy angle iron is used for frames, and the bodies are of number twelve gauge sheet steel. Range tops are constructed from cast iron or chrome nickel alloy (39). Stainless steel is now being used for the interior and exterior construction of ranges. A durable alloy containing approximately twenty per cent nickel is being used for range tops. This alloy has excessively high resistance to corrosion, warping, and cracking (9). The use of these alloys is an important factor in eliminating costly operation and maintenance costs (4).

Standard gas ranges are available in sizes approximately thirty-one to thirty-four inches wide and thirty-five to forty-two inches deep. Electric ranges are thirty-six inches wide and thirty-eight inches deep. Ranges are usually thirty-

six inches high (12).

The selection of range tops is influenced by the menu pattern and other items of cooking equipment which are to be used (10). Various kinds of tops are available for gas ranges (12, p. 165-166):

1. The open burner. These are useful for intermittent short order work or for controlling heat under small pressure cookers. They quickly become grease soaked and are not suitable for pots of large diameter.

2. The fry or griddle top. These are suitable for the heavy production of steaks and chops, eggs, and griddle cakes. They usually have two long parallel burners, extending front to back. Grease troughs around edges; grease receptacle in front and rear.

3. The even-heat top. Here the heat is distributed evenly over the entire surface, one half of which can be shut off or regulated at a temperature different from the other half. It is good for general cooking.

4. The ring top. These provide the greatest heat in the center where it is possible to remove the small round cover and apply heat directly to the bottom of the pot. These tops have less heat toward the edges which can be used for simmering.

The cooking tops of electric ranges may include even-heat sections, round hot plates, griddles, or a combination of these (12).

Ranges are equipped with oven or cabinet combinations. Range-oven or range-broiler arrangements are convenient for establishments that have limited space. The interior of the oven should be lined with porcelain enamel or other rust-resistant material (24). Number ten gauge sheet steel is

likewise recommended for interior oven tops and sides. Cast iron is generally used for oven bottoms. Ovens should have thermostatic heat control, good insulation, sturdy balanced doors, and cold door handles (39). Pilot lights, concealed manifolds, and removable burners are desirable features for gas ranges (24).

Ranges may be combined to form a battery of units. Spreader plates inserted between units will provide a larger working surface (12). Ranges should be placed on a solid fireproof base. Although ranges may be purchased with adjustable legs, the closed base will prevent dirt from collecting and eliminate a breeding place for vermin. The closed base is recessed, thus giving adequate toe space (24).

Range requirements should be based on other cooking equipment available, amount of range cooking for peak load, length of time in which cooking must be completed, type of menu, fuel cost, initial and upkeep costs, and the probable length of life of the range (39).

Deck ovens

Since the war, the trend has been toward using deck ovens rather than range-oven combinations. Sectional ovens are divided into two general classes, individually controlled and multiple deck. The market provides several models of each class (33).

Individually controlled sectional ovens have each deck

heated by a separate unit with individual control. These are available in single, double, and triple deck arrangements. The interior heights for baking ovens are from seven to nine and one-fourth inches while those used for roasting are eleven and one-half to twelve and one-half inches (24). Oven compartments are available in a wide variety of sizes. Exteriors of gas ovens vary from forty-eight to fifty-seven inches in width and thirty-five to forty-eight inches in depth. Exterior dimensions of electric ovens vary from fifty-four to seventy-three inches in width and from thirty-eight to sixty-seven inches in depth. Each section of an electric oven is provided with deck lights, upper and lower heating units, independent thermostatic control, and reversible three-heat switches (12).

The multiple deck unit consists of several compartments heated from one source and operated from one control. The interior shelf sizes vary from thirty-three to forty-two inches in width and from twenty-two to thirty-two inches in depth. These ovens are available in combinations of bake and roast sections. The multiple deck units are for gas, coal, and oil only (33).

To insure efficiency, ovens should have insulation on the top, bottom, and side walls. The doors should be insulated and of counter-balance design. Materials should be durable and easy to clean (39). One manufacturer provides oven compartments lined with tile or steel; another features a steel

deck with porcelain sides and top (12).

Recent developments for deck ovens include heat directors, connections for steam injection, timers, automatic shut-offs, removable shelves, safety pilot lights, and the use of non-corrosive metal for interiors and exteriors (5).

Oven capacity required must be determined by the individual food service establishment. Information needed to determine the correct oven capacity includes: total maximum daily output of baked products; the number of finished products by pans; size of pans; baking temperature for products; baking time for various products; and the hours of operation (33).

Deep fat fryers

Gas or electric deep fat fryers are available in a wide variety of sizes. Some models are designed for installation in a battery of ranges and ovens. Single fryer units hold from twelve to fifty-eight pounds of fat; double fryer units hold from sixty to one hundred sixteen pounds of fat. The openings of kettles vary from eleven to eighteen inches in width and from sixteen to eighteen inches in depth (12).

The bodies of deep fat fryers are generally constructed of heavy gauge steel. Many types are available in stainless steel, chrome plated steel, or Monel metal (24). Gas fryers are usually heated by three or four large-sized tubes through which the heat travels. Electric fryers are heated with immersion type units. Thermostats are standard equipment on all

fryers (12).

Compartment steamers

Compartment steamers are made in four basic types (12, p. 180):

1. Direct connection to a steam line from which the steam enters the compartment and passes over the food.
2. A steam coil, steam generator where the original supply of steam, as in some industrial plants, is not suited for direct contact with foods.
3. An electrically operated steamer.
4. A gas operated steamer.

Direct-connected steamers are available with a choice of two types of steam control. In the synchronized thermostatically controlled steamers, accumulated steam is discharged automatically by a drain valve which is synchronized with the thermostat. The other type is a free venting steamer. Steam passes freely through each compartment to an exhaust line which leads to a vented canopy or which connects with a cold water condenser. In these models, there is a drain line to a floor drain (12).

Steamers equipped with synchronized thermostatic control will process from four to six pounds of food for each pound of cooking steam used. Free venting units under ordinary operation will process from one to three pounds of food per pound of steam. The thermostatic control confines the steam, causing it to yield all of its heat in the cooking compartments. In

the free-venting systems, uncondensed steam escapes unused. These free-venting systems should not be used if the steam supply is limited (12).

It is important that the steamer be lined with a non-porous material. The volatile substances of foods collect in the pores of a porous metal and when steam is turned on, these substances are released and affect the flavor of the foods being cooked (10).

Models are available with stainless steel exteriors and interiors; enameled exteriors and stainless steel interiors; and enameled exteriors and galvanized interiors (12). Stainless steel is the most desirable material for interiors and exteriors because it is non-porous, rust resistant, and easy to keep clean. Stainless steel is also preferred for steamer baskets. Galvanized baskets are objectionable because the color of certain foods is darkened when in contact with galvanized materials (10).

Doors of steamers should be steam-tight. Strong hinges, perforated removable shelves, pressure gauge, safety release valve, automatic steam cutoff controlled by opening and closing doors, and steam condenser on the exhaust pipe are desirable construction features (39).

Steam jacketed kettles

Steam jacketed kettles are usually constructed of stainless steel or aluminum and are available in a wide range of

sizes. Kettles range in capacity from five to one hundred fifty gallons (9). Table tilting-type kettles vary from one to forty quarts (12).

There are two general types of steam jacketed kettles. One type is operated by steam supplied from an outside source, such as a high pressure boiler, a vegetable steamer, or a low pressure heating system. In the other type, known as a self-contained unit, the steam required is generated by heat supplied from gas burners or electric immersion heaters which are incorporated directly into the unit (15).

A steamer operated by steam supplied from an outside source is usually cylindrical in shape with a hemispherical bottom, to which is attached a larger hemisphere to form the jacket. The steam enters the jacket through steam inlets and circulates around the entire area of the inner shell. Steam kettles are available in deep or shallow models and may be either full or semijacketed and of stationary or tilting type. Stationary kettles are mounted on pedestals or frame stands (15). The trunnion kettle is mounted on a frame and is tilted by means of a worm and gear mechanism and is equipped with lever handles and pouring lips. Smaller tilting kettles are available as table top models (6). Kettles should be equipped with safety valves to prevent excess pressure, steam intake and return valves, removable or hinged covers, and removable draw-off faucets (39).

One manufacturer features a self-contained gas heated

steam kettle with automatic water level control. The welded steam jacket has no joints, and the seal eliminates the need for adding water (24). The need for a gauge glass, safety valves, and low water cut-off mechanism is eliminated (15).

