

School Buildings

REMODELING

REHABILITATION

MODERNIZATION

REPAIR

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FOREWORD

SCHOOL PLANTS deteriorate with age and from a lack of proper maintenance. School plant obsolescence results primarily from a lack of adaptation to changing needs. Either deterioration or obsolescence may make a school plant less desirable as a school home for the youth of the community, less effective in protecting children, and less valuable as a learning laboratory.

Adequate school plant maintenance, rehabilitation, and modernization programs are essential to protect property values and to assure the best possible service from the school plants in use. These programs should be planned in advance of need. School officials should make a study of each school plant to determine what improvements are now needed or will soon be needed. Anticipated improvements should be scheduled and the necessary budget allotments made.

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Division of School Administration

SCHOOL BUILDINGS

Remodeling—Rehabilitation—Modernization—Repair

ADEQUATE SCHOOL PLANTS are essential to a modern educational program. The school plant that is not properly maintained soon fails to provide the service for which it was intended. School plants deteriorate with age and from lack of protection. School programs are dynamic and the needs for school plant facilities change from time to time. Frequent adaptation and modernization may be needed to prevent early obsolescence in a school building. Repairs and current maintenance tasks must be cared for if school property is to serve its intended purpose effectively. Periodic rehabilitation may be necessary.

The total program of maintenance, including repairs, renovation, remodeling, rehabilitation, and modernization, should be carefully planned. Some tasks will recur at regular intervals. A few tasks must be handled as the need arises. Other tasks, such as painting, can be scheduled.

Many school districts cannot afford to replace all of their old school buildings. In order to be able to obtain maximum utilization and service from these buildings, the districts find it necessary to rehabilitate and modernize the buildings.

Experience indicates that rehabilitation and modernization needs occur most often in certain areas or parts of the school plant. The following paragraphs outline some of the problems arising in these areas.

Remodeling is commonly thought of as a change in structure or a major structural improvement to the building. Some remodeling is usually done as a part of the rehabilitating and modernizing programs, but all remodeling is not necessarily rehabilitation or modernization. Remodeling might involve a change of partitions, a change in the roof structure, or a change in an exterior wall.

Rehabilitation is usually thought of as a general overhauling of the complete building or a major section thereof the better to adapt it to continued use for the school program. The rehabilitation program might be a comprehensive repair and renovation program. Remodeling may be limited to one section of the building, but rehabilitation generally covers a larger area or scope. Rehabilitation might involve some modernization, but all rehabilitation is not modernization since the latter might

include the replacement of existing facilities with new materials or equipment.

Modernization programs may involve some remodeling and some rehabilitation. The modernization programs are designed primarily for the purpose of adapting existing facilities and spaces to meet the needs of changing educational programs. For instance, the remodeling of a building to provide a music room might be modernization. Likewise, the replacement of obsolete shop equipment with modern lathes and other essential pieces of equipment might be modernization. The rehabilitation of a building to provide better lighting might be a part of the modernization program. However, remodeling or rehabilitation designed primarily to stabilize or protect existing structures is not necessarily modernization.

Repair programs are essentially what the name implies. The repairing or patching of a roof, the tightening of loose copings, the replacement of boiler tubes, or the adjustment of motors might be called repairs.

It is not usually easy to separate each of the foregoing terms completely in planning a program. There is some overlapping in each case. A rehabilitation program often involves some repair work. Likewise, a modernization program may involve some of all of the other three.

The following sections are planned to indicate some of the areas in school plants where remodeling, repairs, etc., are often needed. The listing in these sections does not indicate an order of priority, nor is the listing intended to be all-inclusive. Some suggestions on general procedures and on the results to be obtained have been included. However, these suggestions do not include detailed work plans for a specific remodeling, rehabilitation, or modernization task.

The whole building maintenance program should be planned in advance and standards of service established. These standards should serve as partial goals in the plant care programs.

CORRIDORS, STAIRS, AND EXITS

A most important criterion used in evaluating new or old school buildings is that they shall provide a maximum degree of safety for all who are required to attend school or are permitted to enter the school premises. In many of these older buildings the first step in rehabilitation should be that of providing acceptable levels of safety protection for these in the building. In many cases this will require major construction changes.

Many old and some new buildings are hazardous. Unsafe combustible corridors and stairs are common. In some cases the interior corridor walls are of combustible construction and storage closets are located under the stairs. Some classroom doors often open into the classroom, and the exit doors open into the building. These doors are too often equipped

with fixed lock hardware that can be locked against egress. Long stair runs, winders, open stair wells, or wide ornamental stairs may present real pupil and property hazards. Such stairs and exits are common in older buildings and are present in some of the newer buildings. Improving these conditions and reducing the hazards should be "musts" in many rehabilitation programs.

