A STUDY OF FLOORS IN FOOD SERVICE AREAS ON A COLLEGE CAMPUS

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A STUDY OF FLOORS IN FOOD SERVICE AREAS ON A COLLEGE CAMPUS

By

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I. INTRODUCTION

Floors represent a large initial investment in any food service institution. According to Longshore (12), it has been estimated that they account for six percent of the total cost of a building. The original cost of flooring varies widely according to the type of material selected, size of the job, geographical location, etc. However, in order to emphasize the amount of money invested in floors in institution food service areas, if quarry tile averages $1.00 per square foot and 1,000 square feet are required to cover a kitchen floor, this means an initial investment of $1,000. With this in mind, plus the fact that floors in institution food service areas receive constant use and abuse, it becomes a matter of economic necessity to select the best floor for the specific use intended and to care for this floor according to the best known methods of scientific floor maintenance.

In order to obtain the greatest returns in satisfactory service from the initial investment in floors, there are many things which the institution food service manager

needs to know. Among these are the following:

1. The kinds of floors available and the important ingredients used in the manufacture of these floor materials.
2. How the common floor materials are manufactured, installed and finished.
3. The characteristics of each type of floor; good qualities, bad qualities and comparative advantages of each for the specific purpose in mind.
4. The best type of cleaning and maintenance materials for each floor with a knowledge of ingredients used, their characteristic reactions and why certain materials are injurious to certain floor surfaces.
5. The most economical maintenance methods as well as a knowledge of proper selection, use and care of equipment used in maintenance.

This study is directly concerned with those types of floors already in use in food service areas on Michigan State College campus. The purposes of the study are threefold and they are listed in order of importance:

1. To present information on floor materials which would be of value to institution food service operators. These include desirable qualities for each specific purpose, various types available, their composition, methods of installation,

finishing, maintenance and care, and proper selection of equipment and materials used in floor maintenance.

2. To compare the various types of floors in use in food service areas on this campus with regard to costs of cleaning and maintenance.
3. To evaluate the effectiveness of methods used.

Research work has been done by the United States Government, by flooring manufacturers and by industrial organizations. Although there is a wealth of such information available, it is in widely scattered form. Much of it needs to be critically analyzed for it is colored by financial interests in promoting the production and sale of floor materials. In many cases it is applied to the needs of other than institution food service operators. Therefore, it seemed worth-while to devote the major part of this study to the presentation of information on floor materials and floor maintenance, with the hope that it would aid institution food service operators in getting the greatest possible returns in satisfactory service from the initial investment in floors.

The second purpose was concerned with an attempt to determine whether the original cost of the floor material had any relation to the total cost of the floor, the latter including the original cost plus costs of cleaning and maintenance. It is a matter of vital

importance to the institution food service operator to know whether the floors which are the most expensive to install are necessarily the most expensive to maintain.

In order to determine this, time and cost studies of cleaning and waxing were conducted on various types of floors in use in food service areas on this campus. Preliminary interviews were had with food service managers to obtain such general information as methods of cleaning and maintenance already in use, unit cost of cleaning materials and time and frequency of cleaning. Several managers and employees were questioned to find out whether they regarded the floor in use as satisfactory from the standpoints of fatigue and the safety factor.

The third purpose, an evaluation of the effectiveness of methods used, was based chiefly on the quality of appearance and the opinions expressed are purely subjective. They are not the result of scientific evidence and are included here only because they might be of some passing interest to institution food service operators. It was impossible to say with any degree of authority what effect methods of maintenance would have on wearing quality of finish since many of the floors have been in use only a short time. In cases where the floors have been in use for a longer period, there was no way of determining how much of the condition of the floor was due to methods of

maintenance and how much was due to other factors such as original quality of floor material, method of installation, and type of wear and tear to which the floor had been subjected.

II. REVIEW OF LITERATURE

Since the greater part of the literature to be reviewed has been referred to in detail throughout the following pages, no attempt will be made here to discuss the subject matter covered at any great length. Rather an attempt will be made to point out the general scope of such material and its value to the institution food service manager in the selection and care of floors.

Most of the studies that have been made on floors and floor maintenance consist of reports of research work done by the United States Bureau of Standards, by university and industrial research workers, by individual floor manufacturers and by floor trade associations. Reports by the National Bureau of Standards are of a technical nature dealing with experiments on the physical properties of floor materials in relation to wear and specifications for the quality of certain materials. Research workers in university and industry have conducted tests on certain floor materials and on scientific floor maintenance to determine most efficient in-plant use. Much of the information published by flooring manufacturers is of a more descriptive and less technical nature which is

intended primarily for sales promotion purposes. However, they do issue instructions and recommendations for proper installation and maintenance of their particular floor materials. Trade organizations such as the Maple Flooring Manufacturers Association and the National Terrazzo and Mosaic Association have adopted specifications and grading rules to which all members of the industry must conform.

Sigler and Woodward (22), National Bureau of Standards, conducted experiments to determine the results of indentation characteristics of floor coverings in an atmosphere of 65 percent relative humidity and temperature of 72° F, on specimens at an elevated temperature of 90° F. and on specimens after exposure to accelerated aging. They make the statement that an ideal floor covering for comfort and resistance to indentation is one which exhibits high ability to yield under foot and ability to resist permanent indentation under a concentrated load. Unfortunately these two properties oppose each other in most floor coverings so that a compromise between the two must be accepted. The results of the tests showed that the softer types of rubber floor coverings possessed a fair to good combination of the two values mentioned. If resistance to heavy loads or harsh treatment is essential, then oak and maple wood floors, and magnesium oxychloride floors exhibited good resistance to permanent indentation. Some of the asphalt tiles tested showed good resistance to permanent indentation under normal conditions, but resistance was appreciably

poorer at an elevated temperature or after prolonged exposure to a concentrated load.

According to Sigler's (23) report on the relative slipperiness of floor and deck surfaces, it was found that there was considerable difference in slipperiness between wet and dry surfaces. Among the floor surfaces tested were terrazzo, concrete, magnesite, various types of asphalt, rubber tile and maple flooring. Most of the floor materials exhibited satisfactory anti-slip properties when dry but many would be classed as hazardous when wet.

Sigler, Martens and Koerner (21) conducted experiments on dimensional changes of floor coverings with changes in relative humidity and temperature. The floor coverings tested included rubber, asphalt, strip wood and magnesium oxychloride. They found that changes in relative humidity affected the dimensions of many floor coverings to a much greater extent than changes in temperature within the range usually encountered in buildings. The dimensions of asphalt tile and rubber floor coverings were not appreciably affected by changes in either relative humidity or temperature. In strip wood, such as maple or white oak, the across grain dimension was affected to an appreciable extent whereas the change in dimensions of the grain direction was negligible. The dimensional changes of magnesium oxychloride and other monolithic composition floors were relatively small.

The National Bureau of Standards in its Letter Circular Series (20), (24), and (25) publishes information dealing with maintenance materials, many of which are valuable to those interested in the care of floors. The United States Tariff Commission (26) has issued a report on earthen floor and wall tiles. This is a survey on the production and trade in earthen floor and wall tiles in the United States and in the principal producing countries, with special reference to factors essential to tariff considerations. This report is essentially of greater interest to tile manufacturers but the section on description and classification of the various types of tiles is of value to the institution food service operator who may want to install a quarry tile floor or to use tile walls.

The United States Department of Commerce (19) has published a worth-while bulletin on various types of hardwood flooring and its uses. The bulletin covers flooring requirements, types of American hardwood flooring, grade standards, methods of laying, types of finishes and care of hardwood floors.

Goodrich (7) in a study on floors, points out the fact that the qualities desired in a floor for any specific purpose will depend upon: 1. construction of the building, 2. the amount and type of wear to which the floor will be subjected, 3. the cost, including initial cost and upkeep, and 4. appearance. The purpose of this study was to evaluate certain available floor materials in terms of

the requirements for flooring in institution food service units.

Longshore's (12) manual on floors presents information in nontechnical language which is intended primarily for superintendents and custodians of buildings. Much of the information has been contributed by manufacturers interested in their particular floors and floor maintenance but the manual does contain a great deal of material which is of interest to the institution food service operator. Characteristics, methods of manufacture, installation, finishing and recommended maintenance procedures for several types of floors are discussed.

Joseph E. Seagram and Sons, Inc. (2), (4), and (5) through its Industrial Sanitation Research Department, has been particularly interested in developing the science of sanitation through research and through the collection and dissemination of new developments occurring in this field. The field of interest covered by this department is controlled industrial sanitation. The department issues news letters to its own members and to other interested individuals and companies with the purpose of stimulating interest in industrial sanitation. Since many of the problems of industrial sanitation are basically the same as those encountered in food service institutions, these news letters are of value to institution food service operators.

Paul E. Holcombe (10) Technical Editor, Skyscraper Management and Research Engineer, National Association of Building Owners and Managers, in his manual on floors has outlined the various types of floor materials in common use in office buildings. Each type of floor included in the bulletin is treated in detail with respect to kinds in general use, important ingredients used in manufacture, methods of manufacture, installation, finishing and proper maintenance.

Brainard, Assistant Superintendent of Schools, Dearborn, Michigan, et al. (3) have written a handbook intended primarily for school custodians. The care and maintenance of school buildings and grounds is the particular field of interest of these authors. Included in the handbook are sections on maintenance equipment and materials for care of floors which, for the most part, can be used equally well in both food service institutions and in school buildings.

A booklet by Cornelia D. Plaister (14), outlines information on various types of floors following a generally uniform plan of discussion for each type: 1. history and description of the floor material, 2. new developments, 3. advantages, 4. disadvantages, 5. general specifications for laying, and 6. instructions for maintenance. No one topic is treated in detail, yet as far as the discussion goes it is worth-while. Although the booklet was intended primarily for those interested in the selection and

maintenance of library floors, much of the material is applicable to use in food service institutions.

Department of the Army Technical Manual TM5-609 (6) is intended for post superintendents and foremen of custodial services. It provides information and gives instructions for efficient maintenance procedures on Department of the Army installations. It discusses how to estimate custodial services needed; selection, training, organization and supervision of the work force, characteristics of buildings and fixtures to be serviced; tools and supplies to be used; methods of operation; and possibilities of economies through inspection and training of personnel. The sections on buildings and fixtures, and on custodial equipment and supplies contain information which is helpful to any one interested in floors and floor maintenance.

McGowan (13), Teachers College, Columbia University, discusses the subject of detergents in relation to their specific cleaning functions. The book is intended primarily to aid the consumer in wise selection and use of detergents but it contains several chapters which are helpful to the institution food service operator who must select and use detergents. Chapter I deals with a definition and classification of dirt with a description of methods of removing dirt. Chapter III discusses water and the part it plays in cleaning. The remaining chapters deal with

soap and other detergents. The chemistry of soaps, methods of manufacture, commercial types, builders and fillers, and the cleansing action of soap are all subjects of interest in floor maintenance. Varieties and kinds of other cleansers, tests and evaluation of the efficiency of each are discussed in detail.

Household Finance Corporation (17) in a bulletin on soap and other cleaning agents includes useful information on the theory of the cleansing action of soap, on methods of softening water and types of soap on the market.

The institution food service operator will also find up to the minute information on the selection and care of floors in such periodicals as Institutions Magazine (15), Buildings and Building Management (16) and Soap and Sanitary Chemicals (9).

III. GENERAL INFORMATION ON FLOORS AND FLOOR MAINTENANCE

A. Desirable Qualities for Floors in Institution Food Service Areas

In everyday use the institution kitchen and dining room floors are subjected to heavy traffic and to agents such as soil, grease, food stains, water, acids, alkalis and abrasive materials which have a damaging effect. With this in mind, food managers recognize the importance of serviceable and suitable floor materials.

A survey was made to determine what qualities in flooring were most desired by a group of trained directors of school, college, hospital and commercial dining rooms (7). This study showed that the following qualities were considered desirable in the order given: 1. durability, 2. appearance, 3. ease of cleaning, 4. quietness, 5. non-slipperiness, 6. low maintenance cost, 7. resistance to stain, 8. resistance to moisture, 9. resilience, 10. low original cost.

1. Durability: Unless a floor will stand up favorably under heavy wear it has no place in the institution kitchen or dining room.

Neubreuch (19) classifies the types of wear most damaging to floors as follows: 1. abrasion and 2. damage due to indentation. Abrasion results from continuous foot traffic over the floor throughout the course of the day's work with a resultant gradual wearing away of the floor surface. The quality of resistance to abrasion is important in selecting a floor material, yet there are two extremes to keep in mind. Complete lack of this quality would of course mean a floor that was entirely too soft to be suitable for institution use. On the other hand if the material were entirely resistant to abrasion it would give a floor surface with absolutely no "give" or resilience. Under this condition, the floor would be likely to crack with the weight of heavy equipment, which leads to the second type of wear, damage due to indentation.

A floor that will not withstand the weight of heavy equipment standing upon it, or the movement of heavy equipment across it or falling upon it, will not prove durable under constant use. Some of the floor materials such as rubber tile or linoleum possess certain admirable qualities, but for institution kitchen use they become dented very quickly wherever heavy equipment is placed. On the other hand, materials such as quarry tile and terrazzo stand up very well under the weight of heavy equipment.

With these points in mind, it is recognized that

floors in the food service unit are subjected to more wear and tear than in any other part of the building. As a result, the quality of durability is of prime importance in choosing a suitable floor material.

2. Appearance: Usually the first object that comes to one's attention upon entering a room is the floor. It is almost an instinctive precaution which directs the eye to the floor. Subconsciously one evaluates the floor and the appearance of the room in terms of it. In the food service unit, if the floor is pleasing in color and texture it helps to give a similar impression of the whole room. If on the other hand, it is drab and colorless, or cold, or glaring, it has a disquieting effect on patrons, occasional visitors and on employees. There are many psychological factors which affect general attitude toward work, not the least of which are pleasant surroundings. If this factor is important with regard to patrons who frequent the dining room probably not more than three times daily, it seems even more important for those employees who work long hours in the kitchen. A pleasant environment undoubtedly helps to strengthen feelings of satisfaction toward work and toward management, with a probable increase in production rate and quality of work.

3. Ease of cleaning: This quality is closely linked with maintenance costs and standards of sanitation. A floor

which is difficult to clean or requires a great deal effort to clean is a decided disadvantage in both respects.

Maintenance costs of a food service unit are a vital part of total operating costs. Anything which will help to decrease the time spent on floor maintenance will likwise help to lower total operating costs and increase net profit.. A smooth non-absorbent surface will require much less time and effort to clean than will a rough or fibrous material.

The degree of cleanliness of a floor is very often an indication of the general standards for sanitation in the entire unit. A floor which is rough, cracked or absorbent provides an excellent place for soil and bacteria to collect. It will also need constant effort to keep clean.

4. Quietness: According to Husband (11), noise is a source of both distraction and fatigue. It is therefore reasonable to suppose that one of the causes of undue fatigue among food service personnel may be due to working in noisy surroundings. The rattle of dishes and equipment and the movement of heavy trucks contribute to this condition. Even though one may try to eliminate noise in the institution kitchen or dining room, it is never possible to do so completely. On the other hand, noise may be greatly reduced by choosing floor materials which will absorb sound rather than amplify it. A floor

material which possesses good qualities for sound absorption has a restful effect on the workers.

Goodrich (7) indicates that from the standpoint of the loudness of noise produced when dishes are dropped on the floor from table and tray-carrying heights, the most desirable floor coverings are cork and rubber tile. The least desirable are quarry tile, ceramic tile and terrazzo.

5. Non-slipperiness: The slipperiness of any surface is important to the physical well-being of those who walk on it. The National Bureau of Standards (23) has conducted a series of tests to determine relative slipperiness of various floor and deck surfaces. A pendulum-type machine was used and the surfaces were tested when dry and clean, dry and dirty, wet and clean, wet and dirty, wet and soapy, and in a few cases oily.

Among the types of floor materials studied were terrazzo, asphalt, rubber and wood. Tests were made using the original surfaces of the materials as well as after grinding them with No. 180 silicon carbide. The effect of different wax finishes on the anti-slip properties of several floor materials was studied. Tests showed that anti-ship properties of terrazzo were improved by the addition of abrasive aggregates. The abrasives used were carborundum, a silicon carbide aggregate; alundum, an aluminum oxide aggregate; vitrazzo and anti-slip, crushed ceramic tiles containing abrasives; macanite, a natural aggregate containing aluminum and iron oxides.