Mixing machines

Mixing machines are one of the most useful labor-saving pieces of equipment in the institution kitchen. Pedestal, table, and wall types are available. Pedestal models are recommended for heavy duty, and the bench and wall models, which may be placed on a table or attached to a wall, are suitable for light duty (9).

Desirable construction features of a mixing machine are: enclosed, ventilated, splash-proof, and noiseless motor of sufficient horsepower to carry the maximum load; protected gearing; three or four selected speeds; easily operated bowl lift; circulating type of lubrication; and enclosed mechanical parts (39). One manufacturer features a mixing machine with a speed regulator that involves no gear shifting (12).

The base of the mixing machine is usually constructed of heavily enameled cast iron. Mixing bowls, varying in size from ten to eighty quarts, are available in stainless steel, Monel metal, and heavily tinned steel (39).

In addition to a variety of interchangeable whips and beaters, other attachments include: meat and food choppers; oil dropper; vegetable and fruit slicer with shredder plates;

juice extractor; knife sharpener; bowl extension rim; and bowl splash cover (39).

The type of food service, the quantities of food prepared at one time, and the menu will determine the number and capacity of mixing machines required for a particular food service unit (10).

Vegetable peelers

Peelers of various size, design, and construction are available. According to West and Wood (39), a peeler of twenty-five pound capacity is the average size preferred by food service establishments.

Peelers are frequently located next to the vegetable sink with the peeler door fitting over the sink. In this way, the vegetables may be discharged into the sink, thus reducing time and labor involved in handling. Automatic electric timing bells are used to avoid waste (31).

Points to be considered when purchasing a vegetable peeler are: quietness of operation; mechanical simplicity; ease of cleaning; type and thickness of abrasive lining; location and protection of motor; and durability of construction (22).

Dishwashing machines

The five basic types of dishwashing machines are (12, p. 101):

1. Two or three-compartment sink with turbulent flow in the wash compartment (motor and pump). Baskets with handles, containing dishes, are immersed in these compartments.

2. Small single tank--with superstructure door type with wash (motor and pump) and rinse sprays (water pressure). These have a revolving, telescopic or vertical set of sliding doors; the machines can be located on a straight loading and withdrawal line or at a right angle or corner loading and unloading. Some of these machines may be fitted with automatic timing devices for washing and rinsing periods or cycles.

3. Single and double tank with superstructure--open ends--manual type. These have motor and pump, over and under washer sprays over each tank, with a final "curtain" rinse, actuated by a lever as the rack is pushed through by hand. In view of the findings of sanitation research, relative to timed washing and rinsing periods--minimum of 45 seconds for washing and 10 seconds for rinsing--the manufacture of this manual type is likely to be discontinued.

4. Single tank with superstructure--open ends--rack conveyor. Wash and "curtain" rinse sprays similar to those in type 3. Since the curtain rinse does not provide a 10-second full rinse for each rack, this type is likely to be discontinued.

5. Two- and three-tank machines with superstructure--open ends--rack or belt conveyor. In this type, one tank is for washing at 130 deg. to 140 deg. and the second tank may be regulated to rinsing temperature--170 deg. with a final "curtain" rinse at 170 deg. for good measure. In the three-tank type, the first tank may be used to a great extent for flushing debris, while the other two tanks are for washing and rinsing.

Health departments are encouraging the use of a fourth tank as an integral part of the dish machine or a separate unit with an independent motor and pump for prewashing dishes. Extensions fitted with a superstructure in which compressed air is sprayed over and under the dishes to dry them is

recommended for the link-belt type machines (12).

The body of the dishwashing machine is constructed of heavy gauge galvanized steel, sixteen gauge Monel metal, or stainless steel (24). According to Bryan and Handy (9), the increased cost of the machine due to the use of stainless steel or Monel metal, good construction, and essential sanitary provisions is easily compensated for by the durability and low maintenance cost.

The size of the machine to be purchased is determined by the number of dishes which must be put through the machine in a given time by a given number of operators (10).

The selection of the machine should be based on a record of its previous performance, proximity to repair service, initial cost, operation cost, and certain structural features which, because of local conditions, may be influencing factors. The wash and rinse tanks of all machines may be heated by gas, electricity, or steam (9). Temperature control, increased speed, silent-type steam injectors, automatic rinse, automatic overflow with externally controlled drain valve, and enclosed ventilated splash-proof motor are additional features which should be considered before purchasing a dishwashing machine. Adjustable sanitary feet are an advantage if floors are uneven. Wash arms should be removable and easy to clean (39).

Vented hoods

Hoods designed to provide proper ventilation and to insure good working conditions should be placed directly over the heat and vapor producing equipment. The hoods should extend beyond the equipment over which they are hung by twelve inches in width and six inches in depth. They are available in various types. The wall type is fastened to the wall. The suspended type, desirable if cooking equipment is located some distance from the wall, hangs from the ceiling by chains or rods. Some hoods are the built-in type (24).

Hoods may be constructed of number eighteen gauge mild steel finished with two coats of aluminum or black lacquer; or they may be constructed of aluminum or stainless steel (12).

Grease-proof filters should be installed in hoods to minimize the accumulation of grease in the ducts and reduce fire hazards. These filters should be placed at a forty-five degree angle against the inside wall of the hood or in a V shape near the center of the hood (12).

Fabricated Equipment

Fabricated equipment refers to items which have been designed according to individual specifications.

Sinks, drainboards, dish tables, counters, and cabinets should have rounded corners, and intersections at corners should be fully covered. This feature affords greater ease

in cleaning and maintenance. Under-structures should be built of pipe legs with longitudinal tubular cross bracing and pipe runners of all-welded design. Excess weld metals should be ground smooth and polished. Crevices at joints, sharp edges, and rough surfaces are not only difficult to keep clean, but they frequently are the cause of lacerated fingers and hands (3).

Although dishwashing tables are fabricated equipment, they have been presented elsewhere in this study.

Cafeteria counters

According to Bryan (10) and the Committee (1), the hot food section of the counter should be planned for the exact size and number of wells needed for the menu to be served. Webber (36), however, recommended that the counter be designed in sections to allow maximum flexibility. Each section would resemble a bain marie and the top of each would accommodate three stainless steel collars. Collars with no cut-outs in the top could be used as solid panels to fill vacant portions of the steam table; others would be for rectangular pans or round containers of various sizes.

The hot food units of the counter may be heated by electricity, gas, or steam. There is a trend toward the use of electric units (10). An electric heat diffuser, which eliminates the need for water, steam coils, and waste outlets, is available for the operation of hot food tables. The unit

operates on a fractional horsepower motor with a thermostat. These units are recommended for tables not in excess of five feet. It would seem reasonable to divide the hot food unit into sections, thus affording flexibility in operation by the use of one or all the sections depending on the season and menu involved (35).

Webber (36) recommended that display shelves over cafeteria counters be supported by brackets which are attached to vertical pipes located at the rear of the shelf. Dana (12) emphasized that cafeteria display shelves should be protected by glass shields. To comply with the Public Health Code all food on display should be protected by glass (30).

A desirable form of dish storage is that which places china, glasses, and trays at counter level. This may be effected by the use of an automatic dispenser. Items are stored in a well located within the cafeteria counter. By means of an arrangement of sprockets and calibrated springs, the items are dispensed automatically as needed (36).

Sinks

Sinks should be carefully planned from the standpoint of their use. Durability, sanitation, and ease of maintenance should be considered in relation to the initial cost (10). Number twelve stainless steel or Monel metal is preferred for sinks (39).

According to Bryan and MacFarlane (10), sinks should be

thirty-eight inches high and twelve inches deep. Compartments should be twenty-four to thirty inches long. Dana (12) recommended limiting the width (front to back) of sinks to twenty-four inches and the depth to sixteen inches. Exact dimensions will depend on the particular use to be made of the sink.

Sinks should be welded, seamless, and of one-piece construction. Low splash-backs of approximately six inches may be used if faucets are mounted at the partitions between compartments. Lever-handled waste valves should be used instead of plugs (38). The front edges of sinks should be rolled to form an apron (9).

A recommended type of pot and pan sink has three compartments for soaking, washing, and rinsing. An additional small compartment with a removable perforated tray set on top is recommended to collect the food scraped from the pans. This additional compartment is located between the soak and wash compartments (10). By-pass steam injectors may be used in pot and pan sinks to step up the temperature of the water if the temperature of the water supply should drop below normal (38).

Drainboards should be the same height as the sinks and should slope downward towards the sink. The front and end edges of the drainboard may be turned up three inches and integrally rolled. If adjacent to a wall, the splash-back should be eight to twelve inches high and turned at the edge to a forty-five degree angle (12).