CORRIDORS

It is not always easy to provide fire-resistive corridors in the older buildings. In many cases the corridor walls are not of fire-resistive construction, and would offer but little side protection even if fire-resistive floors were installed. In some cases the supports, footings, and foundations under corridor walls are not designed to carry the added load of fire-resistive corridors. Hence, new pier supports and new footings may be necessary. If the building is not more than two stories in height, it may be possible to install fire-resistive stair wells at locations close enough to each classroom to prevent any child from having to walk more than 60 or 70 feet over a non-fire-resistive corridor to get to a suitable fire-resistive stair which empties at or adjacent to an exit on the ground floor. If the building is more than two stories high, it may be desirable to abandon the third floor if safety fire lanes (top, side, and floor) cannot be provided from each class door to the outside.

STAIRS

It is sometimes easier to install fire-resistive stairs. These should extend from the ground level up to the top of the building and should be of fire-resistive construction throughout. In a few small combustible buildings it may be necessary to locate the fire-resistive stairs outside the building, probably at the ends of existing corridors. Stairways inside the building should be located at right angles to the corridors, where possible. It is not desirable to block corridor width with stairs. The entrances to the stairs from each floor should be hooded from the ceiling down to a height of 7 or $7\frac{1}{2}$ feet from the floor. The stair should be of fire-resistive construction and enclosed in fire-resistive walls. Each stair should empty near a ground-floor exit. Risers and treads should be standard for schools as outlined by the National Building Exits Code.¹ Closets under stairways and doors opening on to stairways should be eliminated. Winding stairs should not be used where there is pupil traffic. No stairs should have fewer than 3 risers. No run should exceed 16 risers without intermediate landings.

¹ *Building Exits Code*, Tenth Edition, 1949, National Fire Protection Association, 69 Batterymarch Street, Boston 10, Mass.

EXITS

Exit doors should have ample width for the building loads they are to serve. They should open outward and should be equipped with suitable exit hardware.

In some instances it is necessary to provide fire escapes on the exteriors of school buildings in order to provide additional exit lanes. These never completely fill the place of fire-resistive stairs. Installing fire escapes is not plant modernization, but should be considered as providing temporary exits to be used until better emergency exit facilities can be provided. If necessary to install fire escapes, they should be installed so that they may be entered at floor level and so that the user will not need to pass by any unprotected openings such as windows or doors from which he may be endangered by escaping flames and fumes. All such openings should be equipped with wired glass and fire-resistive sashes.

EXTERIOR WALLS

In remodeling programs, exterior walls and foundations may be moved or rebuilt. In many cases it is necessary to rehabilitate or make major repairs on walls and foundations in order to preserve structural stability. For the most part this rehabilitation consists of correcting various wall and foundation defects.

FOUNDATIONS AND FOOTINGS

A building structure cannot be more stable than its foundations. Some of the common foundation and footing defects are settling, cracking, tilting out of plumb, and leaking. The lack of foundation stability may lead to wall cracking, deflections, and eventually to structural deterioration.

Some wall settlement for school buildings on soil bases is common. When this settling is uniform there are usually few ill results. However, with the usual school plant design the wall loads vary, and unless the footings are carefully planned, the settling may be uneven. This may lead to wall cracks, or broken arches, and at times to wall bulging or tilting.

Where foundation walls are not too much out of line it is often possible to reinforce the footings with new underpinning. The process is slow and usually costly, but such new supports may add years to the life of walls which might otherwise become hazardous. In placing the underpinning builders customarily dig out the dirt under the old walls, a small section at a time, and pour spread footings under these sections. After these sections have seasoned and are ready to take the wall load, adjacent sections are treated in the same manner.

FOUNDATION LEAKING

Foundations are often subjected to water pressures from the outside soil. Resulting seepage or leaks make damp basement walls and may be harmful to floors on fill or near basement grade levels. Attempts have been made to check this leaking by a coating of waterproofing materials applied to the inside of the foundation walls. These are only partially effective. If the outside water gets into the walls, it tends to push the waterproofing materials loose from the wall surfaces. Leaks should be stopped from the outside. In numerous cases it may be necessary to trench around the building so that the outer foundation wall surface may be reached for waterproofing. It is desirable first to close and caulk all cracks. In some cases it may be necessary to coat rough stone or porous block foundations with a heavy cement plaster applied to the outside before the waterproofing is applied. The waterproofing is then applied, as an outside film of asphalt, tar, or some other plastic waterproof compound that will seal the pores and keep the water from entering the wall.

It is also desirable to provide drains that will carry downspout water away from the building. In some cases it may be necessary to lay farm drain tile around the building at the top of the footings in order to carry away ground water that might decrease the load-bearing quality of the soil under the footings.

WALL REHABILITATION

Wall aging and deterioration are accelerated if the walls are not properly protected. For many years property owners have found it desirable or profitable to rebuild and/or reface exterior wall surfaces of some buildings; where appearance is an important factor. In some school buildings exterior wall surfaces have been protected by a stucco finish, but, in general, complete refacing of exterior walls has not been practiced.