In addition to these tests on abrasives used in terrazzo for anti-slip properties, several specimens of terrazzo containing different amounts of an acid-resisting abrasive were etched with hydrochloric acid before buffing. This was done in order to cause the harder abrasive aggregates to protrude prominently in the surface of the terrazzo and thus represent more nearly a possible service condition. The anti-slip coefficients of the specimens, under wet conditions and with leather heels, were materially increased by the above treatment. The coefficients obtained with rubber heels were not appreciably altered by the treatment.

The anti-slip properties of maple, oak, rubber, linoleum, and asphalt tile were, under most of the conditions, increased by grinding the original surfaces and were subsequently lowered by coating the ground surfaces with finishing materials. The results indicate that water-emulsion wax has better anti-slip properties than either paste or spirit waxes. The results also show that waxed floors are more hazardous, especially under dry conditions, with leather heels than with rubber heels.

The anti-slip coefficients obtained with rubber heels under dry and clean conditions were, in general, much higher than those obtained with leather heels under the same condition. However, under similar dirty or wet conditions, this difference was not nearly so great. The coefficients obtained with leather heels were influenced

by the degree of wetting of the leather, being lower with increase in wetting. This necessitated a thorough soaking of the leather heels prior to testing under wet conditions and probably represents a more severe condition than is normally encountered in service.

In view of the above, the National Bureau of Standards suggests that when the pendulum machine is to be used to establish a rating for a floor, the experimenter should take into account the kind of heel used for the testing, and set the limits accordingly. From the results of the test, the following limits are suggested:

Anti-slip value (Classification)	Leather heel (Anti-slip coefficient)	Rubber heel (Anti-slip coefficient)
Poor	Less than 0.15	Less than 0.25
Fair	0.15 to 0.30	0.25 to 0.40
Good	More than 0.30	More than 0.40

From tests conducted by Goodrich (7) it was found that variations in surface conditions which lower coefficient of friction increase the ease with which sliding will occur. Thus the application of wax decreases the friction coefficient and increases the slipperiness of the floor.

6. Low maintenance cost: Low maintenance cost is closely linked with ease of cleaning and with durability, qualities already discussed. The easier a floor is to clean with

regard to smoothness of surface the less time will be required for cleaning and therefore labor costs will be lower. Resistance to stains, alkalis, grease and moisture will also aid in decreasing costs of cleaning. Floors which absorb stains will need extra attention if they are to be kept in good condition. Floors which are damaged by alkaline materials will disintegrate over a period of time. Floors which are injured by abrasion require constant refinishing.

In considering maintenance costs therefore, one should take into consideration not only the costs of daily cleaning but the frequency and extent of repair work which is likely to be required. A floor which seemed reasonable in original price may turn out to be a very expensive item if maintenance costs are high.

7. Resistance to stain: It is impossible to avoid a certain amount of spillage on the floors in a food service unit. With this in mind, it is necessary to choose a floor material which will not be damaged by stains from food acids, cooking fats or oils, etc.

Goodrich (7) found that French dressing and butter caused asphalt and rubber tiles to soften and disintegrate. The more asphalt the tile contained the greater the disintegration. With regard to this latter factor, dark colors are affected more than light colors because more

asphalt is used in the darker colored tiles.

Again from these tests, grease-proof asphalt tile was not affected by butter. The faint light colored ring produced by French dressing was due to the action of the acid rather than the oil. Rubber tile was not softened to the same extent as asphalt tile but its surface finish was destroyed, leaving rough unsightly areas.

Goodrich conducted tests on certain floorings to determine resistance to such materials as butter, French dressing, crushed fresh blackberries, ink and rusty nails. Results of these tests showed that hard surface floors are more resistant to staining from the agents used in this study than fibrous materials. Red quarry tile is highly resistant to staining but tan quarry tile is slightly stained by French dressing, blackberry juice, ink and iron. Linoleum shows marked resistance to all the stains included in the test. Oil and grease have a solvent effect upon all materials containing asphalt and rubber.

8. Resistance to moisture: The tendency of floor materials to expand or contract with changes in moisture may result in objectionable conditions such as buckling, curling, separation at the joints, or rotting and disintegration of the floor material itself. In institution kitchens where relative humidity is likely to be high due to the use of steam equipment and where water will inevitably be spilled,

it is wise to choose a floor material which is not affected to any appreciable degree by the presence of moisture. Conversely in the dining area, the lack of moisture in the atmosphere may have a damaging effect through excessive drying out of the floor material. This may result in cracking, splintering, shrinkage, or in some cases it produces a floor which is dry and lifeless.

The results of tests conducted by the National Bureau of Standards (21) on dimensional changes of floor coverings with changes in relative humidity and temperature showed that differences in relative humidity affect the dimensions of many floor coverings to a much greater extent than do changes in temperature within the range usually encountered in structures. Such floor coverings as stripwood, linoleum, and felt base show a much greater dimensional change in the across grain direction than with the grain direction. The several monolithic compositions, one of which was magnesium oxychloride, showed relatively small changes in dimension.

Not only does excess moisture in the air affect the suitability of a floor material for institution food service use, but moisture spilled on the floor has a damaging effect. Water which is allowed to remain on such floors as linoleum or rubber will rot the material and over a period of time it will disintegrate. The harder floor materials such as terrazzo and quarry tile are not so readily harmed by water, providing of course that it does

not contain harmful ingredients such as alkalis.

9. Resilience: Quietness has been set up as one of the important qualities of floor materials in respect to reduction of fatigue of the worker (7). Of equal importance in this instance is resilience, the quality in some floors of exhibiting a certain amount of "spring" or "give" to the feet when it is walked upon. Floors which do not exhibit this quality increase fatigue of the workers and thus are a limiting factor in the rate of production.

According to Goodrich (7) the resilience of a floor material may be indicated by its resilience to the force with which a heel strikes the floor. The less resilient the flooring the greater the resistance to the force of the impact of the heel against it. From measurements made by Goodrich, quarry tile is the least resilient floor material. The most resilient floorings are cork, rubber tile and linoleum. They possess this quality to an almost equal degree.

10. Low original cost: Again according to Goodrich (7) low original cost is a desirable quality in selecting a suitable floor material for use in the institution food service unit. High quality floors should be a life-time investment if the proper type is chosen to suit the purpose in mind. The cheapest materials are not always the worst, nor by the same token are the most expensive ones the best.

Reasonable original cost of materials and installation in keeping with the service expected from them should be one of the guides in selecting a suitable floor material.

There is very little authentic information available on actual costs of various floor materials. The reason for this is that it is extremely difficult to quote definite prices since various factors, such as size of job, geographic location and quality of material chosen, all affect the final cost of installation.

Goodrich (7) made a survey of cost of floorings in Seattle, Washington, in 1938 which gives the following information:

Table I

ESTIMATED COST OF FLOORINGS - 1938

Floor Material	Cost per Square Foot
3/16" asphalt tile, dark color magnesite	$ .18 - .24 .22 - .30
1/8" linoleum, battleship	.23 - .35
7/8" beech, first grade	.26 - .38
7/8" maple, first grade	.32 - .45

The above types had the lowest cost per square foot laid. The least expensive was asphalt tile, the price range depending upon the asphalt content and the color. The most expensive was quarry tile, ceramic tile and terrazzo with costs ranging from $ .48 to $ .86 per square foot.

It is interesting to compare and note the trend in prices of floor materials within the last eleven years. The following prices were obtained from a flooring contractor in Battle Creek, Michigan and an architect in Detroit, Michigan.

Table II

ESTIMATED COST OF FLOORINGS - 1949

Floor Material	Cost per square foot	
	Battle Creek	Detroit
1/8" Asphalt tile, Group B	$ .12	$ .16
Greaseproof asphalt tile	.29	.30
Quarry tile	1.00	1.00
Terrazzo	.65 - 1.00	1.00
1/8" Rubber tile	.41	.50

Price for asphalt tile varied with the amount of color and the amount of asphalt. Color in grease-proof asphalt tile did not affect the price. All colors in rubber tile were the same price.

From the foregoing information on qualities desired it is evident that a perfect floor material has yet to be discovered. Each type of floor material possesses some of the desirable qualities but no one possesses them all. The soft materials are resilient, quiet, relatively low in original cost but they do not possess the qualities of durability, ease of cleaning, resistance to stain and

moisture to as great a degree as do the hard surface materials. It seems advisable before making the final choice of a floor material to decide the amount and type of wear to which the floor is to be subjected and what specific effect one wishes to produce. If it is to be subjected to severe wear, durability should be the first consideration. If it is to be used in a dining room perhaps quietness and appearance are the most important qualities to consider. If on the other hand one must operate on a limited budget, then original cost plus cost of maintenance must be given first thought.

B. Description, Installation and Care of Floors in Institution Food Service Areas

Michigan State College has at least nine permanent food service operations with as many different types of floor materials used in these food service areas. From those types available the following materials were chosen to be studied in detail: hardwoods, rubber tile, asphalt tile and terrazzo for dining-room use, and quarry tile, concrete and magnesite for kitchen use.

CLASSIFICATION OF FLOOR MATERIALS

Floor materials in common use fall into three main groups: soft or resilient, semi-resilient and hard or non-resilient. Included in the first group are hardwoods,

rubber tile and asphalt tile. Magnesite is a semi-resilient material. Terrazzo, quarry tile and concrete belong to the non-resilient group of floor materials.

1. Hardwoods

a. Composition: Wood is a product of nature. The hardwoods, suitable for use as flooring materials, have a close cellular structure which gives them strength and ability to resist hard wear. The closer and more dense the cell structure, the greater will be the ability to resist absorption of moisture, grease and stains.

b. Types: A comparison (5) of the wearing qualities of the various woods used for flooring indicates that the following hardwoods are the most durable in the order given: hard maple, beech, birch and oak, the latter usually being quarter-sawed. Maple, beech and birch are very dense hardwoods of great strength and weight. They are adaptable for use where floors are subjected to heavy wear with a limited amount of maintenance. The closeness of the grain prevents easy penetration of dirt and soil. Oak is also chosen for its beauty of grain and warmth of appearance but it has a more open grain than maple, birch and beech.

Northern hard maple is available in about three grades. The better grades are white in color and free from knots. Good maple floors are durable and if properly cared for

will give long service. The better grades of maple bear the mark MFMA indicating the approval of the Maple Flooring Manufacturers Association.

Abrasive tests of flooring materials conducted by the Mellon Institute of Industrial Research show comparative values for wearing qualities of maple and non-wood materials as indicated in Table III. The tests were made with a machine which produced an effect comparable to the action of human footsteps. The test period was the same in each case and from this the percentage loss by abrasion was determined. The indentation test shows hardness, and the abrasion test the resistance to friction. According to this table, the wearing quality of maple is superior to cement and is as good as marble.

Another hardwood, beech is heavy, strong and tough. It shows somewhat more grain pattern than maple and has slightly more natural color when varnished and waxed. Birch is similar in strength to beech but is not quite so close grained as maple and beech. Being somewhat less expensive than the other two it is sometimes stained as an imitation of these woods. Both beech and birch of good quality will bear the mark MFMA indicating approval by the Maple Flooring Manufacturers Association.

Oak provides a hard floor that resists wear. It is darker in color than maple. The National Oak Flooring Manufacturers Association has set up three grades for

Table III

COMPARATIVE WEARING QUALITIES OF

MAPLE AND NON-WOOD MATERIALS*

Material	Average Percentage Loss	Indentation Test
Vitreous tile	4.57	0
Marble	23.18	0
Maple wood	23.79	0
Rubber	20.59	4.0
Linoleum	56.57	13.6
Oxychloride cement	50.10	0
Neat Portland cement	16.79	0
Asphaltic composition	80.11	61.0
Cork tile	45.93	26.7

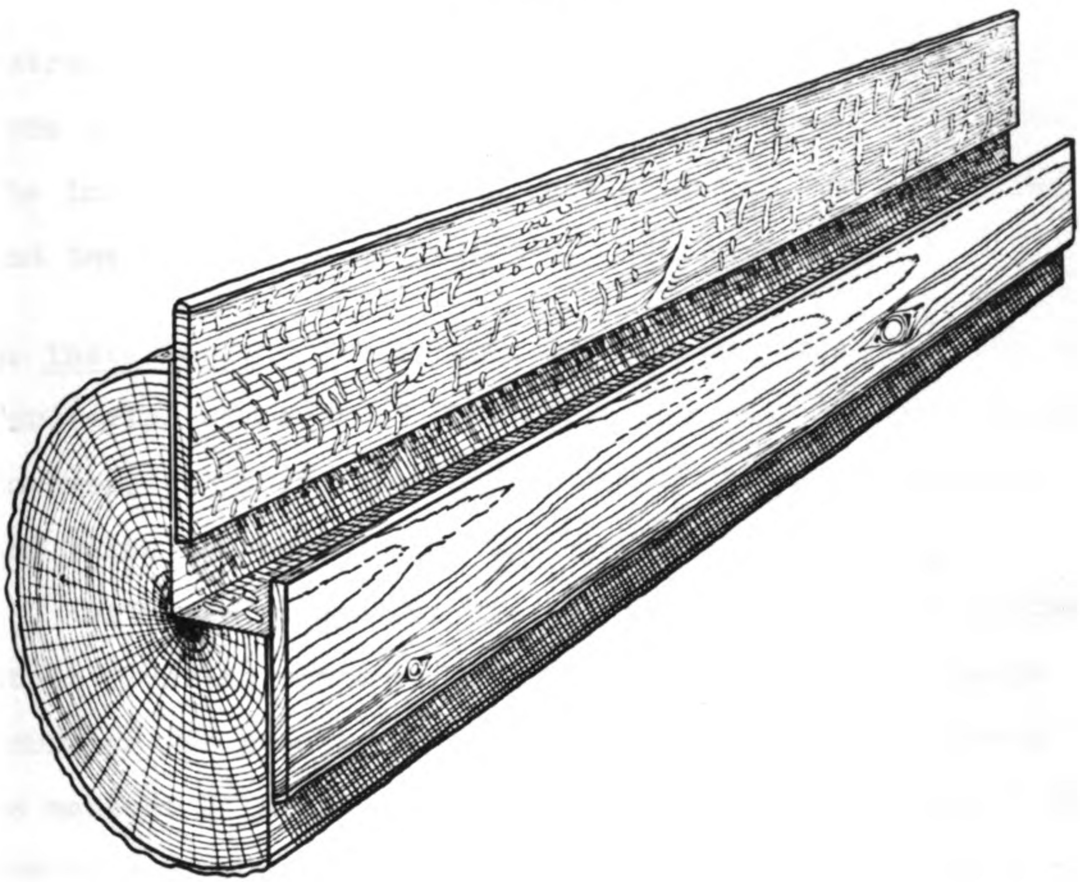
* Adapted from Grading Rules and Standard Specifications, Maple Flooring Manufacturers Association, Chicago, 1935.

quarter-sawed oak and four grades for plain sawed oak. When oak is quarter-sawed it presents a distinct pattern of graining (Figure 1) which makes it particularly attractive. This quarter-sawing is done by cutting the logs parallel to the radial medullary rays which cross the rings of growth. This gives the characteristic "flakes" and figures familiar in quartered oak. Quarter-sawed oak has better wearing qualities than plain sawed oak.

c. Seasoning of Woods: Proper drying or seasoning of woods is very important, as it tends to decrease shrinkage after placement, increases resistance to decay, reduces weight and improves its strength and mechanical properties, and prepares it for preservative treatment (10). There are two methods of drying in common use - air drying and kiln drying. The first method depends upon atmospheric temperature and humidity. This is the cheaper method as far as equipment is concerned but it takes a great deal of time and storage space and there is apt to be a loss in lumber due to checking and warping of woods.

Kiln drying is a controlled procedure which assures more nearly uniform results. Warm moist air or superheated steam is usually the drying medium. The length of time varies from a few days to several months, but it is considered that the longer drying period produces the best results. A certain moisture content in the drying air is used at the beginning of the drying period and this

Figure I



Oak log Top board, quarter sawed bottom board, plain sawed

Courtesy of National Association of Building Owners and Building Managers

amount is gradually reduced as the process proceeds. It is important to keep the surface pores of the wood open while the interior has an opportunity to give up its extraneous moisture. Otherwise a hard, dry covering would form on the outer surface with probable warping later on. The installation of green flooring causes later shrinkage and the appearance of cracks between the joints.

d. Installation: An attempt to give complete instructions for laying of hardwood floors would be out of place here. However, there are some points which may be of interest and value to the food service operator.