Sinks placed along the wall should be wall-hung on brack-

ets. If sinks are mounted on legs, angular or tubular metal legs with ball feet are recommended. Grease traps are necessary for all sinks. Ventilated soap compartments constructed under the left drain board of pot and pan sinks are a convenience (39).

Tables

Work tables for cooks, bakers, butchers, and salad employees may be made of stainless steel, Monel metal, or hard wood. Stainless steel, of number fourteen gauge, is preferable for long time use and for easy cleaning. Wood tops should be of maple or poplar strips tightly fastened together (10).

West and Wood (39) and Dana (12) recommended that table tops should be thirty-four to thirty-six inches above the level of the floor. Webber (38) stated that some authorities are of the opinion that standard working heights should be increased to thirty-eight inches to afford a more desirable working posture. He further stated that the additional vertical capacity of the substructures would make it possible to mount equipment on ten inch legs. Such an alteration would contribute to the ease of cleaning floors, and undercounter areas could be used to greater advantage. Portable garbage cans on dollies and tiers of stacked dish racks may be stored under tables.

Tables vary in length from three to ten feet. If cooks work from only one side of a table, a width of twenty-four to

thirty inches is recommended. Tables thirty-six to forty-two inches wide are recommended if cooks work on both sides. Center overhead shelves may be used on the wider tables (12).

Bakers' tables should have a curb at the ends and back six inches high. The front of the understructure of tables should be left open for the storage of barrel containers on casters (12).

Number fourteen gauge is recommended for stainless steel tables. The alternate edges that may be used are (12, p. 148):

(a) Integrally rolled, 1½" diameter to 180 degrees;

(b) Integrally raised approx. 3/8" and rolled 1½" diameter;

(c) Integrally raised approx. ½" in an inverted V and turned down approx. 2";

(d) Integrally turned down approx. 2" and under ½" with center point of vertical apron recessed approx. ½";

(e) (for dish table) Turned up 3" and rolled integrally at top 1½" to 180 degrees except, when adjacent to machine edge, to be turned down as specified by dish machine manufacturer; and except where, adjacent to a wall, the edge is turned up 8", 10", 12" and returned to the wall 2" at a 45 degree angle;

(f) Same as alternate edge a, b, c or d, except that front, rear, left or right edges (from working side) are to be turned up x" and hemmed or are to be integral with top of adjacent fixture either by weld or field joint.

Tables should be mounted on tubular or angular legs with adjustable ball feet. The table should be fitted with necessary channel braces and supports (39).

Shelves placed under table tops should be constructed of

a single sheet of heavy durable material. The shelves should be attached to the table legs with cast brackets fastened to each leg by substantial screws. Such a shelf is easy to remove and is easy to keep clean. There should be a ten inch clearance between the floor and undershelf for easy cleaning (37).

Refrigeration

The design of institutional refrigerators should incorporate durable construction, permanent finishes, serviceable interiors, and dependable refrigeration. Reach-in and walk-in refrigerators and freezers are used (18).

Manufacturers usually rate the size of refrigerators by the interior cubic content. Reach-in refrigerators are available in a wide range of sizes with capacities from fifteen to one hundred feet.

There are reach-in refrigerators with self-contained condensing units and others with remote condensing units. The condenser in self-contained units is located at the bottom of the cabinet and the front panel should be louvered to permit better circulation of air around the condensing unit. In the remote condensing units, greater cubic space is available for equivalent external dimensions because the condenser is placed on top of the refrigerator or located somewhere near the refrigerator cabinet. Condensers may be air-cooled or water cooled. The latter are preferred for warm climates or where

circumstances require the location of condensers in warm unventilated rooms (12).

Reach-in refrigerators may have wooden or welded steel frames with an exterior of stainless steel, vitreous porcelain enamel, or baked enamel lacquer on all exposed surfaces. Interiors are either stainless steel or vitreous porcelain enamel (12).

Interior lights are needed. Plated or stainless steel is recommended for shelving. Shelves should be adjustable or stainless steel angle slides may be used instead of shelves when salad or dessert trays are stored in the reach-in refrigerator (18).

The cooling device most frequently used within the refrigerator is a self-defrosting fin coil with a blower fan located on the back wall or between the door mullions (12). Straight gravity coils and ice making coils are also used for reach-in refrigerators (18).

Reach-in refrigerators located in the kitchen area should be constructed with at least three inches of corkboard insulation or equivalent (18). Plastic door jambs should be used to serve as breaker strips to prevent conduction of heat and cold from inner to outer walls. Insulated doors trimmed with rubber gaskets will provide a tight seal. Door handles should be designed for padlocking (12).

The function of walk-in refrigerators is to store foods and food products in larger quantities and for longer periods

of time. Separate refrigerated rooms are usually recommended for fruits and vegetables, for dairy products, and for meats and poultry since various foods require different temperature and moisture conditions and because odors from some foods are absorbed by others. The introduction of frozen precooked foods has an important bearing on refrigeration requirements. The use of increased quantities of frozen foods requires flexibility in the low temperature section and in compressor capacity. A fourth refrigerator room is therefore required by establishments using large quantities of frozen foods (18, 4).

The two distinct types of walk-in coolers used in food services are the cold storage room and the cooling room or service cooler. The cold storage room is a structural type which often uses an existing building wall as part of its construction. The structural coolers are built to fulfill the needs and space limitations of a particular establishment; thus standard space and size allowances are impossible to estimate (18).

Stainless steel or tile may be used for the interior walls. The floor may be of tile or concrete. Insulation materials should be installed in the doors, floors, walls, and ceilings (12). An exterior vapor seal should be used to seal the insulation and prevent infiltration of any moisture. Heavy supports are required for installing rails, shelves, and cooling units. Cold storage rooms should be built to the floor level to permit easy access to trucks or portable tables (18).

The cooling room or sectional cooler is a factory made product. The floors, walls, and top are manufactured as separate components. Each section consists of a framework of wood, steel, or other metal with interior ceilings, walls, and floors of metal or wood. One or more walk-in doors are provided to give access to the interior. Meat rails and hooks, shelves, and floor racks are included in interior equipment (18).

The service coolers are portable and may be expanded by adding extra sections and increasing the refrigeration components accordingly. The latest cooler model has cooling and condensing units mounted on one of the wall panels making the cooler a self-contained unit (18). In hot climates, it is desirable to have walk-in units open into a common vestibule which is insulated and chilled (12).

Competent engineers should be consulted for advice on the selection of proper condensing units and evaporators. Forced air units or gravity type coils are the cooling units used most frequently for walk-in refrigerators (18).

The method of defrosting must be considered. If refrigerator temperatures are thirty-five degrees Fahrenheit or above, evaporators may be automatically defrosted by proper adjustment of low pressure controls supplied with condensing units by some manufacturers. When refrigerators are held at lower temperatures, defrosting may be accomplished by scraping the ice accumulation from coils; electric heating devices built into or under the coils; hot gas systems which circulate

the heat from the compressor through tubes of the coil; or water sprays over the coils (18).

All walk-in refrigerators should have fitted doors with hollow rubber gaskets, doors with locking devices, door-controlled lighting, good insulation, floor drains, rounded corners, and shelves and fixtures of noncorrosive materials (39).

Freezers may be either walk-in or reach-in models. The reach-in freezers range in capacity from four to thirty cubic feet and may be of horizontal or vertical construction. The construction features of freezing units are similar to those of refrigerators. More insulation, however, is required for freezers. Freezing of foods is accomplished by means of evaporator plates which are arranged as shelves around the walls of the freezer (18, 12).

Small Equipment

Small equipment items that will lessen the labor required and afford greater variety to the menu are available for institutional use. Ice cream freezers, hardening and storage cabinets, ice machines, and butter cutters will not, however, be discussed in this study.

Food cutters are labor saving devices used primarily for salad and vegetable preparation. Attachments similar to those for the mixing machine are available for cutting vegetables and nut meats and preparing bread crumbs and sandwich materials. Enameled cast iron is used for the base of both bench

and pedestal floor types. Bowls are constructed of heavily tinned cast iron (12, 39).

Slicing machines are used to slice meat, cheese, vegetables, and bread and help to control the size of portions. The base is constructed of stainless steel or porcelain. Bench and pedestal types are available. Pedestal models may be fitted with swivel casters and made portable (39).

Important points for consideration in selecting all cutting machines are the safety features such as automatic pressure feed, safety guard over blades, and a device that prevents the guard from being raised while the motor is turned on. In addition, removable knives, enclosed ventilated splash-proof motors, enclosed gears, and stain-resistant finishes are desirable features.