With few exceptions the manufacturers (19) of hardwood strip flooring recommend its installation on a suitable subfloor for greater satisfaction. The subfloor should be made of kiln-dried or thoroughly air-dried boards. The use of narrow subfloor boards placed with an allowance of 1/8" between boards prevents the development of cracks between joints in the top floor due to shrinkage in the subfloor boards.

The top flooring should not be laid until all other construction work in the building has been completed. Under no conditions should the floor be laid flush with the wall as a certain amount of space must be left for expansion of new boards. The Maple Flooring Manufacturers Association (8) recommends that whether it is summer or winter

the heat should be turned on at least ten days before flooring is laid.

e. Finishing: The location, desired effects, and use of the floor must be considered when deciding on the particular finish to be used, since no one method will suit all purposes.

Practically all standard hardwood floorings are delivered to the user with a comparatively smooth surface, but in the process of laying certain roughening is bound to occur. This roughness may be removed by scraping or sanding. The floor is then ready for the specific finish desired. Neubreuch (19) suggests that there are only two general "use" classifications for hardwood floors; 1. residential and 2. heavy-duty. In the following outline, Neubreuch indicates the procedure and types of finish applied to these two classes of floors:

Procedure	I. Residential Class	II. Heavy-duty Class
Stain	If desired	If desired
Filler	Essential for open-grained woods, i.e., oak, not used for close-grained woods, i.e., maple.	Not essential for any hardwood other than oak.
Finish material	Penetrating seal*, varnish, lacquer, or shellac.	Penetrating seal only.
Wax	Highly recommended for any finish material.	Public safety factor and cleaning methods often preclude use of wax**.

*,** See next page

Stain is applied to floors when other than the natural wood color is preferred or when it is desirable to cover up the natural marks in the wood. If the natural finish is preferred the coat of stain is ommitted.

A penetrating seal is the only type of finish recommended by hardwood flooring manufacturers for heavy duty purposes. A penetrating seal both penetrates into the surface of the wood and seals the minute wood fibers to form a smooth protective surface. It actually becomes a part of the wood and wears only as the wood itself wears. The seal helps to repel the action of water and common stains. Worn spots may be refinished without refinishing the whole floor.

Wax is used on the floors in institution dining-rooms to build up a pleasing sheen on the floor and to act as protection for the floor but care must be taken to use a non-slip wax applied in thin coats. The use of too much wax is a safety hazard.

f. Maintenance and Care: The importance of treating hardwood floors with a good penetrating seal and of building up a protective covering of wax cannot be too strongly emphasized in the finishing of new hardwood floors. If

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* See manufacturer's instructions for application of wood fillers, particularly when penetrating - seal wood finish is used.

** In cases where it is found advisable to use wax on heavy-duty floors, it should be of a non-slip type carefully applied according to the manufacturer's directions.

this has been accomplished and then maintained throughout usage, not only will the problem of daily cleaning be much easier but the life of the floor will be noticeably prolonged. The seal and wax used act as preservatives and eliminate the necessity for frequent, heavy scrubbing of floors - a method of cleaning which should be avoided wherever possible. The use of water dries out the natural oils in unfinished wood. When the surface has been waxed, water will dull and whiten wax.

If a floor is badly stained, the stains may be removed by rubbing with a cloth moistened in turpentine or a special floor cleaner recommended for such a purpose. This procedure will remove part or all of the wax and so may necessitate rewaxing.

Frequent mopping with a dry mop to remove surface dirt accompanied by periodic applications of a good grade of wax should help hardwood floors remain in good condition.

The Maple Flooring Manufacturers Association and the National Oak Flooring Manufacturers Association are two trade associations that have been interested in promoting quality in hardwood floors. They issue information as to what constitutes standard grades. They set up standard specifications and issue instructions for laying floors as well as instructions for proper maintenance. Their advice is made available to anyone interested in good floor maintenance.

2. Rubber Tile

a. Composition: Rubber floors usually consist of pure rubber, sulphur, color pigments, mineral rubber* or other fillers, and sometimes fibers (12). In the manufacture of rubber, the vulcanizing process requires a very high temperature which makes the product fire-proof in itself. Of recent years, a chemical catalyzing agent has been added which hastens the vulcanizing process and thereby cuts down manufacturing costs. According to Plaister (14), several ingredients have been discovered to guard against deterioration by the ultraviolet rays of the sun, as well as offering protection against oxidation.

b. Types: There are two main types of rubber flooring - rubber tile, cut in blocks of varying sizes and available in many different colors, and sheet rubber which comes in rolls and is laid in a manner similar to that used with linoleum. Of the two types, the former is used more frequently today. Rubber tile may be purchased in standard thicknesses of 1/8", 3/16", 1/4" and 3/8".

c. Installation: Rubber floors should never be installed over rough or uneven subfloors nor in areas where grease or oil or moisture is prevalent. The subfloor may be either wood or concrete but the latter is preferred. The tiles are fastened to the floor with a rubber cement paste.

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* Mineral rubber is gilsonite - a black, brittle, lustrous mineral consisting of hydrocarbons.

Any excess cement that oozes up between the seams should be wiped off. After all the tiles are set in place the floor is rolled with a heavy roller to force out air bubbles. Sandbags should then be laid along the seams until the cement is thoroughly dry.

d. Finishing: Unlike many other floor surfaces, rubber tile does not require surface finishing such as grinding or sealing or hardening.

e. Maintenance and Care: Due to the inherent characteristics of rubber flooring, it can be easily damaged if the wrong materials are used in maintenance. Alkalis or soaps containing alkalis should not be used. Spirit waxes or anything containing a solvent and sweeping compounds or anything containing oils should never be used on rubber floors. These have a tendency to soften rubber and finally cause disintegration. Caustic and acid cleaners, as well as excessive dry-buffing of untreated floors, cause heat and have a damaging effect. Abrasive cleaners are too harsh as they have a tendency to roughen and scratch the surface finish, making dirt stick to it and so maintenance is more difficult.

With these points in mind it is wise to choose a good neutral cleaner for rubber tile. In areas where traffic is light, mopping with clear water only may be all that is necessary. To preserve the surface, and enhance

the appearance, the application of thin coats of water emulsion wax is very effective. This also reduces cleaning costs as it tends to prevent dirt and stains from becoming embedded in the floor.

The Rubber Flooring Manufacturers Association has done a great deal toward improving standards for its industry. They have set up certain specifications for quality of product and installation which must be met by all manufacturers belonging to the Association. They have also prepared and issued a list of floor cleaners and floor treatment materials which is a valuable guide to those responsible for maintenance of rubber floors.

3. Asphalt Tile

a. Composition: According to the Asphalt Tile Institute (1) asphalt tile is composed of a thoroughly blended composition of thermoplastic binder of the asphaltic or resinous type, asbestos or cotton fibers, and inert materials as fillers or pigments. The basic materials are thoroughly mixed under heat and pressure. Then they are conveyed to heated rolls where a sheet is formed. This sheet is cut into tiles of various sizes.

To meet specifications of the Asphalt Tile Institute, the tiles must be 1/8" or 3/16" in thickness. The usual sizes are 9" x 9", 12" x 12", 18" x 24" but they may also

be made in 3" x 3", 3" x 6", 6" x 9", 6" x 12" and 12" x 24".

b. Types: Asphalt tiles are classified according to color groupings. The various color groups as listed by the Asphalt Tile Institute (1) are as follows:

Color Group A	
Plain colors only	Black, dark red.
Color Group B	
Marbelized colors only	Background colors black, dark brown, and dark red mottled with any one or more of the following colors: white, red, yellow and green.
Color Group C	
Plain colors	Dark green, light green, light gray, light red, medium red, tan, buff.
Marbelized colors	Seven background colors corresponding to the plain colors listed above, mottled with any one or more colors to make seven color patterns.
Color Group D	
Plain colors	Cream, white, blue.
Marbelized colors	Three background colors corresponding to the plain colors listed above, mottled with any one or more colors to make three color patterns.

The cost of asphalt tile varies somewhat with the colors selected. Group A colors are lowest in cost; Group B colors next. Group C colors are somewhat more expensive

while Group D colors are highest.

c. Installation: Asphalt tile is a thermoplastic material and in order to give satisfactory performance the subfloor must be smooth, clean, firm and free from springiness. The material will follow the contour of the subfloor; consequently it must be exactly even. The tile may be laid over concrete or wood subfloors. Its high resistance to moisture makes it the only resilient flooring which can be satisfactorily installed below grade. Where grease or oils are likely to be present, the Asphalt Tile Institute recommends the use of a special grease-proof type of tile.

Asphalt tile is laid in a manner similar to that used in laying rubber tile. Asphalt tile adhesive is spread in a thin, even film over the subfloor and the tiles are laid starting at the center of the room and working toward the walls. The width of the border is adjusted to that required by the tile.

d. Finishing: When the tile has sufficiently sealed itself, the surface should be thoroughly cleaned with a neutral cleaner, followed by the application of two coats of a good grade of water emulsion wax.

e. Maintenance and Care: Grease or oils should not be allowed to come in contact with ordinary asphalt tile. They have a tendency to soften and stain the floor, causing permanent deterioration.

This tile has a nonabsorbent surface so that stains, other than oily types, do not penetrate. Ink marks can be easily washed off and cigarette or match burns leave no permanent visible effect.

Even though asphalt tile is considered to belong in the resilient group of floorings, it is the least resilient one of the group. It has a tendency to be brittle and will crack under the weight of heavy equipment or under exceptionally heavy foot traffic.

If moisture is allowed to stand on asphalt tile floors it has a tendency to warp and loosen the tiles. Therefore in daily care of these floors, the floor should be thoroughly dried after washing.

The manufacturers of asphalt flooring have, like many other floor manufacturers, grouped themselves together to form their own flooring association, The Asphalt Tile Institute. As a result they have been able to set up and maintain high standards of quality for their products. All manufacturers belonging to this organization must meet standard specifications for installation of asphalt tile.

In order to establish a standard of manufacture which would be the best obtainable, the Asphalt Tile Institute founded a Research Fellowship at the Bureau of Standards. There, a specification for asphalt tile was set up which has been adopted by the government as Federal Specification SS-T306a.

4. Terrazzo

a. Composition: Essentially, terrazzo is composed of small chips of marble or granite held together with a bonding material which is usually cement. According to Brainard (3), good terrazzo has a smooth surface that is 70 percent or more marble and less than 30 percent of neat Portland cement matrix.

b. Types: There are two types of terrazzo, precast and poured-in-place. Precast terrazzo, known as Art Marble, is made by mixing dry cement with marble or granite chips which have been crushed and graded for size. Water is then added and the whole mixed to form a homogeneous mass. This is molded under high pressure into blocks and allowed to dry and cure for several days.

The second type is made in the same way but it is poured on the floor while in a plastic state. It is not as dense as the first type since it is not subjected to the same degree of pressure. Metal stripping is usually laid in squares on the floor before the terrazzo is poured. The metal used is either brass or aluminum, the latter being popular at the present time because it is less expensive. These strips serve as a mold for the terrazzo, allow for expansion of the floor and also make it possible to repair small sections, if necessary.

c. Installation: After the floor has been allowed to dry and cure sufficiently, one of the most important procedures for producing a fine floor is that of grinding and polishing. Coarse silicon carbide stones are used for this purpose. Following this, the floor is given a light grouting of Portland cement of a color to match that used in the terrazzo mix to fill in all blemishes, air-holes and pits. This must be allowed to dry and harden completely and then the floor is ground and polished a second time using finer silicon carbide stones. It should then be washed and rinsed thoroughly using a neutral soap to remove any surplus material.

d. Finishing: In order to protect the surface, it is important that new terrazzo floors be sealed immediately. A penetrating seal, especially adapted to terrazzo, should be applied in order to fill up the pores and present a smooth surface. A good terrazzo sealer should be low in solid content to allow deep penetration and should be non-yellowing. Surface seals leave a film and the standard varnish-type seal has a yellowing effect on terrazzo.

Unless a new terrazzo floor is treated with a penetrating seal, the surface of the floor is likely to be masked by a grayish film. In addition, certain undesirable reactions are likely to occur such as checking, pitting, and powdering. This is due to the fact that

cleaning water carrying alkaline cleaning compounds enters the pores. As the water evaporates, the salts crystallize with a resulting pressure which causes disintegration of the floor.

Terrazzo is also susceptible to disintegration from acids because of its action on the marble chips and the cement.

e. Maintenance and Care: In choice of cleaning materials, it is important to avoid the use of any sweeping compounds containing oil as the latter will penetrate terrazzo and permanently discolor it. Cleaners that contain alkalis, such as trisodium phosphate and sodium carbonate should not be used. These are alkaline salts and their danger to terrazzo floors has been pointed out in the previous section. Similarly, acid cleaners have a harmful effect, causing chemical dissolving of the marble chips. Washing with a neutral cleaner, followed by thorough rinsing is a recommended procedure for satisfactory upkeep of terrazzo floors.

If a new floor has been properly sealed, waxing is not necessary as ordinary foot traffic over the floor will in time produce a sheen which makes the floor appear to have been waxed. However it takes time to build up this sheen and so for new floors it is sometimes thought desirable to use wax. This should be applied in very thin coats and be buffed into the surface. A good water wax

is usually preferred and it may be diluted to prevent tracking and slipperiness.

According to Longshore (12) terrazzo, when it is stained with ink, iron or various other things, is one of the most difficult floors from which to remove stains. A non-alkaline abrasive cleaner may sometimes be needed for removing stubborn stains and for removing accumulations of water wax. It must however be used with caution as it has a roughening effect on the surface. Grease and other similar spots may be removed by using a poultice of whiting mixed with a solvent of the material causing the spot.

The National Terrazzo and Mosaic Association has set up certain standards and specifications for its products which must be met by all manufacturers belonging to the Association. It also issues a list of approved cleaning and finishing materials which is available to those interested in the maintenance of terrazzo floors.

5. Quarry Tile

a. Composition: Quarry tiles, or "quarries" as they are often called are unglazed tiles made from fine clay or shales (26). The clays are mixed with water and run through a pugging machine until of a uniform consistency. They are then forced through a die or orifice of desired width and thickness. As the ribbon of clay comes out it is cut into units of predetermined size. These units

are next put into molds to dry thoroughly and then into kilns where they are fired at a high temperature. During the firing process it is impossible to maintain the same temperature in all parts of the kiln. As a result there are variations in color of the tiles.

b. Types: There are two main types of quarry tile on the market - domestic, and imported. Due to irregularities in color, size, etc. during the firing process, domestic quarries are generally sold in three grades (26): select, standard and seconds or commercials. Select grade of tiles must have uniformity of color with only slight variations in measurements and they must be free from any imperfections. Standard grades must be similar in quality to select grades but are permitted some variation in color or shade. Seconds or commercials include all those other than select, standard and rubble random grades. The latter include any broken or cracked tiles suitable only for use in pathways or terraces where irregular shapes can be used.

Usually only the best grade of imported tiles find their way into this country.

c. Installation: The subfloor may be concrete or wood, the former being preferred. In either case the surface must be perfectly level and solid. Cement mortar is spread evenly over the subfloor and the tiles, which have been soaked in clean water to make a bond with the cement, are

placed on the mortar. After the tiles are put in position they are firmly pressed down to make a level surface.

When the cement has hardened sufficiently the floor should be scrubbed with clean water and the joints grouted with pure cement mixed to a plastic consistency. As soon as this begins to stiffen, it should be rubbed off with sawdust or fine shavings and the floor left perfectly clean.

d. Finishing: Quarry tile floors are alkaline in nature and unless treated will bloom just as terrazzo. They develop a dull gray film which is unattractive in appearance. This may be prevented by treatment with a penetrating sealer. Wax will also improve the appearance of the floor and prevent dirt from sticking to the surface. However, for kitchen floors, this procedure is not practical.

e. Maintenance and Care: Holcombe (10) states that vitreous tiles, which include paving, flint, quarry and aseptic tiles, are the hardest tiles known. For this reason quarry tile is a very durable flooring material, being impervious to moisture, stains and dirt. It is resistant to abrasion, freezing and thawing. Because of these qualities, quarry tile makes a long wearing and highly sanitary floor. About the only damage that can occur is that the cement grouting in which the tiles are set may loosen if strong acids come in contact with it.

As a general rule, the floor should be washed with a neutral cleaning solution and rinsed thoroughly.

The trade association promoting the tile industry is known as the Tile Manufacturers' Association, Inc. Its purpose is to promote the use of tiles made of clay, sponsor research and development of tile products and to compile statistical information for the industry. Most of the large tile companies and many of the smaller ones belong to this organization.

6. Concrete

a. Composition: Longshore (12) describes concrete floors as being made of Portland cement* and aggregates of sand, gravel (or crushed rock) and water. The materials must be thoroughly mixed with the correct proportion of water to get a homogeneous mass.

Color is obtained in concrete floors by mixing color pigments with the sand before water is used. Only mineral pigments should be used, as other pigments are likely to fade.

A rubber base paint may be applied to the finished

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* Portland cement is made by mixing and grinding limestone and clay or shale and then heating until it begins to vitrify. The clinker thus produced is pulverized, mixed with gypsum and finely ground a second time. The name "Portland" was given to this type of cement first made by an English stonemason, Joseph Aspdin because the color of the product after hydration reminded him of the Isle of Portland.

surface but since it is merely a surface treatment it does not have the long wearing qualities of color pigments added to the concrete mix. Thus in areas where there is heavy traffic the surface paint wears off leaving a floor that is unsightly in appearance.

b. Types: As well as the ordinary monolithic type of cement floor already mentioned, concrete tile has been used in various designs and colors. These tiles may be made in pre-cast form and set into place, or may be poured on the job by the use of brass stripping. However, this increases the cost of the floor and the chief advantage of using concrete is its low original cost.

c. Installation: There are two methods of laying ordinary concrete floors. One type consists of a single unit, in which the topping is placed while the base course is still in a plastic condition.

The second type is used where the base course has been allowed to harden before the finish course is in place.

Concrete floors must be smooth and dense if they are to be durable, if they are to avoid the tendency to catch dust and dirt and if they are to resist the absorption of grease and oils. Smoothness is acquired by the processes of trowelling and screeding, levelling off, and density from the right mixture of cement, sand and water.

When the cement has partially set, and only an expert can determine the exact time, the surface is trowelled to produce a smooth finish. Excessive trowelling of soft concrete brings water and fine materials to the surface which causes dusting. The surface is then levelled carefully to smooth out any high or low spots and to compact the topping. When the wearing course has hardened a grinding machine is used to produce a hard smooth finish. During the process of laying and finishing, the floor must be kept wet at all times. The floor should be cured while wet for at least ten days.

d. Finishing: Concrete floors should be hardened and sealed to prevent dusting and penetration of dirt, grease and oils. There are many floor hardeners on the market. The safest choice is to select one that has the approval of the Portland Cement Association.

When the hardening solution has dried, the surface of the floor should be carefully cleaned to remove all fine dust. The floor is then ready for a preservative treatment.

The usual penetrating seals are suitable for concrete. These are designed to fill up the pores and produce a smooth finish. Where appearance is important, the floor may be waxed. The use of wax will also protect the floor against dirt.

e. Maintenance and Care: According to Brainard (3), continual scrubbing of concrete floors, with either a caustic or an acid cleaner will ruin them. Caustic cleaners permit the formation of salt crystals in the pores with a resultant cracking or surface spalling* similar to that which occurs in terrazzo floors or in the grouting of quarry tile floors. The composition of concrete makes it susceptible to the action of acid cleaners. It is also injured by strong bleaching agents and by oils.

With these points in mind, a neutral soap or cleaner should be used in cleaning concrete floors. This should be followed by thorough rinsing of the floor.

The Portland Cement Association is the trade association which promotes the use of concrete for floors and other building purposes. It is interested in research and development of its products and issues helpful information on specifications for installation and maintenance.

7. Magnesite

a. Composition: Magnesite is the popular name given to sorel cement or magnesium oxychloride cement. When sorel

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* Spalling or cracking of the floor surface results from the pressure exerted by the formation of salt crystals within the pores of the concrete.

cement is used for floors it is composed of a mixture of magnesium oxide, magnesium chloride and Portland cement. The base is mixed with various fillers and binders such as cork, sawdust, leather, asbestos or marble chips. The whole thing is mixed very thoroughly under heat and pressure until of a plastic consistency.

Color in magnesite floors is obtained by adding mineral pigments such as iron oxide for red coloring. Magnesium oxychloride, which is formed, has a bleaching action on the metal type coloring pigments so that the floor is apt to lose its color rapidly, especially if low grade coloring materials are used. This is why many red magnesite floors fade into a washed-out pinkish color.

b. Types: Magnesite floors in general have basically the same composition but within the last few years a new type of particular interest to food service operators has been developed. Finely divided powdered copper was incorporated in magnesium oxychloride cement and this floor was found to have an inhibiting effect on the growth of molds and bacteria. The research on this type of floor (Hubbellite) was carried out by the Mellon Institute of Industrial Research. Concurrently Mallman (9), Department of Bacteriology and Public Health, Michigan State College, demonstrated that Hubbellite produced a lethal effect upon bacteria, yeasts and molds.

A few years later tests were made to determine the

repellency of this flooring to roaches. Different colors, red, gray, brown and green, were used in the tests to determine what, if any effect this would have on roach repellency. Three species of roaches were used - German, American and Oriental. Tests showed that gray-colored Hubbellite exhibited a marked degree of repellency against all three. Red, brown, and green Hubbellite were equally repellent to German and American roaches, but less effective against the Oriental species.

The results of these tests are of particular interest to food managers since control of insects and pests and the maintenance of generally high sanitary standards is a necessity wherever food is produced or served.

c. Installation: This floor may be used as a subfloor or as a surface finish in itself. It is frequently used as a relay over old worn-out floors provided that the latter have been first properly levelled.

Magnesite floors are laid in two coats, each approximately 1/4 inch thick. The undercoat is fibrous and serves as a cushion that levels worn or uneven floors. Such floors may be laid with metal strips, arranged in squares, which are set in the first coat and into which the top coat is poured. This method greatly increases the cost of the floor.

d. Finishing: Magnesite, like terrazzo, quarry tile and cement floors, is subject to deterioration from crystallization of alkaline salts if not properly treated. Therefore, immediately after installation, the surface should be rinsed thoroughly and then sealed with a penetrating seal. If this is not done the floor will show efflorescence or blooming which produces an undesirable grayish cast in the floor. The use of a sealer also makes the floor easier to keep clean. The passage of ordinary foot traffic over the floor will gradually develop a sheen on the floor. This may be hastened by the application of wax but is not practical in kitchen areas.

e. Maintenance and Care: Caustic or acid cleaners have the same effect on both magnesite and concrete floors. Therefore, these floors should be washed with a neutral cleaning solution, followed by thorough rinsing.

Magnesite has a very porous surface and so stains readily. These stains are difficult to remove and the ordinary method of wet mopping found effective for most hard surface floors, is not efficient when used on magnesite. Deck-scrubbing with a long handled brush or even hand scrubbing, getting down on the hands and knees, may be necessary to remove stubborn stains and dirt.

C. Equipment and Materials for Floor Maintenance

Before considering specific equipment and materials it is necessary to have in mind the aims in good floor maintenance. These are six in number:

1. To remove dirt, stains and grease spots.
2. To perform the task in as short a time as possible and at the same time maintain high standards of sanitation.
3. To provide a finish that will protect the floor, render it impervious to dirt, stains and grease and thereby increase its length of life.
4. To produce a finish that is safe to walk upon.
5. To produce a finish that is pleasing in appearance.
6. To perform the task with as little attendant fatigue on the part of the worker as possible.

In order to accomplish these aims, the institution manager must select equipment and materials which are suitable for each specific type of floor. Where one combination might be satisfactory for a certain type of floor, it would not accomplish a good cleaning job or might even be definitely injurious if used on another type of floor. For instance, rubber floors are damaged by sweeping compounds containing oils and also by any wax containing a spirit solvent. Wood floors on the other hand are unharmed by either of these maintenance materials. The institution manager must therefore have a good scientific knowledge of

the advantages and disadvantages of various types of maintenance equipment and materials. She should be well acquainted with the construction, operation and care of such equipment. She should have some idea of the physical and chemical properties of various types of cleaning materials and how they affect various floor surfaces.

1. Equipment

The type of equipment used will naturally be influenced by the specific cleaning job to be accomplished. In any case, there is nothing to be gained by investing in poor equipment. A mop purchased at a supposedly "bargain" price may well turn out to be an expensive mop if in a short time the strings pull out or if they prove not to be water absorbent. Again the saving of a few dollars in the initial cost of a mop truck made from a metal that rusts readily will in the long run prove more expensive than the purchase of one made from a non-rust metal. Frequent repairs and short length of life will soon prove more costly than the purchase of a more durable truck. Or finally, a floor scrub brush made from a soft fiber will prove not only inefficient in cleaning but will make it necessary for the operator to expend more time and energy on the job, both of which are expensive items.

Many more examples could be cited but these should be sufficient to show that equipment which is efficient in

performance, is well constructed and durable, and that will reduce time in operation will soon pay for itself in decreased maintenance costs.

In general there are eight methods of floor maintenance which require various types of equipment. These methods are dry mopping, wet mopping, deck scrubbing, power scrubbing, dry cleaning with a power vacuum cleaner, dry sweeping, waxing and polishing. Table IV shows suitable equipment for each method. Each type of equipment will be considered in some detail in the following pages.

a. Mops

Mops are used for both dry and wet cleaning of floor surfaces. Though they differ somewhat in construction the material used in a good mop head for either purpose is the same. It should be made of a long fibered, eight-ply staple cotton yarn. The mop handle should be constructed to allow easy attachment and removal of the mop and should have no exposed edges that would scratch baseboards or furniture. The Industrial Sanitation Research Foundation (2) has found that for general use the mop holder should have a sixty-inch aluminum handle with a knob at one end for ease and efficiency of operation. If the metal handle is not available, polished hardwood one and one-eighth inches in diameter may be used.

Table IV

EQUIPMENT SUITABLE FOR VARIOUS METHODS OF FLOOR CLEANING AND MAINTENANCE

Method	Equipment									
	Mops							Floor Maintenance Machines		
	Dry	Wet	Lamb's Wool	Mop Bucket or Mop Truck	Floor Squeegee	Brushes	Floor Pick-up Pans	Vacuum Sweeper	Scrubber	Polisher
Dry mopping	X						X			
Wet mopping		X		X						
Deck scrubbing				X	X	X				
Power scrubbing				X	X				X	
Vacuum sweeping								X		
Dry sweeping						X	X			
Waxing		X	X							
Polishing										X

Still a third type of mop is that used in applying liquid wax or floor seal and frequently known as a lamb's wool applicator.

1) Dry Mops: Dry mops should be made from cotton yarns which are attached to a canvas mitten. The canvas mitten allows the mop head to be slipped over a wire or wood frame so that the mop head may be easily removed for washing. The size of the mop head may vary from sixteen to thirty-six inches, the larger widths being suitable where there are large areas of unobstructed floor surface.

Unless mops are kept in good condition they will not perform an efficient cleaning job. It is important, therefore that they be cleaned frequently. This may be done by placing the mop head in a solution of two tablespoons of trisodium phosphate to a gallon of warm water, shaken out to separate the yarns and allowed to dry by hanging in a well ventilated equipment closet or out of doors in a service area.

2) Wet Mops: Although most wet mops are made of cotton yarn, some are occasionally made of linen yarn. Linen is better because it is stronger, wears longer and is more absorbent than cotton. On the other hand it is more expensive in initial cost. The mop head should be fastened in the center with a wide firmly stitched tape. Length of life will be increased by training the worker to reverse

the mop head periodically so that both surfaces are used. It should be remembered that ability to absorb water for new mops is low and increases with use up to a certain point.

The same procedure for cleaning should be followed as with dry mops.

3) Lamb's Wool Mops: This tool consists of a long handle, similar in appearance to that used on wet or dry mops, set in a wood block about 4 inches wide by 9 inches long. Lamb's wool is stretched over a second block of the same size. These two blocks are fastened together by two small bolts equipped with wing nuts, so that the flesh side of the skin is next to the wood.

The lamb's wool mop may be used to apply water emulsion wax, spirit-type wax, and floor seal. For large areas, it is sometimes better to use a wet mop since it may be spread more quickly, evenly and economically.

After using, the lamb's wool should be removed from the block and thoroughly washed in a lukewarm neutral-soap solution. It should not come in contact with hot water or heat in drying as it will shrink and become hard. If the applicator has been used to apply floor seal it should be first washed in kerosene and then in lukewarm neutral-soap solution.

b. Mop Buckets and Trucks

To reduce time and labor in cleaning operations it is essential that equipment be easily transported. For this reason it is strongly recommended that the mop bucket or truck be equipped with rubber tired wheels or castors.

Buckets and trucks should be constructed of durable, non-corrosive metals. Stainless steel is preferred but they are also available in galvanized sheet iron or iron which has been dipped in molten zinc after construction has been completed. The latter is better since all seams have been covered in the dipping process.

An oval-shaped bucket is better than a round one since it provides more space for inserting the mop after the wringer has been attached. Similarly an oval-shaped truck is better than a square truck for the same reason. In addition the oval-shape makes for ease in cleaning the truck.

The mop bucket should be fitted with a sturdy bail and a 3/4 to 1 inch chime on the bottom to permit easy emptying. It is advisable to use two separate buckets placed in a metal dolly rather than one bucket. If the latter is used the operator is forced to use dirty water for rinsing and this defeats the purpose of the washing process.

Mop trucks should be built with a two-compartment tank mounted on a metal frame, one tank for wash water

and one for clear rinse water. The tanks should be equipped with direct draw type drains for easy emptying.

An easily operated mop squeezer is an essential addition to a mop bucket or truck. The gear type squeezer may be attached to the side of a bucket and is operated by hand. Modern mop trucks are equipped with easy operating foot-action wringers which allow the operator to regulate the amount of water left in the mop.

Mop buckets, trucks or wringers should be washed, rinsed and thoroughly dried after each time they are used. Drying is particularly important if a metal other than stainless steel is used.

c. Floor Squeegees

Floor squeegees are used on floors to pick up excess dirty mop water or surplus floor seal. They consist of a rubber strip held between two metal strips to which a handle is attached. The rubber strip may be from 1½ to 3 inches wide and from 12 inches to 3 feet in length.

d. Brushes (4)

With some floor surfaces, such as magnesite and wood, the most satisfactory method for cleaning is deck-scrubbing, that is scrubbing by means of a long handled brush suited to that purpose, or even using a brush with no handle, the

operator getting down on hands and knees. In dry sweeping, surface soil is removed by means of brushes. Again certain brushes are used on power machines for scrubbing and for polishing waxed floors. Therefore a knowledge of the various types of brushes available and their suitability for specific cleaning jobs is essential to efficient floor maintenance.

Brushmaking as an Industry: The manufacture of brushes is a comparatively small industry and though it has been carried on for a long time much of the work is still done by skilled craftsmen. The materials used, methods of combining them and methods of brush construction all account for wide variation in price. The materials may be of animal, vegetable or synthetic origin. The ones most commonly used are bristles, horsehair and vegetable fibers, such as bass, bassine, palmyra, palmetto and tampico. Nylon has been used within recent years for some types of brushes but for maintenance purposes, the price of nylon is still prohibitive.

Source of Brush Materials: Many countries contribute raw materials to the brush industry. At present bristles come chiefly from China, South America and India but before 1900 Russia supplied most of the bristles in the United States. Domestic bristles are excellent in quality but in this country pigs are marketed in a year or less and in that

time the bristles do not grow to a sufficient length to be used for brushes. The term "bristle" is often used loosely to denote any fiber from which brushes are made; the true bristle however, is defined as the hair of a pig or boar (4).

Factors Affecting Quality of Bristles: Quality is affected not only by the methods of dressing but also by the climate, terrain and food of the regions in which the boars live. Mountainous, rugged areas produce stiff bristles while bristles from low, marshy districts are soft in texture. The best bristles, which come from North China and Siberia, are very resilient and long wearing. Russian bristles are usually thicker than the Chinese variety. Distinguishing characteristics of bristles are that they are tapered, they have elasticity, and the ends are split or flagged. The flagged ends are advantageous in that they act as tiny fingers in moving small particles of dirt. The cost of a bristle brush increases with the length of trim.

Factors Affecting Quality of Horsehair: Horsehair is less expensive and more easily obtainable than bristles. It is imported chiefly from Australia and Argentina. The raw Australian and South American hair is shipped to other countries, e.g., China, England and Italy, which specialize in its preparation. Some domestic horsehair is used but it is usually shipped to China to be prepared for manufacture

because it can be dressed more cheaply than in the United States. English dressed Australian horsehair is considered the best, since it is of firmer structure than the American. Horsehair is taken from the mane and tail of the horse and is of varying textures. The ends are sometimes flagged by a special cutting process to simulate bristles. Horsehair is often blended with bristles to give a better sweeping tool. A combination of horsehair and bristles produces a denser sweeping surface than pure bristles and makes a more effective floor brush for specific areas (4).