Electric toasters are available in two and four slot sizes and one or more toasters may be arranged in a battery to meet the demand of the institution. The slot models are particularly desirable if service is intermittent as the electric current automatically shuts off when not toasting. Conveyor type toasters with a capacity of six to twelve slices per minute are made for both gas and electric heating. The conveyor motor in all types is operated electrically (12). According to West and Wood (39), a battery of four-slice electric toasters is usually more satisfactory than one toaster of larger capacity. Stainless steel, chromium plate, and porcelain finish are used for toasters.

Floor and counter platform scales are used to weigh food supplies when received and issued. There are two types of platform scales, the springless, dial-faced scale and one which is equipped with counter weights and a sliding tare beam and indicator. The springless, dial-faced type is preferred. Although this type is more expensive, it is more accurate. The exact weights are registered on the dial face thereby eliminating the need for a beam slide except for very heavy objects (12). For weighing smaller quantities of food, balance type scales are recommended. These are usually fitted with a beam graduated in quarter ounces with a capacity of ten pounds (39).

Coffee urns and vacuum coffee makers are available for coffee preparation. There appears to be a trend toward the use of eight and twelve cup vacuum brewers particularly in schools where only limited quantities of coffee are served (12).

Additional items of equipment for the institution kitchen are portable racks, trucks, small gas or electric plates, storage bins, and proof boxes. The needs of the particular food service would determine the material, construction, and size of these items (39).

In addition to the equipment discussed in this study, cooking and baking utensils and other miscellaneous items are essential for adequately equipping an institution food service department.

PROCEDURE

Basic data for this study were collected from three major sources: closely related literature; a survey of layout and equipment needs for institution food service in the Territory of Hawaii; and Punahou School administrators.

Closely related literature was reviewed in detail to present criteria for layout designs and equipment selection applicable to the requirements for the proposed food service building at Punahou School, Honolulu. A thorough study was made of available periodicals, books, research studies, and equipment manuals.

A survey of layout and equipment needs for institution food service in the Territory of Hawaii was conducted to determine the modifications necessary in a subtropical insular location. The enquiry form for the survey was designed to obtain pertinent information concerning problems encountered in layout design and equipment selection in Hawaii.

The original form was submitted to members of the Institution Management staff at Iowa State College for criticisms and suggestions. The final form, incorporating these recommendations, was later tested by a staff member in charge of a food service unit at Iowa State College. A list of active members of the American Dietetic Association located in the Territory of Hawaii was provided by a member of the Hawaii Dietetic Association. Enquiry forms were mailed to members

believed to be engaged in institution food service; however, forms were sent to only one member in any organization. A total of twenty-five were contacted. A letter was enclosed explaining the purpose of the study and soliciting cooperation. A copy of the letter and questionnaire appears in the appendix.

Eight enquiry forms, 32 per cent, were returned with complete information; eight were returned unanswered; and nine were not returned. Of the eight returned unanswered, six indicated that the respondents were not engaged in food service work in Hawaii; one indicated that the respondent was employed at an army hospital to which she felt the survey did not apply; and one was labeled "unclaimed" by postal authorities. Three types of institutions were represented in the study. Six of these were hospitals.

Punahou School administrators have cooperated by furnishing information relevant to this study. Building location, architectural limitations, and multiple functions of the proposed food service unit were discussed in preliminary conferences with architects and Punahou School administrators in May and June, 1949. The author has been apprised of subsequent conferences and that information has been made available for this study.

Criteria for planning layout designs and equipment specifications were based on recommendations in the literature of authorities in the field of food service planning, the

information provided by dietitians in the Territory of Hawaii, and the specific requirements of Punahou School.

Considering these criteria, a layout was planned for the food service department in Punahou School.

FINDINGS AND DISCUSSION

The findings are presented in three sections: one, information obtained from active members of the American Dietetic Association in Hawaii who participated in a survey of equipment and layout needs for institution food service in the Territory of Hawaii; two, criteria for planning and equipping a food service department in Punahou School in Honolulu; and three, application of these criteria.

Survey of Equipment and Layout Needs for Institution Food Service, Territory of Hawaii

Data concerning the number of meals served per day in each of the participating organizations were classified according to type of service as indicated in Table II. Code letters were assigned to each institution.

The total number of meals served per day ranged from 305 to 3190. In addition, four of the respondents mentioned "special" meals which were served to small groups at irregular intervals.

Cafeteria facilities were provided in all but one of the institutions. It is of interest that this type of service was used for approximately 71 per cent of the total number of meals reported.

Table II

Meals Served Per Day Classified by Types of Service

Institutions	Total	Types of service		
		Cafeteria	Table	Tray
A	3190	2800	90	300
B	1815	675		1140
C	1500	1500		
D	925	300	25	600
E	530	200	30	300
F	425	125		300
G	338	94		244
H	305		85	220

Of the 263 employees reported by the eight institutions, 58.6 per cent were men and 41.4 per cent were women. Data regarding the racial ancestry of the total group are shown in Table III. Of the total group of employees represented, approximately 87 per cent were of Oriental extraction and only about 5 per cent reported were Caucasian. Ninety-two per cent of male employees and 79 per cent of female employees were Orientals.

Little recognition has been given to the problems arising from certain cultural and physical differences which exist between persons employed in food service in Hawaii and those

in comparable American mainland situations. The fundamental tendency in Hawaii is toward a general lessening of interracial barriers. Language differences, however, are still perceived amongst first and second generation Hawaiian Orientals.

Table III

Racial Ancestry of Employees

Racial Ancestry	Total		Male		Female	
	No.	Per cent	No.	Per cent	No.	Per cent
Filipino	105	39.94	103	66.80	2	1.84
Japanese	100	38.04	22	14.35	78	71.56
Chinese	24	9.14	17	11.05	7	6.42
Caucasian	14	5.33	3	1.95	11	10.09
Hawaiian	11	4.12	6	3.90	5	4.59
Other	9	3.43	3	1.95	6	5.50
Total	263	100.00	154	100.00	109	100.00

All but one respondent considered the language barrier as a problem when introducing new ideas, equipment, and materials to Oriental employees. Five indicated that it was a problem of great significance. One respondent, who reported language differences as of only slight significance, qualified the statement by explaining that the assistant dietitians in that particular institution were Chinese and Japanese. Several

respondents pointed out the difficulty in giving oral and written instructions to employees who could neither speak nor understand English. According to one respondent, the tendency of many Orientals to follow established habit patterns is responsible for their reluctance to accept new ideas, equipment, and materials.

The physical difference among employees with which this study is mainly concerned is that of stature. In a study published by the Bernice Pauahi Bishop Museum in 1930, Wissler (40) reported the average heights of Japanese and Chinese male adults living in Hawaii as five feet three inches and five feet four inches respectively.

Few somatic studies have been conducted which were concerned primarily with Filipinos living in Hawaii. One respondent, however, reported five feet four inches as the average height of her predominantly male Filipino staff.

According to Wissler (40), the average height of Caucasian American males is five feet seven and one-half inches. This represents a difference in the average heights of Orientals and Caucasians of from three and one-half to four and one-half inches.

Several of the respondents mentioned the stature of Oriental employees as a problem specifically related to working heights of standardized equipment. The following comments were made by two respondents who pointed out the inefficiencies and safety hazards which result when Oriental employees use

equipment of standard height and depth:

> Because most Oriental people are quite short, working surfaces need not be as high as for other nationalities. With standard equipment, such as three-deck bake ovens, it will always be necessary to have boxes to stand on in order to reach the top deck when removing baked goods from the oven. The cooks stand on boxes to stir large pots of food and we find it necessary to use duck boards in front of ranges and sinks.
>
> I have found that many of the employees working in food preparation are much shorter, so that equipment is too high. Often times, special platforms have to be built for them to stand on to reach ranges and ovens. Accidents are likely to occur if they slip. The depth of many large size steam kettles is too great.

Table IV shows the heights of cooks' tables in use and those preferred by respondents from each of the eight institutions. Preferences ranged from thirty to thirty-six inches, with an average of thirty-four inches. It is interesting to note that in the institution which reported the lowest used and preferred table heights all but one of the twenty-seven employees were Japanese.

According to Webber (38), thirty-four inches is generally stipulated as the height above the floor for working surfaces. He has recently reported that some authorities are recommending that working heights be increased to thirty-eight inches to provide a working posture which would be more convenient and less tiring to the employee. Before accepting such a recommendation in Hawaii, it would be necessary first to establish the differential in standard working heights for Oriental employees. Based upon comparative data concerning average

heights, this might be said to be approximately four inches less than the standard suggested for Caucasians; hence, a recommended working height of thirty-eight inches for mainland employees would be translated as thirty-four inches for employees in Hawaii.