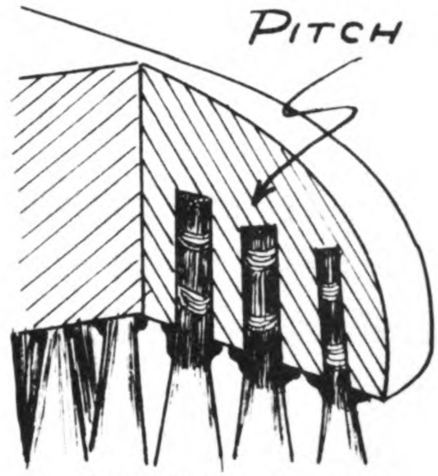
Factors Affecting Quality of Various Vegetable Fibers: The vegetable fibers most commonly used as floor brush materials come from several species of plant life. The piassa palm that grows in Africa and Brazil furnishes a coarse, very dark brown fiber called bass, which is used chiefly in heavy utility brushes. Bassine, another fiber of coarse texture, dark brown in color, comes from an entirely different source although the names of the two fibers are similar. Bassine is the superior quality of the fiber taken from the palmyra palm which flourishes in India and Ceylon. This tree also supplies palmyra fiber which is reddish brown and not as coarse and stiff as bassine. Palmetto fiber, tough and flexible, grows on a dwarf palm in the swamps of Florida. This light brown fiber is rather scarce because of the difficulties involved in harvesting it. Tampico, which is fine in texture, is taken from the

"century plant", a type of cactus that grows in Mexico, Texas, New Mexico, and southern California. In its natural state tampico is white but it is often dyed black or red. Fibers of these three colors are frequently combined in brushes to form grey tampico.

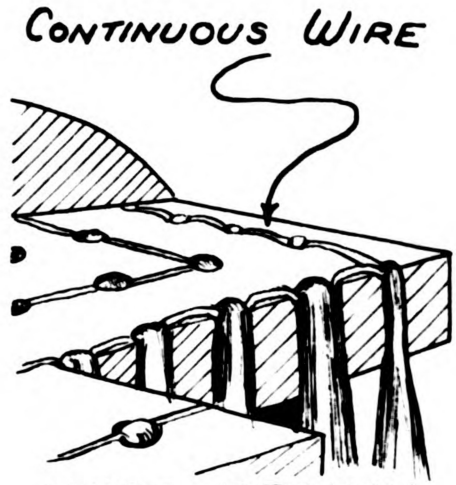
Methods of Brush Construction: The methods used vary considerably but, in general, manufacturers use hard wood, such as birch, beech and maple, for making the blocks to which the fibers are attached. Certain specifications should be followed in regard to the length and diameter of the block and the number and size of the holes which are bored in the block. The weight and trim of the contact material and the depth of the holes into which it is inserted should also be specified.

There are three ways of attaching the material to the block: pitch-set, wire-drawn, and stapled (Figure 2). The best method is the pitch-set, which is done by hand, and is generally used in making expensive brushes, such as bristle or nylon. A group of bristles is tied together to form a tuft and then dipped into hot pitch and inserted into the hole in the block. The wire-drawn method, also done by hand involves the use of a continuous wire. Each tuft is bent into a U-shape and then attached securely to the block by a fine wire which forms a network along the length of the block. The stapling process is done by machine and is used mostly for the less expensive brushes.

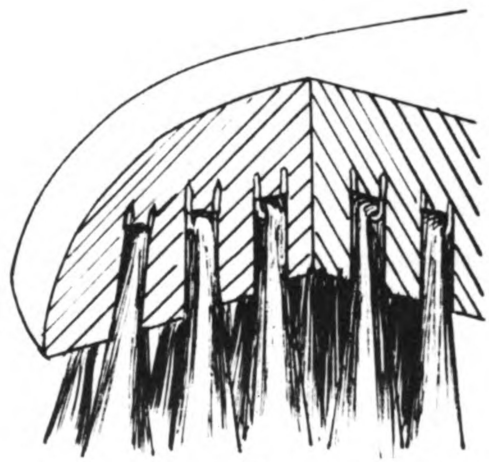
Figure II METHODS OF BRUSH CONSTRUCTION



PITCH SET



WIRE DRAWN



WIRE STAPLED

Courtesy of Joseph E. Seagram and Sons, Inc.

The tufts are bent into a U-shape as in the wire-drawn method, but are stapled individually into the block with short pieces of wire.

Relative Merits of Various Types of Brush Fibers: Several factors are involved in determining the true worth of a floor brush. Quality of performance is the first consideration but along with this the type of flooring and the kind of soil to be removed are important considerations. In kitchens where there is likely to be heavy soil from grease and other forms of dirt, it is not wise to use the most expensive type of brush.

In general it may be said that for heavy duty scrubbing a brush with all, or at least a large percentage of bassine fibers will be most satisfactory. For removing surface litter on such floors as asphalt tile, a softer brush using tampico fibers is satisfactory. For polishing and buffing, either tampico or a mixture of tampico and palmetto fibers is satisfactory.

e. Floor Pick-up Pans

Floor pans are a convenience to use, both for picking up dust in dry sweeping or for picking up water in wet mopping. Dust pans about 16" wide may be obtained with either a long or short handle. The latter is less expensive but involves more effort on the part of the worker.

Pick-up pans for water are usually made with a hump so that water may be pushed into the pan by the use of a squeegee. The lip of the pan extending to the floor should be on the long side of the pan to permit the use of a long squeegee.

In both types of pan, they should be so constructed that the edge fits close to the floor thus facilitating the picking up of dirt or water. Heavy galvanized materials do not rust as quickly as the lighter weight pans.

f. Floor Maintenance Machines

Man hours of work on floor maintenance may be considerably reduced where power machines are used for scrubbing, waxing, polishing etc. Their use results in lessened fatigue on the part of the worker, less time spent on floor maintenance, fewer people required to do the job with a resultant decrease in labor costs. For these reasons, an increasing proportion of floor maintenance work is being done by machine labor rather than hand labor.

In selecting a floor machine, it is possible to select one which, because of various attachments available, will sand, refinish, scrub, wax, polish, buff and dry clean. Whether all, or only some of these attachments will be needed, will depend on the particular needs of each institution kitchen and dining-room unit.

Construction of Floor Machines: Floor machines are equipped with a motor driven brush, the scrubbing and polishing effect being provided by the motion of the brush and the weight with which it presses upon the floor. The brush may be either disk or drum type. Since most of the machines in use at present are of the disk type (6) only this machine is described. There are two general classes of disk machines, the concentrated-weight and the divided-weight machine. In the concentrated-weight machine the entire weight of the machine is carried on the brush when the machine is in use. It is equipped with castors or wheels, but these are used only for transporting the machine from one job to the next. In the divided-weight machine part of the weight is carried by the castors and the balance on the brush. Some machines can be adjusted for varying the proportion of weight carried by the brush.

1) Typical Construction of Disk-type Machines (6): The essential parts are the housing or frame, motor, gear train, handle and brush.

a) Housing: The housing may be aluminum, cast iron, or pressed steel. It serves as the frame to which the motor and handle are attached and houses the gear train. It extends down over the brush as a skirt. A rubber bumper is attached to the skirt part to protect baseboards and furniture.

b) Motor: Motors vary in type and size but most machines in use have a motor of one-half horsepower. It is important to be sure that the current used corresponds to that described on the motor name plate.

c) Gear train or transmission: The gear train or transmission serves to transmit the power of the motor to the brush and to reduce the motor speed of about 1725 revolutions a minute to a brush speed of from 160 to 280 revolutions a minute. The motor-to-transmission shaft and the shaft that drives the brush are usually mounted on ball or roller bearings. They are sealed to prevent grease leakage.

d) Brush: The brush consists of a laminated wood or cast-aluminum disk to which the fibers are attached by stitching with brass wire or sealing with hot shoemakers' pitch. The brush is attached to the main-drive shaft by a cast-iron or pressed-steel collar with lugs that fit the shaft. The fibers used vary with the work to be performed. The bassine brush of stiff, dark-brown fiber is most commonly used for scrubbing. The tampico brush of soft, white fiber is used for polishing, waxing and buffing. The palmetto brush with medium-brown, fairly stiff fibers is used for spreading wax. A mixture of tampico and palmetto is also a satisfactory combination for heavy duty polishing. Steel-wire brushes, steel-wool pads, sanding disks, hot-wax applicators and rug-cleaning brushes

are among special attachments available. Machines are usually furnished with one scrubbing and one polishing brush as standard equipment.

e) Handle: The handle guides the machine and tilts it back on the castors. On most machines it may be adjusted to suit the individual operator.

2) Sizes of Floor Machines: Disk-type floor machines are available in a variety of sizes usually determined by the brush diameter. This varies from 9 to 22 inches. A 15 inch machine is satisfactory for most purposes.

3) Care of Disk-type Machine: The disk-type floor machine is an expensive piece of equipment. How long it will give efficient service depends entirely on the care given it. Proper care involves periodic inspection, repair and replacement of worn or broken parts, lubrication, cleaning, storage and common handling.

a) Periodic inspection: Floor machines should be inspected periodically by a qualified maintenance engineer. If the machine needs repairs they should be made immediately.

b) Repairing machines: Minor repairs may be made by the maintenance engineer but more extensive repairs may need to be done by the manufacturers of the machine.

c) Lubrication: To keep a machine in good running order, the kind and frequency of lubrication is most important. Manufacturer's recommendations should be followed explicitly.

d) Cleaning: The machine should be wiped with a clean, damp cloth after use each day to remove accumulations of wax and dirt.

e) Storage: When the machine is not in use it should be stored in a clean, dry place. The brush should be removed and hung on a hook so that the fibers are free to straighten out. The cord should be wound loosely on hooks provided on the machine.

f) Handling machines: More machines are damaged because of carelessness and a lack of knowledge of proper handling than all other causes combined. To avoid this adequate instructions for operating the machine should be given to each new operator.

g) Uses of disk-type machines: The disk-type machine may be used for buffing both waxed and unwaxed floors, scrubbing, polishing, steel-wooling or sanding. The proper brush or attachment must be used for each operation.

2. Materials

Materials used in floor maintenance may be classified into the following general groups: a. water, b. soap, c. new type detergents, d. waxes, e. sealers, f. sweeping conpounds, g. alkaline cleaners, h. volatile organic solvents and i. abrasives.

a. Water

Of all cleansing agents water is by far the commonest. The type of water available, whether soft or hard, has an important bearing on the efficiency with which cleaning operations can be performed. Hard water contains a mixture in varying amounts of any or all of the bicarbonates, normal carbonates, chlorides and sulfates of sodium, calcium and magnesium with much smaller amounts of nitrates, iron and aluminum. It is the presence of the salts of calcium and magnesium, even though in dilute concentration, which gives water its hardness. Hard water reacts with soap to form an insoluble curd which will leave a grayish film on the surface to be cleaned. If allowed to remain on certain types of floor surfaces it may prove injurious to the floor itself. This is due to the fact that the deposit is alkaline in nature and alkalis have a detrimental effect on some floor materials.

Soft or softened water does not precipitate mineral salts. There are three methods for softening water (17): 1) Boiling: Temporary hardness may be removed by boiling the water. Upon standing, the mineral salts settle in the bottom of the vessel. The clear water may then be poured off. This method is however impractical for institution use as it is inconvenient when used for large quantities. 2) Chemical treatment: Using this method, water is softened by adding various alkaline compounds. The chemicals

most commonly used are various carbonates, phosphates, and silicates of sodium. Since these are alkaline in nature, water softened by this method may still attack many of the types of floor surfaces with detrimental results.

3) Zeolites: Many institution food services install "softening tanks" in regions where hard water is a problem. The water is filtered through a special kind of sand that changes the calcium and magnesium compounds into sodium compounds which do not interfere with the cleansing process. This method is generally considered the most satisfactory for institution purposes because it requires little supervision and produces water of practically zero hardness.

In any case where hard water only is available, it is extremely important to plan for some method of softening the water. Not only will it facilitate good cleaning of floors but it will reduce costs of maintenance since less soap will be required.

b. Soap

If it is conceded that water is the most generally used cleaning agent in floor maintenance, then second place must be given to soap.

A soap is a salt of a high molecular weight fatty acid (25). Only two metals form such salts which are

soluble in water. These are sodium and potassium and so the only soaps that have any value as cleaners are the sodium and potassium soaps. Hard soaps are made with sodium and soft soaps are made with potassium. The kind of fat used affects the hardness as well as the solubility of soaps. The hard soaps commonly use tallow, lard, palm oil or hydrogenated vegetable oils. The soft soaps use fish oils, cottonseed oil or linseed oil. For practical purposes, only the hard soaps are suitable for floor maintenance because they produce a suds that stands up well and there is no undue wasting away of the soap.

Again because alkalis have a detrimental effect on most floor materials it is important to choose a neutral soap, that is, one which has no free saponifiable fat and no more than a minute trace of free alkali.

In order to use soap effectively in floor maintenance it is well to know something about how and why it acts as a cleaning agent. The following facts must be considered:

1) Solubility: If soap is to have any cleansing power it must be soluble in water. Soap will dissolve more readily in warm or hot water than in cold water and hence cleaning is more effective with warm water than with cold water. On the other hand, certain soft soaps dissolve

too quickly with a resultant wasting of soap. For good floor maintenance it is important to choose a soap that will dissolve readily in warm water without undue wasting away.

2) Rinsibility: Closely connected with the solubility characteristics of a soap, is its ability to be rinsed off a surface with ease and completeness. When soap is left on a floor it leaves a grayish film containing dirt and, in addition, the film is likely to have injurious effects on the floor surface over a period of time. Therefore there is a close correlation between rinsibility and solubility. From these facts it would seem logical to recommend a medium hard soap which would dissolve sufficiently at warm temperatures to give good cleaning action and at the same time allow thorough rinsing.

3) Sudsing Power: One of the most obvious characteristics by which a soap may be judged is its ability to form suds (7). Although the suds in themselves do not have cleansing power yet they are necessary for good cleaning. They help to wet the surface of the floor and the dirt adhering to it. They remove dirt from the surface of the floor. They keep the loosened dirt suspended in the suds so that it may be carried away in suspension. It is important to have the right amount of suds. If it breaks before the cleaning job is complete, dirt and grease will be redeposited

on the floor surface. An excess amount of suds on the other hand is a waste of soap.

4) Emulsification: An emulsion is a system where one finely divided and dispersed liquid is distributed throughout another liquid with which it will not mix. The ability of a colloidal soap solution to act as an emulsifier is one of the principal reasons why it is such an effective detergent. Some soaps of course form more stable emulsions than others. In cleaning floors, especially kitchen floors, one of the commonest kinds of soil to be removed is grease. In its capacity as an emulsifier, the film of soap surrounds each particle of grease and carries the latter off in the suds.

5) Wetting Power: The cleaning ability of a soap is closely linked with its ability to act as a wetting agent. The surface tension of plain water is relatively high. This phenomenon is of practical importance in any cleaning operation because it means that the molecules within the water exhibit a strong attraction for each other and tend to reduce the ability of water to penetrate the surface to be cleaned. Soap lowers the surface tension of water so that it can creep in between particles of dirt thus dislodging them. Soapy water has a surface tension approximately one-third lower than plain water. Thus it is more able to wet the surface to be cleaned and do a better

cleaning job.

Summary of Detergent Action of Soap: Although the preceding discussion by no means thoroughly covers the explanation of the detergent action of soap, the physical properties mentioned are the ones of greatest interest and importance to the institution manager. To be effective in floor maintenance a soap must dissolve readily but not excessively in warm water. It must be one that is suited to the kind of water available so that it can be rinsed off with ease and completeness. It must be able to produce a sufficiently strong suds to carry off dirt in suspension during the cleaning operation. It must be capable of forming a stable emulsion so that it will carry off grease in the suds. Finally it must act as a wetting agent in being able to lower the surface tension of water with consequent power to spread and penetrate the surface to be cleaned. These properties give to soap its importance as a universal detergent.

Types of Commercial Soaps: Either hard bar soap or liquid soap may be used effectively for floor maintenance. There are advantages and disadvantages in the use of either. Bar soap is the least expensive to buy because it is in a more concentrated form, yet it may not be economical to use since there is a tendency to let it soak in the water. Both white and yellow bar soaps are available. The white soaps contain sodium silicate or water glass as it is

commonly called. Sodium silicate helps the soap to remain hard and it prevents it from becoming rancid. The fat used is often a combination of beef tallow and coconut oil, but other animal fats as well as cottonseed, palm-kernel, and other natural or hydrogenated vegetable oils can be used. Builders such as soda ash, sodium silicate, borax, trisodium phosphate and other phosphates of soda in proportions up to 40 percent may be used to increase cleaning power and to act as water softeners (17).