Table IV

Used and Preferred Heights and Widths of Cooks' Tables

Institutions	Heights in inches		Widths in inches	
	Used	Preferred	Used	Preferred*
A	33½	33	28½	30
B	34½	34½	35**	26
C	34#	34	32	30
D	34	34	36**	26
E	35	35	36	30
F	36	36	36**	30
G	30	30	34**	30
H	35	35	39**	26
Median	34¼	34¼	35½	30
Mean	34	34	34	28½

*Worked from one side.
**Worked from both sides.
#Duck boards are used.

Data regarding widths of cooks' tables as reported on the enquiry forms are likewise shown in Table IV. The widths of tables used in the reporting institutions ranged from

twenty-eight and one-half to thirty-nine inches. The preferences as to widths of cooks' tables where employees work from one side only ranged from twenty-six to thirty inches, with an average width of twenty-eight and one-half inches and a median of thirty inches.

The recommended width for cooks' tables where employees work from one side only was reported by Dana (12) as twenty-four to thirty inches. These standard table widths suggested for the average mainland employee apparently correspond to the stated preferences of the respondents.

In Table V are given the heights reported as preferred for the floor of the top and bottom tiers of deck ovens. The

Table V

Preferred Heights of Deck Oven Floors

Institutions	Preferred heights in inches	
	Floors of top tier	Floors of bottom tier
A	50	18
B	10½	4
C	53½	15 3/4
D	41	20
E	53½	15½
F	48	24
G	54	24
H	65	18

wide range would tend to indicate that there may have been a misinterpretation of the question in two instances. There was some concern regarding the advisability of Oriental employees using three-deck ovens. Two respondents mentioned the hazardous practice of standing on boxes or platforms to reach the third tier of a three-deck bake oven.

In reviewing the literature, it was impossible to find authoritative information concerning the advisability of using a two or a three deck oven as based upon stature and arm reach.

The limited data reported on safety devices and automatic timing controls used or preferred by the eight cooperating institutions was of little value for this study. No deviation from mainland standards was indicated.

Opinions regarding the need for specialized equipment for the preparation of island foods are shown in Table VI.

According to Shoemaker (25), only 10 per cent of the total land area of the Territory is arable, and only 8 per cent is actually under cultivation. Despite this fact, the economic life has been channeled toward a specialization in sugar and pineapples. Considering its size and agricultural restrictions, Hawaii has a remarkable variety of foods and of different customs in preparing these foods. This is the result of the influence of typical American foods, Oriental edibles imported from China, Japan, Korea, and the Phillipines, and native Hawaiian foods.

Rice, poi, coconut, and pineapple are of importance to this study because of the time and labor involved in their preparation for institution use.

Table VI

Indicated Need for Specialized Equipment for the Preparation of Island Foods

Island foods	Yes		No		No opinion	
	No.	Per cent	No.	Per cent	No.	Per cent
Coconut	7	87.5	0	0.0	1	12.5
Pineapple	6	75.0	1	12.5	1	12.5
Poi	3	37.5	3	37.5	2	25.0
Rice	1	12.5	5	62.5	2	25.0

Rice represents the largest tonnage of any food product imported into Hawaii. In 1944, five million pounds of rice were imported monthly (21). It is eaten in large quantities by most island residents and is, for the most part, preferred to potatoes. The oriental method of cooking rice with only enough water to steam the grains is commonly used throughout the Territory. One of the respondents stated that rice may be cooked satisfactorily in steam jacketed kettles. Another respondent commented on the thick inedible crust that is formed on the inner surfaces of steam jacketed kettles when they are used for this purpose. She suggested that a special rice steamer be devised that would save time and energy and eliminate

waste.

Poi, a starchy paste made from the root of the taro plant, was the staff of life of the ancient Hawaiians. Today it is eaten in varying amounts by all racial groups in Hawaii. Poi is prepared by cooking the taro corms from one to three hours. The cooked taro is then pounded with a stone poi pounder. Water is added and the poi is kneaded until a smooth paste is formed. The poi is often allowed to ferment for several days (19). Specialized equipment for the preparation of taro products has not been developed for institution use; however, it is possible to purchase prepared poi from small poi factories. According to Lind et al. (20), taro when eaten in large quantities is a good source of thiamine and minerals. If preparation methods were simpler, the diets of many racial groups in Hawaii might be greatly improved by substituting taro for a part of the white bread and rice which constitute a large portion of the diet.

Fresh island fruits such as pineapple and coconut are plentiful and available the year round in Hawaii. Although coconut is an essential ingredient of many island dishes, its use is limited because of the labor and time required for preparation. All but one of the eight respondents expressed a need for specialized equipment for the preparation of coconut. One respondent stated that an electric grater would be useful for grating large quantities of coconut.

Fresh pineapple is served extensively in the islands.

Although it is a comparatively inexpensive fruit, its preparation entails the time-consuming hand process of removing the tough rind. Equipment is not available for either the removal of the rind or cutting the edible portion of the fruit. Six of the eight respondents indicated the need for specialized equipment for the preparation of fresh pineapple.

The effect of the equable climate permeates every aspect of life in Hawaii. The average temperature of 75.2 degrees (25) eliminates the need for central heating systems, and therefore steam is seldom available except in hospitals. Fuel is necessary only for cooking and power in most institutions. All of the respondents reported the use of electricity as a fuel. Five who were associated with hospitals reported that steam was also used in their kitchens. Gas was used in three institutions and oil in two.

Table VII indicates the fuel respondents preferred for specific equipment. It is interesting to note that seven of the eight respondents expressed a preference for electricity for ovens, and six preferred electricity for ranges and fryers. Although steam was available in only five of the reporting institutions, each of the respondents preferred steam for serving counters.

The question concerning the source of the steam supply was misinterpreted by four of the seven respondents who reported that steam was available in their institutions. Two respondents reported that steam was supplied from a central

plant and one that it was self-generated.

Table VII

Preferred Fuel for Specific Equipment

Equipment	Fuel			
	Electricity	Gas	Steam	Gas or Electricity
Ranges	6	1		1
Ovens	7			1
Fryers	6			1
Serving counters			8	

The amount and types of refrigeration space used in six of the institutions are shown in Table VIII. Two of the eight respondents misinterpreted the schedule item, and the data reported could not be included. The total refrigeration space recorded ranged from 875 cubic feet for 305 meals served per day to 12,620 cubic feet for 3190 meals served per day.

In each of the institutions the number of cubic feet of refrigeration space per person served exceeded the maximum amount recommended by food service authorities. West and Wood (39) suggested an allowance of one and one-half to two cubic feet of refrigeration space per person served per day. This corresponds to the statement by Bryan and Handy (9) that 1.5 cubic feet per person served per day provides adequate refrigeration space in the average residence hall. The mean was 4.32 cubic feet per meal served in these island institu-

tions; the median was 5.19 cubic feet. These figures reflect the need for increased refrigeration space in sub-tropical Hawaii where, according to Shoemaker (25), 65 per cent of the food supply is imported from the American mainland, and

Table VIII

Refrigeration Space

Institutions	Meals served per day	Cubic feet of refrigeration space				
		Total	Reach-in	Walk-in	Freezer	Per meal served
A	3190	12620	100	12520	0	3.96
B	1815	9328	228	6000	3100	5.13
C	1500	3114	114	1500	1500	2.08
D	925	4806	0	4836	30	5.25
E	530		*	*	*	
F	425		*	*	*	
G	338	875	75	800	0	2.59
H	305	2115	15	1500	600	6.93
Median						5.19
Mean						4.32

*Respondents reported data but misinterpreted question.

shipping strikes are frequent and protracted. The data given for institution B is of particular interest because it represents one of the newest and most modern food service installations in the Territory.

Questions were asked about various aspects of sanitation.

In regard to equipment construction, seven of the eight respondents considered that the greatest sanitary benefits are derived from constructing fabricated equipment with full-turned edges. One respondent expressed no opinion with regard to this schedule item.

The respondents were requested to rate and comment on the seriousness of certain sanitation problems affecting food service operation in their specific institutions. The ratings given to eleven of these sanitation problems are indicated in Table IX. Problems ranking in seriousness from first to eighth place were given values from eight to one respectively. To determine the weighted score for each problem, the sum of these values was divided by eight, the total number of respondents. The problem with the highest ranking score was considered the first in degree of seriousness by the group, while the problem with the lowest score was judged the least serious. In several instances more than one problem was assigned an identical rating by a respondent.

Termite control was considered the most important sanitation problem affecting food service operation in the eight cooperating institutions. The seriousness of the problem was attributed to climatic conditions and the use of wooden structures for food service buildings. Three of the respondents commented that some relief had been derived from the use of commercial extermination.

Dry food storage was rated as the second most serious

Table IX

Sanitation Problems Classified by Degree of Seriousness

Problems	1	2	3	4	5	6	7	8	Weighted score	Rank
Garbage disposal				1			1		.9	9
Hot water supply		1	1		1				2.1	6
Corrosion of metals	1	2	1						3.5	4
Dry food storage	2	2		1		1		1	4.9	2
Utensil storage		1				1	1		1.5	7
Food display			1				1		1.0	8
Mice and rat control	3				1				3.5	4
Roach control	2	2		1					4.4	3
Fly control			3	1				1	2.9	5
Termite control	4	1	1						5.6	1
Mold growth	1	2	1						3.5	4

problem. The ant weevil was mentioned by four of the respondents as a main source of the difficulty. The larvae of this small beetle eat out the interior of nuts, fruit, and grain. One of the respondents suggested the need for a large walk-in refrigerator, with a temperature of 50 degrees and very low humidity, in which to keep all dry stores such as rice, flour, cereals, paste products, and dried beans, lentils, and peas, which are easily infested.

Roach control, always a problem in warm humid climates, ranked third in order of seriousness as a sanitation problem in the eight island institutions participating in the survey. Commercial extermination service provided satisfactory control of the problem in one situation but in another institution the respondent stated that the same service afforded slight relief.

Scores for corrosion of metals, mice and rat control, and mold growth placed these sanitation problems fourth. Two of the respondents who considered corrosion of metals a problem emphasized the high humidity of the climate as a causative factor. Two others remarked that the difficulty in their particular situations was due to the use of inferior war-time equipment and old, inadequate, galvanized sinks respectively. One respondent who reported that the corrosion of metals was no problem in her institution because stainless steel was used commented as follows:

> In this climate I would recommend that all metals be non-corrosive - stainless steel for all work surfaces, heavy aluminum for cooking, stainless steel

> for all small equipment. Where tinned steel is used in mixer bowls, there is no satisfactory re-tinning or repair done in Honolulu. Galvanized iron is not satisfactory in this climate in any situation.

Comments generally expressed the need for rodent-proof storage space and refrigerated space for garbage. The high humidity of the island climate throughout the year was indicated as the reason for the prevalence of mold growth in Hawaii.

Fly control is, perhaps, little different in the islands than on the mainland. It was rated fifth in seriousness as an island problem. Two respondents mentioned that the problem was intensified on days when fish was cooked. Another respondent stated that the control of flies in her particular situation was difficult because of the absence of double-door protection. Two mentioned the use of a particular insecticide but reported that it did not completely eliminate the problem of flies. One of these respondents stated that painting screen doors with a 50 per cent solution of the insecticide afforded some relief.

The hot water supply was considered sixth in seriousness of island sanitation problems. Low water pressure was given as the cause of difficulty in three institutions. Others did not list this as a problem.

Storage space for utensils was considered a major problem by only three of the respondents. Absence of sufficient storage space was the comment made by two who considered this a

problem. One respondent commented that there was no problem in her situation because the kitchen had been provided with a large pan storage area near the pot sink.

Food display was considered to be a problem of minor importance by the majority of respondents. Others indicated lack of sufficient counter space, refrigeration space, and glass encased space for food display as problems.

Garbage disposal was rated as the least serious of the eleven sanitation problems listed. Several respondents indicated that refrigerated facilities for garbage eliminated this problem.

Pineapple flies were considered as an island problem by one respondent, and the difficulty of ant control was mentioned twice as an additional problem.

Criteria for Layout Designs and Equipment Selection
for Food Service Department
Punahou School, Honolulu

1. The school food service is an integral part of the total school program and therefore should be designed for efficient management and the effective use of the food service department in the school program.

2. Detailed plans for the food service department should be formulated by the architect, the food director, and the administrators.

3. A thorough knowledge and understanding of the basic requirements for the specific situation are essential for intelligent kitchen planning.

Layout and architectural features

4. The arrangement of areas and equipment should be based on the flow of materials in direct routes from receiving to storage, pre-preparation, preparation, and serving.

5. Individual units within the food service department should be planned to provide adequate working space with a minimum of cross-traffic and back-tracking.

6. The work units should be separated to avoid confusion, but the number of partitions should be kept at a minimum.

7. Traffic aisles should be clearly defined and carefully routed to avoid waste of time, confusion in service, and

friction between employees. Work aisles between equipment should be three to four feet in width.

8. Rooms in which food is stored, prepared, or served, or in which dishes and utensils are washed should be well-ventilated with outside windows or with partial or complete mechanical ventilation. In addition, vented hoods and fans should be used over cooking equipment. Dehumidification may be necessary.

9. Twenty to thirty foot-candle intensity should be used for general lighting with an increase up to fifty foot-candles on working surfaces. Outside windows are desirable.

10. Noise should be reduced by the extensive use of sound-absorbing materials for the construction of walls, ceilings, floors, equipment, and furnishings.

11. The length of a rectangular kitchen should be no more than twice its width. The doorways between the kitchen and service area should be on the longer side of the rectangular kitchen.

12. The main kitchen area should be approximately one-fourth to one-third as large as the dining area.

13. The receiving area should be adjacent to or near to the storeroom and refrigerators.

14. The receiving platform should be separate from the receiving room and sufficiently long to allow for simultaneous unloading of several trucks, and the height from the driveway should be equal to that of the floor of a standard truck.

15. The amount of storage space should be determined on the basis of the amount of food and supplies to be stored at any one time.

16. A separate room should be provided for the storage of fruits and vegetables which do not require refrigeration.

17. A space of four to five cubic feet per meal served per day should be used as a basis for estimating the refrigeration needs.

18. Walk-in refrigerators should be divided into four rooms and equipped with individual thermostatic controls to regulate the temperatures according to the type of food stored.

19. The exterior aisles in front of walk-in refrigerator doors should be at least six feet in width.

20. Sufficient refrigeration space should be provided for each preparation and serving unit.

21. A refrigerated area for garbage storage should be located near the service entrance.

22. Space for the collection, sorting, and counting of soiled linen should be well-ventilated and convenient to receiving platform.

23. The meat pre-preparation unit should be located between the refrigerator and the meat cooking unit, and it should be near the receiving area.

24. The fruit and vegetable pre-preparation unit should be located near the dry storage and refrigerated areas. Allowance should be made for the direct flow of fruits and

vegetables from storage areas to the preparation unit and to the vegetable cooking and the salad and sandwich areas.

25. The meat and vegetable cooking unit should be located in the center of the main kitchen on the long axis of the room. This unit should be contiguous to the pre-preparation units, the pot and pan washing unit, and the service units. Meat and vegetable units should be approximately ten feet in width; an additional two feet should be allowed for adequate cleaning if the unit is placed against a wall or back to back with other equipment.

26. The bakery should be located as near the serving unit as possible.

27. The salad and sandwich unit should be easily accessible to the serving area.

28. Dining areas which are to be used for other educational and community activities should be separated from the kitchen and serving area.

29. The dishwashing area should be located in a soundproofed, well-ventilated, and adequately illuminated room.

30. Sixty per cent of the total dishwashing table space should be allocated to soiled dishes and 40 per cent to clean dishes.

31. The dishwashing area should be located so that soiled dishes may be returned without interfering with service or crossing traffic.

32. The pot and pan washing area should be easily

accessible to the cooking and baking areas.

33. Locker rooms with showers, toilets, individual lockers, and dressing space should be provided for employees. These facilities should open onto a corridor.

34. The food director's office should be located in or near the kitchen and an outside exit. The kitchen-side partition should be of glass above a level of three feet.

Equipment

35. Stainless steel should be eighteen-eight, number 4 finish, and generally twelve to sixteen gauge.

36. Gas ranges should be constructed of stainless steel and should be thirty-four inches wide, forty-two inches deep, and thirty-four inches high. They should be equipped with recessed closed bases, pilot lights, concealed manifolds, and removable burners. Ranges should be placed on a solid fireproof base.

37. Deck ovens should be used rather than range-oven combinations. Ovens should have insulation on the top, bottom, and side walls. Doors should be insulated and of counterbalance design. Ovens should be equipped with heat directors, timers, automatic shutoffs, removable shelves, safety pilot lights, deck lights and stainless steel interiors and exteriors.

38. Each electric bake or roast oven should consist of two individually controlled decks. Approximate size of each

oven should be fifty-two inches wide and thirty-six inches deep.