Yellow bar soap may contain some sodium silicate, but the chief addition is resin soap (13). Resin soaps increase sudsing power but an excess will produce a sticky soap that is difficult to wash off.

The American Society for Testing Materials and the United States Government specifications for ordinary bar soap require a pure soap content of at least 52 percent, a moisture and volatile matter maximum content of 36 percent, and a maximum resin content of 25 percent. (17).

Liquid floor soaps vary in degree of purity. They are easy to use but the cost is high when considering their actual detergent value. Many liquid floor soaps have a pine oil base. This is an excellent solvent, helping to dissolve grease, oils and resinous materials. A pine oil base soap however must not be used on asphalt, rubber or certain plastic floors because it has a dissolving effect on these materials.

Some liquid soaps are soap solutions being either a straight potash soap or a mixture of potash and soda soaps, containing from 10 to 25 percent anhydrous soap (18). Others are emulsions with varying percentages of solvents and used for special purposes. The general standard for floor scrub soaps is a liquid containing 25 percent of linseed oil potash soap, thickening agent such as potassium carbonate or trisodium phosphate (18). Other oils used are soya bean, corn, sunflower and peanut oil. Resin is used in some of the cheaper products. The addition of potassium carbonate and trisodium phosphate as thickeners has certain disadvantages in that alkalis attack the linseed oil in linoleum floors. For particularly greasy floors, these alkalis aid in cleaning.

Potash soaps from low titre* fats are adapted for cleaning floors because they are readily soluble in warm water and rinse clean with cold water. Linseed oil is preferred in a scrub soap because any excess oil remaining in the soap which might remain on the floor oxidizes and forms a protective coating. Next to linseed oil, soya bean oil is the best as a fatty base. For linoleum or other floors attacked by alkali, soaps containing a slight excess of oil are said to be best suited because they leave the linoleum glossy and offset the bad

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* Titre is a term applied to the temperature at which a liquid mixture of fatty acids will freeze or solidify. High titre soaps will dissolve only in hot water while low titre soaps dissolve readily in warm water.

effects of an excess of alkali (18). There is one disadvantage in their use. Superfatted soaps do not have as high cleansing or rinsing properties as do soaps that are slightly alkaline.

In general, a high grade neutral vegetable oil soap is recommended for most resilient type floors where a liquid soap is to be used. For the non-resilient group of floor materials, a slightly alkaline soap not more than .15 percent alkali, will have better cleansing properties and the alkali does not react with the hard floor materials.

There are many other types of soaps on the market such as beads, powder, and flakes. These forms are however not recommended for institution use because of their high cost. The amount used is harder to control and the initial cost is usually prohibitive.

c. New Type Detergents

Although soap has been called the universal detergent it has two limiting characteristics which make it unsuitable for some cleaning situations. It does not exhibit good cleaning action in hard water for the reasons previously mentioned and it is decomposed by acids. To offset these two limitations of soap a new group of sulfonated alcohols followed by other synthetic detergents has been developed. These exhibit pronounced ability to cleanse and to act as emulsifiers, and are not affected by hard water. At

the present time, use of these synthetic detergents is confined for the most part to home use but one new type, calgon, is gaining in widespread popularity for institution use. It is not a sulfonated alcohol but rather a complex molecularly dehydrated phosphate. Calgon is readily soluble in water, has excellent detergent properties, will emulsify fats, and will not precipitate with hard water.

d. Waxes

Wax is a natural protective covering for many plants and it also acts to conserve moisture within the plant. It has been used by man in ancient times as well as in modern times. The Egyptian Pharaohs used wax to protect color paintings in their tombs. As a protective covering for floors it has been used for only a few hundred years.

In its earliest form it was usually made from beeswax. Now it may be a combination of many waxes such as carnauba, candelilla, ozokerite and ceresin, montan, paraffin and other waxes.

As sold on the market, commercial waxes are usually a blend of several waxes. There are however two main types: (1) Oil base or organic solvent type, (2) Water emulsion type (15).

Oil base or organic solvent waxes: may be obtained in paste or liquid form. They consist of a blend of softer

waxes in an oil base. Use of this wax necessitates buffing if a good finish is desired. Before 1930 most waxes on the market were of this type. Because of the type of solvent used they are inflammable.

Paste waxes are a mixture of several waxes in a volatile, organic solvent such as naptha, gasoline or turpentine. The solvent is selected from the standpoint of cost, drying time, odor and availability. Resins are sometimes added to give a hard finish and to reduce slipperiness. If added in excess amounts they give a "tacky" finish to the floor.

Liquid solvent waxes are essentially the same as paste solvent types except that they contain a lower percentage of wax and a higher percentage of solvent. Because of this difference they are easier to apply than the paste waxes.

Water emulsion waxes are a blend of hard waxes and resins emulsified in water. This type of wax appeared on the market about 1930. They do not require buffing although this is sometimes done if an extra high gloss is desired. They are non-inflammable, easy to apply and relatively non-slippery. The kind of water used in an emulsion wax is important. Hard water will cause a precipitate to form. Therefore it is essential that soft water be used.

Many qualities of water emulsion waxes such as durability, stability, gloss, ease of application and non-

skid properties are affected by the emsusifying agent used. Among the ones used are sodium and potassium soaps, triethanolamine, ammonium linoleate and morpholine.

These waxes are commonly used on linoleum, rubber tile, asphalt tile and other floorings. The organic solvent type may not be used satisfactorily on the floors mentioned due to the detrimental action of the solvent used.

Characteristic Ingredients of Commercial Waxes (15): Because the type and blend of waxes used in commercially prepared products affects the efficiency of the wax for specific types of floors, it is important to know some of the outstanding characteristics of each kind of wax.

1) Carnauba is the most important ingredient of any wax. It is obtained from the leaves of the carnauba palm in Brazil. It is the hardest vegetable wax on the market and so will give a high, lasting polish. Wax which does not contain a good proportion of carnauba is not a good grade wax. This is especially true of the self-polishing water-wax emulsion types. Decrease in amount of carnauba wax gives a wax which proportionately decreases in quality. This decrease in quality is less noticeable with the solvent type of waxes where other waxes such as beeswax are included in addition to carnauba.

During World War II carnauba wax was scarce and others such as paraffin and candelilla, had to be used. These produced a wax which was not nearly as durable and which

did not produce as satisfactory a finish.

2) Candelilla is extracted from the stem surfaces of a leafless Mexican shrub of the same name. It is not a cheap or inferior wax but does not emulsify as readily as does carnauba. Hence it is not satisfactory in a water-emulsion wax. It is suitable for use in solvent type waxes. Because it is softer than carnauba, it tends to give a tacky surface which leaves tracks and is harder to clean.

3) Montan is a wax found in brown coal, peat, bituminous shale and lignite. In its unrefined state it contains many impurities such as carbon, chalk, bitumens and resins which may be extracted through the use of suitable solvents. The wax is used for the same purposes as carnauba.

4) Ozokerite is a mineral wax of petroleum origin and is found in small quantities through-out the world. When it is purified it gives a yellow wax. Upon further purification it gives a refined wax called "ceresin" which is often mixed with carnauba to increase its hardness or melting point. Both ozokerite and ceresin are often mixed with paraffin to reduce their cost.

5) Cauassu is also found in Brazil and grows on the leaf of the cauassu palm. It grows easily and can be produced under cultivation. It closely resembles carnauba wax and for this reason can be substituted for it.

6) Ouricury wax is formed on the leaves of the ouricury palm which grows in Brazil. It is obtained and refined in a manner similar to carnauba and is often used as a substitute for gray carnauba.

7) Beeswax is produced from the comb of the domestic honey bee. Although it is unimportant commercially it is mixed with some floor wax compounds to add plasticity and to lower costs.

8) Paraffin is a mineral wax obtained from crude oil. It too is often added to waxes to increase their plasticity. If used in too large amounts it gives a soft greasy finish which tends to mar easily.

9) Resin is sometimes used in waxes to give a high, water-proof gloss, to reduce slipperiness and to increase durability. It is much less expensive than carnauba wax and so is sometimes used to cut down costs in poor quality waxes. It gives a tacky surface and this can be detected by the fact that as one walks over the floor the heels tend to crack against the floor surface. The floor marks easily and these marks are difficult to remove. The floor is difficult to mop as the mop sticks to the floor. It is a common ingredient of so-called "non-slip" waxes. What is gained in non-slip properties may be lost in increased difficulty in cleaning if too much resin is used. Other ingredients used to produce relatively non-slip surfaces

are synthetic resins, rubber and probably gums. Such precautions as controlling the amount of wax applied and being sure the surface is absolutely clean before application will help just as much in producing non-slip surfaces. However the National Bureau of Standards states that it is doubtful if there is such a thing as an absolutely skid-proof waxed surface (20).

10) Shellac*, is often used in wax compounds for different purposes. It helps to lower costs, sometimes gives better spreading characteristics, decreases drying time or increases gloss.

Ways to Detect Poor Quality Wax

Low price is sometimes an indication of inferior quality. Carnauba, which is the best wax on the market, is never cheap. Therefore, when one buys a wax that is exceptionally low in price one can be almost certain that carnauba wax is not one of the ingredients.

Greasy appearance of the dry wax coating indicates that paraffin wax is an ingredient. This gives a soft finish which mars easily, is likely to be slippery and will not stand up under wear or high temperatures. This wax sheds water readily and salesmen will often use this as a selling point.

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*Shellac is the purified form of a certain resin called lac. Lac is obtained from various plants by the incisions of a scale insect.

Candelilla wax is not a cheap or inferior wax and serves well in the solvent type waxes, but it does not emulsify well and therefore is not suitable in a water wax. It is sometimes used as an extender of carnauba in water waxes. Since it is softer and inclined to be a little sticky, it gaves a somewhat tacky film, causing tracks and making it harder to clean. Its presence may be detected by rubbing the finger over the dried surface. If there is a slight drag which leaves a mark, candelilla or some other substitute wax is likely to be present.

Water waxes which become water-proof immediately upon drying are likely to be poor in quality. Most of the better waxes of this type are slow in giving up their moisture and until they do they will not become water proof.

Resins when used in small amounts are an asset but when used in excess give undesirable results as previously mentioned. To test for presence of resins apply a little of the wax to a piece of varnished, painted or glossy paper. Allow the paper to dry thoroughly, then press the finger against it. If the paper sticks it probably contains resins.

Use of the proper wax for each specific type of floor willadd greatly to the life of the floor. Since it is used in nature as a protective covering for plants it will likewise serve as a protection for floor surfaces. It prevents dirt, stains and grease spots from penetrating

the pores of the floor and gives a finish which is attractive and easy to clean. According to Smalley (16) best results are obtained when the temperature of the floor is at least 60° F. or above. Water wax is difficult to apply at temperatures below 40° F. and the solvent type cannot be applied satisfactorily at temperatures below 60° F.

e. Sealers

All wood floors as well as the harder types of floors such as magnesite, terrazzo, quarry tile and concrete should be protected by a sealer coat to lengthen the life of the floor. A sealer is a finish coat given a floor to seal the pores against possible dampness and to produce a hard smooth surface that will be impervious to dirt, grease and stains. By treating a floor in this manner, it reduces the need for frequent scrubbing and makes maintenance easier.

Sealers are of two general types, surface and penetrating seals. Where it is desirable to produce a smooth film as a protective covering for the surface, the first type is used. This is frequently the case for various articles of furniture such as desks, chairs, etc. A surface sealer is comparatively high in solid content and for this reason much of it remains on the surface. If on the other hand,

it is desirable to fill the pores of the floor material to prevent splintering, where wood is used, and to seal the surface to prevent absorption of moisture, grease, dirt and stains, a penetrating sealer is recommended. In this case a sealer with low solid content should be chosen in order to allow complete penetration of the sealer into the pores of the floor material. There will be very little gloss apparent as only a minute amount remains on the floor surface.

Constituent ingredients used in sealers vary to some extent but the best of the modern floor sealers contain bakelite, a phenolic type resin which is tough and flexible. It makes a sealer which is slow drying. A quick drying sealer gives a dry, brittle film which soon disintegrates under heavy traffic. Tung oil is used in sealers to put "spring" in the finish.

A bakelite type of sealer when used on wood floors helps to bring out the natural grain of the wood. If the floor is not treated it will begin to dry out with attendant cracking and splintering. Continued scrubbing opens the pores and produces crevices in which dust, grease and stains can collect. The use of shellac, wax or ordinary varnish affords some protection but these materials do not penetrate the pores of the wood and hence give only surface protection.

Sealers for magnesite, quarry tile and cement floors

are also made with a bakelite base and those designed for cement floors may often contain color pigments. The use of a sealer on these floors prevents efflorescence, or the formation of a whitish dust commonly called "bloom". The dust is a saline substance formed due to the evaporation of water from the porous flooring material and to the presence of lime formed by the hydration of the cement.

Sealers for terrazzo should be of the chlorinated rubber type or of certain suitable plastics. They should be low in solid content to allow for deep penetration. Manufacturers of terrazzo warn against the use of varnish type sealers as they produce a yellowing effect and are hard to remove without damage to the floor itself. Here again, the use of a suitable sealer prevents efflorescence on terrazzo floors.

f. Sweeping Compounds (24)

Preliminary to actual scrubbing or mopping of a floor surface dirt should be removed by means of dry sweeping. Since high standards of sanitation are essential wherever food is produced and served, it is important that dust should not be raised. For this reason it is recommended that where dry sweeping is done special sweeping compounds should be used as dust layers. A small amount is as effective as a large amount and is certainly more economical.

There are many sweeping compounds on the market which are essentially made up of sawdust, sand, or ground feldspar, mixed with ingredients such as coloring matter, oil, wax emulsions, disinfectants etc. Fine sawdust moistened with water is also used for this purpose.

The National Bureau of Standards suggest that the following formula makes a satisfactory sweeping compound:

Material	Parts (by weight)
Fine sand	35
Pine sawdust	40
Paraffin oil	15
Water, and dye if coloring is desired	10

Iron oxide is sometimes used to supply color in commercial compounds. Likewise certain oils such as oil of eucalyptus, oil of sassafras etc. are often used to mask any undesirable odors. Pine oil, creosote oil and other materials are used as disinfectants.

Institution managers are cautioned against the use of ordinary sweeping compounds on floors which are injured by oils e.g., rubber tile, ordinary asphalt tile, linoleum and polished wood. For these floors a water-wax emulsion type of sweeping compound has been developed as an outgrowth of the water-emulsion floor waxes. In this case the oil has been replaced by waxes, resins, water and emulsifying agents.

g. Alkaline Cleaners (25)

Alkalis or soda compounds are used as water softeners, directly for cleaning purposes or as cleaning aids with soap solution. On the average they cost about half as much as soap and have a greater cleansing power.

It is well known that many salts, when allowed to lodge in a porous material, crystallize within the pores and cause disintegration of the surface. Consequently, alkaline cleansers must be completely rinsed off.

Although there are many alkaline cleansers on the market only those which are suitable for floor maintenance will be discussed here. In connection with this it should be remembered that although an increase in alkali gives increased detergent qualities, yet at the same time many floor materials are injured by too much alkali.

1) Ammonia Water: This is more commonly known as household ammonia. It is a solution of ammonia gas in water with or without the addition of small amounts of soap and sodium carbonate or borax. Ammonia water is mildly alkaline in nature and is used chiefly as a water softener in cleaning floors.

2) Powdered Ammonia: This consists of a mixture of an ammonium salt (generally ammonium sulfate, sometimes a mixture of this salt and some ammonium chloride) and sodium

carbonate. When dissolved in water the ammonium salts and sodium carbonate react to liberate ammonia, which is dissolved by the water. Again powdered ammonia is mildly alkaline in nature and so its chief value lies in its ability to act as a water softener.

3) Borax: It is found on the market as sodium tetraborate with 10 molecules of water of crystallization ($Na_2B_4O_7 \cdot 10H_2O$). It is a mild alkaline salt, with a consequently low detergent value. Borax may be used as a partial softener of very hard water, as a cleansing agent, as a component of some soap powders and as a "builder" in some soaps.