39. The two-compartment steamer should be self-generating and operated by gas. The interior and exterior should be of stainless steel. The steamer should have steam-tight doors; strong hinges; perforated, removable, and automatic sliding shelves; pressure gauges; and safety release valves.

40. Self-generating steam jacketed kettles, constructed of stainless steel or aluminum, should be gas operated. Small tilting type kettles for vegetable cooking should be mounted on tables.

41. A vegetable peeler of twenty-five pound capacity should be located next to the vegetable sink with the peeler door opening over the sink.

42. A dishwashing machine should be equipped with a tank that may be regulated for washing at 130 degrees to 140 degrees Fahrenheit and a tank that may be regulated for rinsing at 170 degrees. A separate unit with an independent motor and pump should be used for prerinsing dishes. The body of the dishwashing machine should be of stainless steel construction. The machine should be equipped with an automatic temperature control, automatic rinse, automatic overflow with externally controlled drain valve, and an enclosed ventilated splash-proof motor.

43. A sixty quart mixing machine should be provided for both the meat and vegetable cooking unit and the bakery. A

two horsepower noiseless motor should be of ventilated splash-proof type with grease-packed ball bearings. Gear shift should be three-speed, automatic, sliding gear type. Beaters and whips should be provided for the sixty quart bowls with similar equipment for a thirty quart bowl with adapter.

44. Vented hoods should extend beyond the equipment over which they are hung by twelve inches in width and six inches in depth.

45. The cafeteria counter should be as short as feasible to facilitate supervision and minimize the number of employees required. The cafeteria counter should be at least twenty-four inches wide; the tray slide, twelve inches; the space from the counter to the back bar, four feet; and the back bar, twenty-four to thirty inches wide. The hot food unit of the cafeteria counter should be divided in three independent electrically heated sections. Cafeteria display shelves should be protected by glass shields.

46. Dishes should be stored at the cafeteria counters in automatic dispensers.

47. Sinks, drainboards, and splash-backs should be constructed of stainless steel with all vertical joints welded, ground, and polished. Corners should be rounded, intersections of corners fully coved, and each compartment equipped with lever-handled waste valves.

48. Three compartment sinks for washing, scraping, and rinsing, equipped with drain boards, splash backs, and grease

traps should be used for soaking, washing, and rinsing pots and pans.

49. Work tables should be constructed of number 12 to 14 stainless steel. The tops of tables should be thirty-four inches from the floor and should be mounted on tubular legs with adjustable ball feet. If cooks work from one side only, tables should be thirty inches in width. Tables and counters should have rounded corners and intersections at corners should be fully coved.

50. Competent engineers should be consulted for advice on the selection of condensing units and evaporators. Condensers should be water cooled.

51. Exteriors and interiors of reach-in refrigerators should be of stainless steel.

52. Interior walls of walk-in refrigerators should be of stainless steel or tile. The floor of walk-in refrigerators should be of tile construction and should be level with the kitchen floor. Walk-in refrigerators should be equipped with hollow rubber gaskets, doors with locking devices, automatic lighting, heavy insulation, rounded corners, and stainless steel shelves.

53. Specialized equipment should be designed for the preparation of taro products, rice, coconut, and pineapple.

Sanitation

54. Stainless steel should be used for all fabricated equipment. Cooking and baking utensils should be stainless steel or aluminum.

55. Edges on fabricated equipment should be fully turned.

56. Food in case lots should be stored on platforms, elevated ten to twelve inches from the floor to minimize dirt accumulation and lessen opportunities for vermin and rodent breeding.

57. All storage shelves and bins should be of non-corrosive metal, and wherever possible, metal should replace wood for construction purposes.

58. Rice, cereal, flour, and paste products should be stored in dry vermin-proof areas.

59. A specific area should be allocated for storing cleaning equipment.

60. All windows and doors should be screened with fine mesh screen.

Layout for the Proposed Food Service Building at Punahou School, Honolulu

The proposed food service building at Punahou School is to be one wing of a memorial center which, when completed, will consist of a center court flanked on the northwest by a students' building and on the southeast by the food service building.

The shape and size of the building is circumscribed by the architectural plans for the center as a whole and by the proximity of existing structures and campus roads to the site chosen by Punahou administrators and architects. These architectural and physical limitations, plus certain topographical difficulties have necessitated some deviations from the criteria presented for layout designs and equipment arrangement for the proposed food service building, and demand some explanation of the layout design presented in Figure 1.

The total floor area of the kitchen is 3611 square feet. The combined area for the elementary, main, and faculty dining rooms is 9996 square feet. In addition, 3240 square feet of terrace adjoining the main dining room will be available for outdoor dining. The total seating capacity is 900. This allows 14.7 square feet per seat dining area and four square feet per seat kitchen area, approximately the amount suggested by West and Wood (39) who recommended fifteen square feet per seat dining area and three to four square feet per seat kitchen area for residence halls.

A sliding door will separate the elementary and main dining rooms. Sliding doors will also be used to divide the main dining room so that the northwest end may be partitioned off for the dinner service. The entire area may be opened to accommodate large groups for banquets and other school functions. Glass brick partitions part way to the ceiling will separate the serving and dishwashing areas from the dining room.

The total walk-in refrigerator space is 6432 cubic feet or 5.3 cubic feet per meal served based on 1200 meals per day. This corresponds to 5.19 cubic feet, the median reported in the survey of food service institutions in Hawaii. In addition reach-in refrigerator space is shown in the following areas of the proposed plan: baking, meat and vegetable cooking; salad and sandwich preparation, counters, and refrigerated pass-through section. The frequent and often protracted shipping strikes necessitate more refrigeration and storage space than is generally recommended for comparable institutions on the mainland.

The amount of space required for kitchen and dining facilities eliminated possibilities of a road and parking area at the rear of the building. For this reason, the route from the receiving area to the central storeroom is longer than desirable.

The amount of available space and the shape of the building necessitated placing the meat and vegetable cooking area

on the short axis of the room rather than the preferred long axis. The salad and sandwich area is more remote from the fruit and vegetable pre-preparation area than is desirable; however, all preliminary preparation of fruits and vegetables will be in the pre-preparation area. This will eliminate transporting bulk fruits and vegetables through the kitchen. Work areas in the proposed plan have generally been separated by means of the arrangement of equipment.

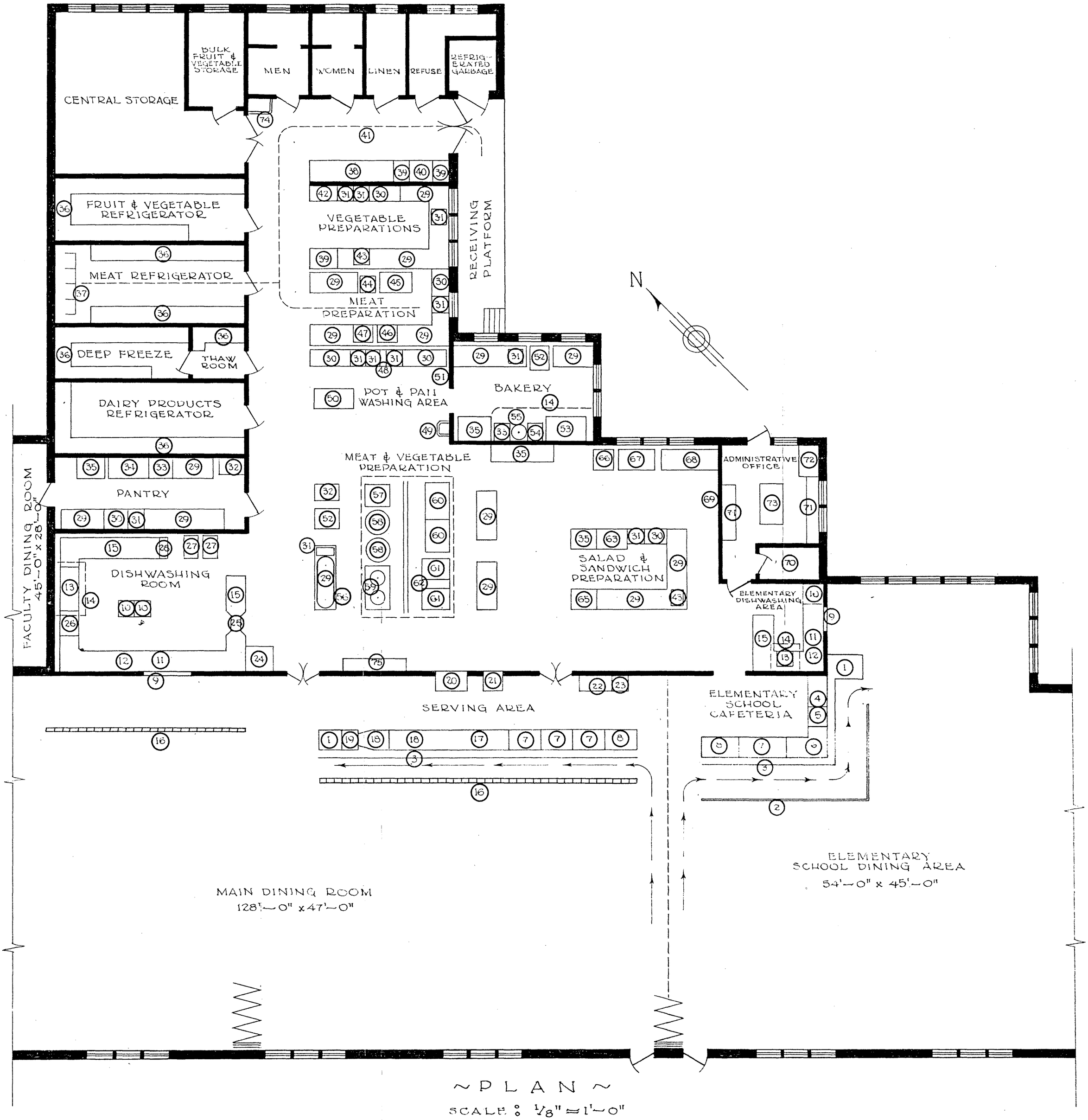
Although there are no windows in the dishwashing areas, there will be adequate artificial ventilation.