4) Soda Ash: The chemical name for soda ash is anhydrous sodium carbonate (Na_2CO_3). It is found on the market in three grades, viz, "58-percent ordinary or light", "58-percent extra-light", and "58-percent dense" (about 58 percent of sodium oxide and about 42 percent of carbon dioxide). Chemically, the three grades are identical and perform the same functions. Soda ash is a moderately strong alkaline salt and is used as a water softener and as a cleanser for certain floor materials. It should be completely soluble in water and free from caustic alkali.

5) Laundry Soda (Washing Soda): Laundry soda is a so-called "modified soda" or neutral soda. Modified sodas are mixtures of varying proportions of sodium carbonate and

sodium bicarbonate. The presence of the latter ensures the absence of caustic alkali. These sodas are milder alkaline salts than soda ash or straight sodium carbonate. They are suitable for cleaning floor surfaces where a mildly alkaline material is not injurious.

6) Sal Soda ("Washing Crystals" or "Soda Crystals"): Sal soda is sodium carbonate combined with 10 molecules of water of crystallization. ($Na_2CO_3 \cdot 10H_2O$). This compound contains over 60 percent of water. Upon standing, the water may be expelled by heat or otherwise, in which case its alkalinity increases. It lumps readily making it difficult to handle; it is hard on the hands and unless used in very dilute concentration will damage most floor surfaces.

7) Trisodium Phosphate: This material is a white crystalline product with the chemical formula $Na_3 \cdot PO_4 \cdot 12\ H_2O$. It usually contains a small amount of sodium hydroxide or sodium carbonate owing to the process of manufacture. It is sold in flake (fine crystals), granular, and globular (beads) forms. It contains about 56 percent of combined water, is readily soluble in water, and is a rather strongly alkaline salt. Many washing powders on the market consist of trisodium phosphate or mixtures of this material with soda ash, borax, soap and other ingredients. It is suitable for cleaning some floors but with painted floors it

must be used in very dilute solution as it is often used as a paint remover. It is also useful as a soap "builder" and as a water softener.

8) Silicates of Soda: There are a number of these available, the chief differences being in the ratio of sodium oxide (Na_2O) to silica (SiO_2). They are used directly as cleaning agents and are frequently a part of many commercial cleaning materials. Sodium metasilicate ($Na_2 Si O_3 \cdot 5 H_2O$) is one of the most widely used silicates due to it's rapid solubility and alkalinity. It is easily rinsed off but for floor surfaces that are damaged by strong alkali, a less alkaline material should be chosen.

Choice of Alkaline Cleansers on Floor Surfaces: In general it must be pointed out that these materials when used alone have only limited use for floor cleaning purposes. All floor surfaces are injured by strongly alkaline materials. However, mild alkaline materials, as a dilute concentration of ammonia, may be used to remove light stains, if care is taken to rinse the floor quickly and completely. Where traffic is heavy, unwaxed wood floors and rubber tile may be cleaned with a dilute concentration of trisodium phosphate provided that the floor is again rinsed quickly and completely.

Experience has shown that when an alkaline solution seeps into the tiny pores of marble chips in terrazzo, upon drying it crystallizes and expands breaking the walls

of the pores and "spalling" or fine dusting, ensues. For this reason it is important to use a neutral soap (not more than .15 percent on the alkaline side) on terrazzo floors (16). The same may be said for magnesite and quarry tile floors. Alkaline cleaners are not recommended for linoleum or asphalt tile since the alkali reacts unfavorably in both cases. In the first case it reacts with the oil in linoleum causing it to dry and crack. With asphalt tile it leaves a floor surface that is dull and lifeless and leaves a white sediment in the joints between the tile.

The chief value of alkaline cleansers for floor maintenance lies in the fact that these materials may be used in commercial cleaning compounds and soaps to increase detergency where they are added in controlled amounts.

h. Volatile Organic Solvents

Volatile organic solvents most commonly used are gasoline, kerosene and turpentine. They are used more for spot cleaning to dissolve grease, gum, paint etc. than for general cleaning purposes. They should not be used on floor surfaces that are damaged by solvents such as rubber tile and asphalt tile. Since these substances are inflammable they must be used with care.

i. Abrasives

An abrasive is a hard, gritty like substance which may be used for removing stubborn stains or an accumulation of water wax. Because of its nature, a coarse abrasive will scratch and wear away the surface so that care must be exercised in its use.

Abrasives may be used alone or mixed with other cleaners - soaps, alkalis or volatile oils. Melgaarde et al.* list the following as ones in common use:

1) Precipitated Chalk or Whiting: Whiting is relatively high in price but has been called the only conveniently available abrasive that is safe for all-around use as a scouring powder. It is sometimes mixed with a solvent of grease, such as kerosene, with powdered soap and with alkalis.

2) Pumice and Volcanic Ash: Fine volcanic ash is relatively soft and continues to crush as more pressure is applied, so it is a safe cleanser to use for most surfaces.

3) Silica: Silica may be made from many sources. It may be as coarse as sand or ground as fine as silica flour, which will pass through a 400-mesh sieve. In its finer

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* Adapted from J. Marie Melgaarde et al., Care of Food Service Equipment, Burgess Publishing Co., Minneapolis 15 Minnesota, 1946, pp 15-16.

forms it may be used for cleaning equipment and floors.

4) Crushed Quartz: This is a much harder and coarser type of abrasive, the utility of which on account of its harsh abrasive action is very restricted in the care of equipment and floors.

IV. DISCUSSION OF SPECIFIC FLOORS STUDIED

In order to compare costs of cleaning various floor surfaces, time studies were conducted in several of the women's dormitory food service areas, in two men's dormitories, in the College Union cafeteria and in one college-operated grill shop. Table V shows the floor materials studied, their location and age. Since costs of cleaning and maintenance for dining-room floors are not comparable to those for kitchen floors due to the physical arrangement in these areas, the results will be considered separately for each.

Table V

LOCATION AND AGE OF VARIOUS FLOORS IN FOOD SERVICE AREAS ON MICHIGAN STATE COLLEGE CAMPUS

Floor Material	Location on Campus	Location in Food Service	Age of Floor
Rubber tile	Abbot Hall	dining-room	10
Greaseproof asphalt tile	Quonset Cafeteria	dining-room	2
Asphalt tile	The Huddle	dining-room	2
Terrazzo	Union Cafeteria	dining-room	1
Hardwood	Yakeley Dormitory	dining-room	1
Hardwood	Landon Dormitory	dining-room	2

Table V (Cont.)

Floor Material	Location on Campus	Location in Food Service	Age of Floor
Quarry tile	Yakeley Dormitory	kitchen	1
Concrete	Wells Hall	kitchen	44
Magnesite	Campbell Dormitory	kitchen	10

Several food service managers and employees were questioned to determine what they really thought of the floors in their food service areas. Their comments are shown in table VI.

Table VI

COMMENTS OF FOOD SERVICE MANAGERS AND EMPLOYEES

Floor Material	Fatigue Induced	Slipperiness	Ease of Cleaning
Hardwood	Was not tiring.	Slippery only when wet or greasy.	Required a great deal of time and effort to maintain a good appearance.
Rubber tile	Was not tiring.	Slippery only when wet or greasy.	Required considerable time to clean.
Quarry tile	Very tiring.	Very slippery when wet.	Easy to keep clean.
Magnesite	One person said it was tiring, the others disagreed. One said it was much less fatiguing than quarry tile.	Slippery when wet but not when dry.	Very difficult to keep clean.

A. Description of Cleaning Methods and Materials in Use for Each Specific Type of Floor Studied.

1. Dining Room Floors

a. Hardwood: 1) One study on hardwood floors was conducted in Yakeley Dormitory dining room. The method studied was daily dry sweeping using a dry-sweep type mop and without the use of water. One regular woman employee was responsible for this job. The entire dining room floor was cleaned with the exception of the space occupied by the legs of the tables. The chairs were pulled aside but the tables were not moved.

2) A second study on hardwood floors was conducted in Landon Dormitory dining room. The procedure studied was waxing and buffing. It included also preliminary dry sweeping and wet mopping. Student labor was employed.

The plan for this operation was to divide the floor into thirds and to clean, wax and buff one-half of the floor on each of three days within one week. Following this plan, the entire floor could be covered each week. However, in actual practice, this plan was not always carried out and the student responsible for this job frequently waxed areas which were less than the intended one-third.

Chairs and tables were moved from the section of the floor to be waxed so that the entire floor space could be covered. The floor was given a preliminary sweeping with a horsehair push broom in order to remove surface dirt. Trisodium phosphate and a neutral liquid soap were used in the wash water. During the washing operation, each section of the floor was covered four times: 1. washed , 2. partially dried, 3. rinsed, 4. partially dried. Two slasher type wet mops were used, one for washing and one for rinsing. Washing and rinsing was done in the direction of the grain of the wood. Undiluted water emulsion wax was then applied using a lamb's wool applicator and again working with the grain of the wood. The floor was finally buffed with a power polishing machine and the chairs and tables put back in place.

b. Rubber Tile: The study on rubber tile floors was conducted in Abbot Hall dining room. Methods of cleaning and maintenance studied were: 1. Vacuum sweeping, 2. Wet mopping using clear water, 3. Waxing and buffing using a water emulsion wax diluted with water. Regular employees of the food service looked after floor maintenance.

The plan of work established required the vacuum operator to precede the other workers. A home-size tank type vacuum cleaner was used. Daily cleaning involved pushing the chairs aside and vacuuming under the tables. Then the floor was washed using a slasher type of wet

mop. Depending on the condition of the floor, either clear water or water plus water-emulsion wax was used. The floor was then buffed using a heavy duty polishing machine.

Weekly cleaning differed from daily cleaning in that the chairs were placed on the tables and the floor vacuumed, wet mopped with dilute water-emulsion wax and buffed. The proportion of water-emulsion wax to water used for weekly cleaning was considerably more than that used for daily cleaning. In bad weather it was sometimes necessary to repeat this more extensive cleaning oftener than once each week.

c. Asphalt Tile: 1) One study on asphalt tile was conducted in the dining room of The Huddle, a college-operated grill. The method studied was daily dry sweeping using a horsehair push broom. A regular employee of the food service was responsible for this job. The entire dining room floor was cleaned with the exception of the space occupied by the legs of the tables. The chairs were pulled aside but the tables were not moved.

2) A second study on asphalt tile was conducted in the dining room of the Quonset Cafeteria. This involved special cleaning in which the chairs were set on the tables, the floor swept using a horsehair push broom, then washed, rinsed and buffed. Student employees looked after this work during the regular school session but

during these observations regular employees were used. Clear water was used for washing and the floor was rinsed twice, using slasher type wet mops. After the floor had dried thoroughly, it was buffed using a power polishing machine. Finally the chairs were put back in place.

This cleaning operation was usually carried out weekly, but in bad weather it was sometimes necessary to do it more frequently.

d. Terrazzo: The study on terrazzo floors was conducted in the Union Cafeteria dining room. Two methods of cleaning were studied, dry sweeping with an industrial type vacuum cleaner and wet mopping. Four regular employees looked after floor cleaning in this area, but they were responsible for other duties as well. Three of these employees swept and mopped the floor in the morning while the fourth swept the floor in the afternoon. This study was particularly concerned with morning cleaning.

The work was organized so that the sweep operator preceded the wash and rinse operators. Both tables and chairs were moved so that the entire floor space was cleaned.

A neutral liquid cleaner was added to the wash side of a 2 compartment mop truck. The mop truck was equipped with a hand operated roller-type wringer. Two slasher-type wet mops were used, one for washing and one for rinsing.

2. Kitchen Floors

a. Quarry Tile: The study on quarry tile was conducted in Yakeley Dormitory kitchen. Daily cleaning methods studied included dry sweeping and wet mopping. Three part-time student employees were responsible for floor cleaning in the kitchen.

The work was planned so that one student swept the floor in advance of the two students who washed the floor. The same soapy water was used for rinsing as for washing. The only attempt at rinsing was to wring the wash mop tightly and to go over the same area the second time.

A horsehair push broom was used for the sweeping except in the area between the steamers and pot sinks. Here the floor was inclined to be wet and a corn broom was more satisfactory. A vegetable oil soap was used in the wash water and two slasher-type wet mops were used for washing.

b. Concrete: The study on concrete floors was conducted in Wells Hall kitchen. The cleaning method studied was deck scrubbing. One regular employee was responsible for this job.

Since the procedure used differed from any of the others observed, it might be of interest to describe it in some detail. The floor was first washed by using a hose connected to a hot water tap. Dry trisodium phosphate

was then sprinkled over the floor. Next the floor was completely scrubbed using a long handled deck brush. Following this the floor was rinsed using the hose the second time. The cleaning operation was completed by using a rubber squeegee to remove excess water.

c. Magnesite: The study on magnesite floors was conducted in Campbell Dormitory kitchen. The method of cleaning observed was deck-scrubbing. This included preliminary dry sweeping. Three student employees looked after the cleaning of the kitchen floor.

One student was responsible for sweeping the floor before the washing operation started. This same student deck-scrubbed the floor and was followed by a second student who removed excess water with a squeegee. The third student rinsed and partially dried the floor, using a mop tightly wrung out of clear water.

The cleaning agent used was a neutral liquid soap. Two mop buckets equipped with hand operated wringers were used, one for washing and one for rinsing. A horsehair push broom was used for sweeping except in the area between the steamers and pot sinks. Here again a corn broom was more satisfactory as the floor was inclined to be wet. A long handled brush was used for scrubbing and a slasher-type wet mop for rinsing.

B. Observations on Procedures Used in Maintenance

1. Method of Computing Costs

a. Time Involved: In constructing time studies on cleaning and maintenance methods for floors, the purpose was to estimate the average length of time required for the total operation performed under normal conditions of work. No effort was made to increase speed of work or to change methods already in use. An average of three trials was the figure used in computing time if the results of each trial were similar. In some cases it was necessary to repeat the time study as many as six times, if the length of time varied considerably.

Total time spent on the cleaning operation started with the assembling of equipment and materials and ended when the same had been put away. Any time which could not be directly charged to the cost of cleaning the specific floor studied was deducted from the total time. Some examples of this may be cited here. In many cases, part of the job requirement was to collect and take out garbage or to clean stock pots. In some instances the employee cleaned certain floor areas in addition to the one being studied. Still another deduction was made for that time required to clean the pit under the steamers in each kitchen. It was considered that, due to special conditions

of moisture and spillage of food, the time spent on this particular area was not comparable to that needed to clean the rest of the floor. In one instance also, the floor material used in the pit differed from that used in the main part of the kitchen.

After the time studies were made, the floor area was measured. In order to know the actual number of square feet of floor space cleaned, the floor area occupied by equipment closets or posts in the kitchen or in the case of the dining rooms, such things as fireplaces, steps and posts, were deducted from the total floor area.

b. Cost of Labor: The next step was the computation of labor costs. Since a large percentage of student labor is employed on this campus, and since it was necessary to use a basic wage rate if comparisons were to be significant, labor costs were computed at the student rate of $ .65 per hour.

c. Cost of Materials: To find out the cost of cleaning materials, the materials were either weighed or measured and from the unit cost, total cost was determined.

d. Total Costs: Total cost of labor and materials for the specific floor area in question was then computed. In order to bring all figures to a common basis of comparison, cost of cleaning or maintenance per 1000 square feet of

floor area was used.

Any attempt to compute total costs of upkeep on a weekly or yearly basis was found to lead to several difficulties in determining frequency of cleaning. The latter depended upon such factors as weather conditions, on availability of help or on severity of foot traffic. Regular schedules of work were often disrupted on week-ends and holidays. Sometimes frequency of cleaning depended upon the type of food served, that is whether it was food that spilled easily or stained readily. In other cases it depended on the standards of cleanliness and appearance maintained. Because one dining room floor was wet mopped daily and another only weekly, did not mean that the latter could not have been improved by more frequent mopping. It was not due to any particular characteristic of the floor but rather to the standards set up and maintained.

For these reasons then, it was felt that total costs of maintenance could be based only on the cost to perform one complete daily cleaning operation plus one complete weekly maintenance operation. It is a simple matter for any institution food service operator to compute his or her own weekly costs of maintenance by using the figures given in Table VII or Table IX and multiplying them by the number of cleanings per week which may be found desirable under each individual set of conditions.

2. Analysis and Comparison of Cleaning and Maintenance Costs for Dining Room Floors Studied

Table VII

COMPARATIVE COSTS OF CLEANING AND MAINTENANCE FOR DINING ROOM FLOORS*

Method Used	Hardwood	Rubber Tile	Asphalt Tile	Terrazzo
Dry mopping (mop)	.16			
Dry sweeping (push broom)			.20	
Vacuum sweeping		.28		.11
Wet mopping (clear water)		.40		
Wet mopping (water plus liquid cleaner)				.46
Wet mopping (water plus wax)		.47		
Buffing		.22		
One complete cleaning operation	.16	.90-.97	.20	.57
Weekly Maintenance	3.54	1.37	1.10	-
Total cost of 1 complete cleaning operation plus 1 weekly maintenance operation.	3.70	2.27-2.34	1.29	.57

* Figures based on cost per 1000 square feet and student wage rate of $ .65 per hour.

Table VIII

DINING ROOM FLOORS RATED ON BASIS OF COST OF UPKEEP AND ORIGINAL COST

	Hardwood	Rubber Tile	Asphalt Tile	Terrazzo
Cost of upkeep*	4	3	2	1
Original cost per square foot laid	2	3	1	4

* Cost of upkeep is based on figures for 1 daily cleaning operation plus 1 weekly maintenance operation. 1 indicates least expensive; 4 indicates most expensive.

a. Hardwood: In comparing costs of cleaning and maintenance for various types of dining room floors it was found that not only must daily costs be taken into account but also any costs for periodic maintenance which the floor may require. It would appear at first glance that hardwood floors were the cheapest floors to maintain at $ .16 cents per 1000 square feet. This however is only the cost for one dry mopping procedure, which is practically the same as dry sweeping. In most dormitory food services it would be necessary to do this two to three times each day, or after each meal with the possible exception of breakfast or dinner. In addition to this daily care, in order to keep hardwood floors in good condition and to maintain an attractive appearance, it was found that a thorough weekly cleaning and waxing was necessary. This

increased the total cost of maintenance considerably, making the hardwood floors the most expensive to maintain of those dining room floors studied.

b. Rubber Tile: As usual in dining rooms, the results of this study show that rubber tile rates second highest in total weekly costs of upkeep and highest in daily costs of upkeep. The great difference in daily costs of cleaning for hardwood and rubber tile is probably due to differences both in procedure used and materials used. It has already been pointed out that the figure for hardwood floors must be multiplied at least by 2 to get total daily cleaning costs. This however is counteracted by the fact that it would probably be necessary to vacuum sweep the rubber tile floor at least one additional time each day. On the other hand, the complete daily cleaning operation for rubber tile included preliminary vacuum sweeping, wet mopping sometimes with clear water and sometimes with wax added to the water, rinsing and buffing. The inclusion of wax in daily cleaning accounts for a small part of the greater cost for rubber tile floors. Much of the difference is due however to the more extensive daily cleaning procedure used on rubber tile as against that used on hardwood.

In comparing weekly maintenance costs, the results show that hardwood floors are more than twice as expensive to maintain as are rubber tile floors. One reason for this

is that cost of materials used is higher. Where water-wax diluted with water was used for rubber tile floors, undiluted water wax was used for hardwood floors. Another reason for increased costs is that in the dining room where hardwood was used, tables and chairs were cleared from the space to be cleaned and had to be replaced at the end of the procedure. In the second case, the chairs were merely placed on the tables, this method taking less time than the first one.

c. Asphalt Tile: This floor material rates second lowest in daily costs of cleaning and second lowest in costs of weekly maintenance, as indicated by the results of this study. The low cost of daily cleaning as compared with rubber tile may be accounted for in the fact that it included only dry sweeping, moving the tables but not the chairs. There were no cleaning materials used. On the other hand, weekly cleaning involved somewhat more expense since the chairs were first placed on tables and the floor swept, washed, rinsed and buffed and then the chairs finally returned to position.

d. Terrazzo: The results of this study indicate that terrazzo, as used in dining rooms rates third lowest in costs of daily cleaning and does not require any special weekly maintenance. Thus when considering total costs of upkeep it is the least expensive to maintain of those

Table X

KITCHEN FLOORS RATED ON BASIS OF COST OF UPKEEP AND ORIGINAL COST

	Quarry Tile	Concrete	Magnesite
Cost of upkeep*	1	2	2
Original cost per square foot laid	3	1	2

* Cost of upkeep is based on total cost of 1 daily cleaning operation plus 1 weekly maintenance operation. 1 indicates least expensive; 4 indicates most expensive.

a. Quarry Tile: The results of this study indicate that quarry tile has the lowest cleaning costs of the three kitchen floor materials studied. The reason for this may be due to the fact that this floor is smooth, non absorbent and does not stain readily.

b. Concrete and Magnesite: The results of studies on these two floors show the same costs for daily upkeep. In comparing these costs with that of quarry tile, it would seem to indicate that those floors which require deck-scrubbing also require more time and effort to do the job. It was necessary to deck-scrub the concrete floor because the surface was rough and ordinary wet mopping would not have accomplished a satisfactory job. The magnesite floor required deck-scrubbing because it stained so readily.

dining room floors studied. In some cases where terrazzo is used for dining room floors, it is considered desirable to wax and buff the floor periodically. This would add to total costs of upkeep but it was not considered in this study.

3. Analysis and Comparison of Cleaning and Maintenance Costs for Kitchen Floors Studied

Table IX

COMPARATIVE COSTS OF CLEANING AND MAINTENANCE FOR KITCHEN FLOORS*

Method Used	Quarry Tile	Concrete	Magnesite
Dry sweeping	.17		.06
Wet mopping (water plus soap)	.38		.21
Deck scrubbing		.50	.47
Hosing		.42	
Squeegeeing		.08	
One complete cleaning operation	.57	1.05	1.05
Weekly maintenance	-	-	-
Total cost of daily upkeep	.57	1.05	1.05

* Figures based on cost per 1000 square feet and student wage rate of $ .65 per hour.

From these studies, it would seem to indicate that the original cost of the floor material has very little relation to the total cost of the floor. Only in one instance, asphalt tile, was there any indication that a low original cost was accompanied by low costs of daily cleaning. When weekly maintenance costs were taken into consideration, asphalt tile became a relatively expensive floor to maintain. Rubber tile, a medium priced flooring, has both high daily and weekly cost for upkeep. Quarry tile and terrazzo, the two most expensive in original cost, were the cheapest to maintain. Concrete and magnesite, both of which have a low original cost, showed high cleaning costs.

V. EVALUATION OF THE EFFECTIVENESS OF METHODS USED

An attempt was made to evaluate the effectiveness of cleaning and waxing methods in use, the evaluation being based chiefly on the quality of appearance. Some comments on wearing quality of finish are included but it should be emphasized that all opinions expressed are purely subjective and are not based on scientific evidence. With three exceptions, the floors studied were too new to evaluate the effect of methods used over a long period of time. Even in the case of the three floors mentioned, there was no way to determine how much of the condition of the floor was due to maintenance methods and how much was due to other factors such as original quality of materials, methods of installation, severity and kind of traffic, etc.

A. Dining Room Floors

1. Hardwood: The method of daily cleaning by dry-mopping was satisfactory as far as removing surface dirt was concerned. Any stains or embedded dirt could not be removed by this method. Since there were no materials used in cleaning there was no way of harming the finish of the floor.

The method of weekly maintenance included washing, waxing and polishing. It produced excellent results as far as immediate appearance was concerned. The use of a dilute solution of trisodium phosphate helped to remove any embedded dirt and possibly also wax. The employee was careful to remove excess water quickly after both washing and rinsing. Since the use of too much water on hardwood floors has a damaging effect, this procedure was commendable.

One criticism of the method used was that the waxed finish did not stand up too well under traffic. The surface appeared to be badly marked before it came time to wax again. Possibly a solvent type wax would have been more durable but there were reasons for not using it. It would take longer to apply and it has less coverage, both factors making it a more expensive operation.

A second criticism of the effectiveness of this method lies in the practice of cleaning and waxing the floor in thirds. In actual practice, it was often done in sections smaller than a third due to an insufficient number of workers. From results of a time study conducted in another dormitory dining room, but not included in this study, it would seem to indicate that it would be less expensive to employ more assistance and to clean and wax the entire dining room in one operation. The reasons for this are apparent. Cleaning equipment and materials must be collected and put away three times instead of once.

Within certain limits of area the same proportion of cleaning materials to water would be used for a large or small area. Moreover, the flow of work would be less smooth in a small area and thus time would of necessity be wasted.

2. Rubber Tile: The condition of the floor offered evidence for the effectiveness of methods used. General appearance was excellent. A sufficiently heavy coat of wax helped to protect the floor from embedded dirt and from stains. Any surface dirt or stains were removed by wet mopping.

There was very little evidence of deterioration in the tiles such as cutting or indentation. This fact was particularly worth noting since the floor has been in use 10 years and during that time it has been subjected to the heavy foot traffic of a dining room for men students.

3. Asphalt Tile: Weekly cleaning methods were effective in immediate appearance and since the floor was mopped only with clear water there was no possibility of damaging the floor surface.

Daily cleaning method was considered inadequate to completely clean the floor. It was effective in removing larger pieces of surface dirt such as scraps of paper etc, but the floor still had a dusty appearance when cleaning was finished. This method of cleaning needed to be supplemented with more frequent wet moppings.

4. Terrazzo: Cleaning methods used here were such as to produce excellent standards of sanitation. The floor was in very good condition from the standpoint of appearance and general cleanliness. From the standpoint of wearing quality of finish, the floor already showed signs of cracking. From observation of methods and materials used it hardly seemed probable that this could be due to incorrect methods of maintenance. It was more likely due to defective installation or to the quality of materials used.

B. Kitchen Floors

1. Quarry Tile: General appearance of the floor was excellent. The one criticism of the method used was that there was no actual rinsing of the floor with clear water. Even though quarry tile is a very durable floor and is injured as little by cleaning agents as any of the floor materials, it would seem advisable from the standpoint of the slip hazzard alone, to rinse the floor thoroughly after washing.

2. Concrete: This floor was in very poor condition, it being badly pitted and cracked. It was impossible to say whether it was due to cleaning methods used, to the age of the floor or to the original quality of the floor material. However, the practice of sprinkling undiluted

trisodium phosphate powder on the floor cannot be recommended. Where the occasional use of a dilute solution completely removed by rinsing would not be harmful and would be effective in cutting grease, the concentrated form is likely to have a disintegrating effect which has been referred to previously as "spalling". Although the floor was rinsed using a hose and then excess water was removed by means of a squeegee, at the end of the cleaning period, the floor was still quite wet. Upon drying, the salt crystals from the trisodium phosphate have an opportunity to penetrate the pores of the concrete. As the cleaning process is repeated, the crystals increase in size, finally exerting considerable pressure with resultant surface cracking or spalling.

3. Magnesite: The method of cleaning was considered effective in so far as immediate appearance was concerned. However, due to the characteristic tendency of this type of floor to absorb dirt and stains readily, it did not remain clean long. In order to maintain the appearance of cleanliness achieved with some of the other floors it would have been necessary to have deck-scrubbed the floor twice each day. This practice would have meant an increase in cleaning costs as well as interfering with food production in the kitchen.

VI. SUMMARY AND CONCLUSIONS

A study was made of seven different types of floor materials as used in institution food service areas. The types selected for study were hardwood, rubber tile, asphalt tile and terrazzo for dining room floorings and quarry tile, concrete and magnesite for kitchen floorings. all of these being in use on this campus.

The purposes of this study were three-fold and are listed in order of importance:

1. To present information on floor materials which would aid the institution food service operator in getting the greatest possible returns in satisfactory service from the initial investment in floors.
2. To compare the various types of floors in use in food service areas on this campus with regard to costs of cleaning and maintenance.
3. To evaluate the effectiveness of the cleaning and maintenance methods used.

Although there is a wealth of information available on the selection and care of floors it is in widely

scattered form. Much of it needs to be critically analyzed because it is colored by financial interests in promoting the production and sale of floor materials. In many cases it is applied to the needs of other than institution food service operators. It seemed important and worthwhile to devote a large part of this study to the presentation of information regarding the selection, use and care of floors.

Time studies were conducted in various campus food services in order to determine comparative costs for cleaning and maintenance of the floors studied. Preliminary interviews were had with managers in charge of the various food services in order to obtain such general information as cleaning procedures in use, time of cleaning and unit cost of materials. Several managers and employees were questioned as to whether or not they regarded the floor as satisfactory from the standpoint of fatigue, the safety factor and ease of cleaning.

In computing costs for cleaning and maintenance of the various floors, total cost of labor and materials was estimated. Final figures did not include depreciation costs on equipment used since there were no records available on length of life of equipment. In computing labor costs, total time for the cleaning operation started from the moment equipment was assembled and ended when the same was put away. Any time spent on other than

actual floor cleaning or maintenance was deducted from the total time.

In order to make comparisons significant, all labor costs were computed on the basis of the student wage rate of $ .65 per hour. All total costs for labor and materials were computed on the basis of cost per 1000 square feet.

A. Results of Maintenance Cost Studies on Cleaning and Waxing of Dining Room Floors

1. Hardwood: This floor appeared bo be inexpensive to maintain as far as daily cleaning costs were concerned. The cost for one daily dry-mopping was $ .16 per 1000 square feet. However the floor required frequent special maintenance work in order to keep it in good condition. When this was taken into consideration it was the most expensive to maintain of those dining room floors studied. The total cost for one dry-mopping and one cleaning and waxing procedure was $3.70 per 1000 square feet. The practice of cleaning and waxing small sections of the floor on different days was found to be more expensive than to employ more assistance and complete the cleaning and waxing in one operation.

2. Rubber Tile: Results of the study on rubber tile floors showed that it ranked highest in daily cost of cleaning at $ .90 or $ .97 per 1000 square feet cleaned. The difference in price depended on whether or not water-emulsion wax was added to the wash water. The great difference in daily cleaning costs for hardwood and rubber tile may be accounted for by the fact that the method of cleaning used for the latter was much more extensive than that used for hardwood. The total cost for one daily cleaning and one weekly cleaning and waxing varied from $2.27 to $2.34 per 1000 square feet, the difference in price again depending on whether or not water-emulsion wax had been used in the wash water for daily cleaning. This made rubber tile the second most expensive floor to maintain.

3. Asphalt Tile: Results of the study on asphalt tile showed that daily cleaning costs at $ .20 per 1000 square feet were relatively low as compared with rubber tile and only slightly higher than hardwood. The total cost of one weekly cleaning operation plus one daily cleaning operation was $1.29 which ranked this floor as third most expensive to maintain.

4. Terrazzo: Results of the study on terrazzo showed that this floor cost $ .57 per 1000 square feet for one daily cleaning operation. Special weekly cleaning or

maintenance was not required so that this floor was the least expensive to maintain of those studied. The results seem to indicate that those floors which require no additional care beyond daily cleaning are the least expensive dining room floors to maintain.

B. Results of Maintenance Cost Studies on Kitchen Floors

1. Quarry Tile: Results of the study on quarry tile showed a cost of $ .57 per 1000 square feet for one daily cleaning. No special weekly care was required.

2. Concrete: Results of the study on the concrete floor showed a daily cleaning cost of $1.05 per 1000 square feet of floor cleaned. No additional weekly cleaning was required. This floor was almost twice as expensive to clean as was quarry tile.

3. Magnesite: Results of the study on the magnesite floor showed a daily cleaning cost of $1.05 per 1000 square feet of floor cleaned and here again no additional weekly cleaning was required. From comparative costs obtained for cleaning these three types of kitchen floors, it would seem that those smooth, non-absorbent floors such as quarry tile, which require only dry sweeping and wet mopping, are much less expensive to clean than those which require deck-scrubbing, such as magnesite and concrete.

In general, these observations on cleaning and waxing procedures show that there is very little relation between original cost and total cost of upkeep for a specific type of floor. The two most expensive floors to install, terrazzo and quarry tile, were the least expensive to maintain. Two of the lower priced floors, concrete and magnesite, had a comparatively high cost of maintenance due to the fact that they must be deck-scrubbed. Rubber tile, a medium priced flooring, proved to be a very expensive floor to maintain. Asphalt tile and hardwood, comparatively low priced floorings, showed low daily costs of cleaning but expense increased when weekly costs were taken into consideration.

An attempt was made to evaluate the effectiveness of methods used in terms of appearance and wearing quality of finish. The opinions expressed were merely the result of random observations and were not based on scientific evidence. Floors, with three exceptions, were too new to evaluate the effect of methods used over a long period of time. With regard to those floors which had been in use for a suffieicnt length of time it was impossible to determine how much of the condition of the floor was due to maintenance methods in use and how much was due to other factors such as age, method of installation or quality of original materials. More information is

needed on the effect of maintenance procedures on wearing quality of finish and this presents a subject for further investigation.

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