The survey of food service institutions in Hawaii indicated a preference for electric ranges. It will be necessary to use gas ranges in the Punahou kitchen because of the present electric load limit on the Punahou campus.

A steam generator placed in a stainless steel table will supply the steam for the small trunnion steam kettles.

Code for Figure I

1. Cashier's desk
2. Aisle rail
3. Tray rail
4. Ice cream cabinet
5. Refrigerated milk storage
6. Refrigerated salad and dessert display
7. Hot food section
8. Trays, silver, and napkins
9. Pass-through window
10. Soaking sink
11. Soiled dish table
12. Garbage disposal
13. Dishwashing machine
14. Hood
15. Clean dish table
16. Glass brick partition
17. Salad and sandwich display
18. Desserts and beverages
19. Checker's station
20. Pass-through refrigerator
21. Pass-through warming oven
22. Griddle
23. Toaster
24. Janitor's closet
25. Glass washer
26. Prerinse machine
27. Dish truck
28. Silver rinse
29. Table
30. Drainboard
31. Sink
32. Portable table
33. Gas plate
34. Hot food conveyor
35. Reach-in refrigerator
36. Shelves
37. Meat rack
38. Receiving clerk's table
39. Truck
40. Scale
41. Overhead meat conveyor
42. Vegetable peeler
43. Food cutter
44. Meat block
45. Meat saw
46. Slicer
47. Grinder
48. Scraping compartment
49. Hand sink
50. Pot and pan rack
51. Five foot partition
52. Sixty quart mixer
53. Two deck gas bake oven
54. Portable rack
55. Trunnion kettle
56. Overhanging utensil rack
57. Two compartment steamer
58. Steam jacketed kettle
59. Table model trunnion kettle
60. Two deck electric roast oven
61. Gas range
62. Spreader plate
63. Supply cabinet
64. Overhead shelves
65. Bread cabinet
66. Ice cream freezer
67. Ice cream hardening cabinet
68. Ice cream storage
69. One-way view glass
70. Dressing room
71. Low book shelves
72. Filing cabinet
73. Desk
74. Mop sink
75. Dish cabinet



~PLAN~

SCALE: 1/8" = 1'-0"

LAYOUT FOR PROPOSED FOOD SERVICE BUILDING, PUNAHOU SCHOOL, HONOLULU

FIGURE 1.

SUMMARY

This study was conducted to formulate criteria and make recommendations for the application of these criteria in planning the layout designs and selection of equipment for the proposed food service building at Punahou School, Honolulu. The recommendations of authorities in the field of institution food service planning were reviewed in detail, and data submitted concerning specific layout and equipment needs in Hawaii were analyzed.

The findings revealed that certain recommendations for standardized equipment and space allowances required modification for use in Hawaii. It was concluded that space allowances and equipment selection are dependent upon the geographical location and climate of the specific situation, the size and shape of available space, the cultural and anthropometric characteristics of the employees, the extent and type of service, the menu pattern, and the budget allowance for the installation. The space required can be determined only by an actual layout of the equipment.

Criteria for layout designs and equipment selection for Punahou School were presented. Application of these criteria was made in the form of a proposed layout design.

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APPENDIX

Institution Management Department
Iowa State College
Ames, Iowa
May 17, 1950

As a member of the American Dietetic Association you are invited to participate in a study which is being conducted at Iowa State College under the direction of the Institution Management Department. Your suggestions and cooperation will be appreciated.

Food service problems that arise in Hawaii because of the geographical location, climatic conditions, and the personnel are being studied. Your replies, and those of others to whom the schedule is being sent, will be used as bases for developing criteria for equipment selection and layout designs for institution kitchens in Hawaii.

Won't you please fill out the enclosed sheets and return them in the accompanying envelope without delay? It will take only a few minutes of your time and your cooperation will be a genuine service.

Sincerely yours,

Marjorie S. Arkwright

SURVEY OF EQUIPMENT AND LAYOUT NEEDS FOR INSTITUTION FOOD SERVICE
TERRITORY OF HAWAII

ERAL INFORMATION

Meals served (Indicate for each type of service the average number you serve per day)

Table service_____ Tray service_____
Cafeteria_____ Special party_____

Other (specify)_____

Employees (Indicate number)

Japanese men_____women_____ Chinese men_____ women_____
Filipino men_____women_____ Caucasian men_____women_____
Hawaiian men_____women_____ Other men_____women_____

LEMS OF EQUIPMENT SELECTION AND LAYOUT DESIGN

Related to employees' efficiency

1. What is the height of your cook's table?_____inches
2. What height would you prefer for a cook's table?_____ inches
3. Do employees work from one or both sides of the cook's table? One____Both____
4. What is the width of your cook's table?_____ inches
5. In selecting a cook's table where the employees work from one side only, what width would you choose?_____inches
6. In selecting a deck oven what height would you choose for the floor of the top tier?_____inches; what height would you choose for the floor of the bottom tier?_____inches
7. What special safety devices are provided on your equipment?_____
8. Which safety devices do you consider most valuable?_____
9. What automatic timing controls are provided on your equipment?_____
10. What automatic timing controls do you consider most valuable?_____
11. Should specialized equipment be accessible for the preparation of island foods, such as: coconut, Yes___No____; poi, Yes____No____ ; rice, Yes___No___; pineapple, Yes____No___?
12. When introducing new ideas, equipment, and materials do you find the language differences present problems of great____, slight____, no____ significance?

Related to climatic conditions

1. Fuel (Please check)
   a. What kinds of fuel are used in your kitchen? Oil____Gas____Steam_____ Electricity____Other (specify)_____
   b. Which fuel would you prefer for: Ranges_____ Ovens_____ Fryers_____ Serving counters_____?
   c. Is your steam supply from a central plant, Yes____No____; Self-generated, Yes____No____?
2. Refrigeration
   a. What is the approximate reach-in space in your kitchen?_____ cu. ft.
   b. What is the approximate walk-in space in your kitchen?_____ cu. ft.
   c. How much freezer space do you have in addition?_____cu. ft.

3. Sanitation

a. Do you consider the greatest sanitary benefits are derived from constructing fabricated equipment with edges turned $\frac{1}{2}$____, $\frac{3}{4}$____, full____?

b. Please rate (1, 2, 3, 4, etc.) the following sanitation problems that affect your food service operation. Explain why each is a problem. Rate the most serious problem #1.

	RATE	EXPLAIN
Garbage disposal	____	_____
Hot water supply	____	_____
Corrosion of metals	____	_____
Dry food storage	____	_____
Utensil storage	____	_____
Food display	____	_____
Mice and rat control	____	_____
Roach control	____	_____
Fly control	____	_____
Termite control	____	_____
Mold growth	____	_____
Others (specify)	____	_____
	____	_____

ADDITIONAL COMMENTS

Please list any further suggestions you may have for equipment selection and layout designs for institution food service in Hawaii.

_____

_____

_____

_____

_____

_____

_____

_____

Signature _____ Title _____

Name of organization _____

PLEASE RETURN BY JUNE 1 TO:

Marjorie S. Arkwright
Institution Management Dept.
Iowa State College,
Ames, Iowa