WALL DEFECTS

Probably the most common defect of exterior walls is the failure to exclude moisture. Water enters through holes around window and door openings, through open copings and parapets, and through masonry joints. It is possible for some moisture to enter through certain types of masonry units, but this does not seem to be the source of most wall leakage.

Another common defect is wall cracking. Builders often think of small breaks as expansion and contraction or settling cracks. It is not always easy to avoid these cracks. However, it should be realized that each such crack provides a hole for the entrance of water that may hasten wall deterioration. Other cracks originate from such causes as foundation

breaks, sagging lintels, or broken arches. Some originate where water enters through broken parapets or around flues and chimneys. In some cases wall deflection occurs when foundations settle or tilt.

Another wall defect, often too long neglected, is the deterioration of the mortar in the walls. For various reasons the old mortar may have given way and surface joint openings permit water to enter the building.

It is not desirable to attempt to outline here the various steps to be followed in rehabilitating school building walls. It is desirable to call attention to some of the general problems involved and to the importance of wall care to school plant preservation. Most of the school building masonry walls are built of some type of masonry blocks, such as brick, tile, concrete, or stone. The mortar between these masonry units serves primarily as a cushion between masonry units and may not have great resistance to side thrusts. Consequently these walls lose some of their stability and strength if they have much variance from a perpendicular position. As indicated previously, wall deflection usually results from uneven foundation settling, slipping, or major breaks. Some of the building walls of monolithic masonry have more cohesive strength, particularly if suitably reinforced. However, monolithic units may crack from expansion and contraction.

It is desirable to correct building wall defects early. Slight corrections or rehabilitation made early may prevent major deterioration later. It is usually not wise to attempt major remodeling tasks inside the building if the exterior walls do not give promise of serving for a period of years. Note that the comments here refer primarily to load-bearing wall construction. Many of the newer buildings are of skeleton construction with either steel or concrete beam supports. In these buildings the walls between the supports are often little more than curtain walls and are not as much affected by slight defects as are load-bearing walls.

REPAIRING WALL CRACKS

Wall cracks arise from several causes, and methods of correction will vary. In numerous buildings, erected during the years when unbroken banks of from four to six windows for each classroom were the style, the long lintels have sagged and the walls above have cracked. If such deflections and the resulting cracks are not excessive, it is often possible to support the lintels on piers or posts. Caulking these cracks may then be all that is necessary.

Cracks developing from broken arches are harder to handle, but if not checked quickly may extend to the top of the building. In many of the older buildings these arches are held together by end thrusts from the walls, and if there is much movement the best solution may be to relay the walls. If the movement is slight and is not continued, steel lintel inserts may check the cracking.

Cracks from building settling can usually best be checked by controlling the settling, as was outlined under the heading on foundations. Parapet wall cracks originating from the top can usually be checked by relaying the parapet walls and resetting the coping.

In either case leaks through cracks can usually be checked by caulking. However, it should be understood that caulking is effective only so long as the crack does not widen. Permanent improvements may require measures that prevent further settling or cracking.

WALL LEAKAGE

One of the most common defects of masonry walls is that of leakage. Sometimes water goes through the masonry unit. This is not common with the harder of glazed masonry units. As a rule, water absorbed by the masonry units is evaporated into the air and little of it reaches the inner surface. This is not necessarily true for all types of masonry units nor in areas where blowing rains persist over long periods. The two or three principal sources of water in walls are seepage downward from parapets, seepage from around openings such as doors and windows that are not properly caulked, and seepage through poor joints. It is possible to protect against seepage from openings around doors and windows by caulking all openings or holes, where water might enter, with a plastic caulking compound. The fact that no leakage shows at that particular point does not indicate the lack of leakage around such openings. The effect may be noted several feet distant. Seepage through joints is also common. In many cases masonry units such as brick are laid in a hard cement mortar, and if the mortar dries quickly, it may pull away from the brick unit, leaving a small hairline crack which may permit the entrance of water. In other cases mortar may have deteriorated to the point where it will not resist seepage. In either case one of the best remedies is to rake and repoint the joints.

WATERPROOFING WALLS

In many instances a film waterproofing painted on the exterior of the masonry units is used to prevent seepage. If the holes and pores in the walls are small enough to be bridged by the paint film, the film may be a satisfactory repellent so long as it lasts. It will not be effective if the holes are so large that the film does not give complete coverage. In many cases this film is a transparent material that will weather and lose its protective features. As the walls age the pores or small cracks may fill up with dirt so that seepage is checked.

Much of the leakage of brick walls enters through wall cracks and holes around window openings. It is sometimes necessary to check these leaks before it can be determined whether leakage or seepage is occurring through mortar joints. It is not always wise to apply a wash or paint to

brick walls if their appearances are materially changed. For such walls corrective flashing and repointing are generally preferred. However, if other means do not suffice, the exterior washes may be necessary.

For certain other masonry walls such as block (and as described above on brick when necessary) an exterior coating of cement-water paint (equal to Federal Specification TT-P-21) may be used with satisfactory results. Walls to be painted with this paint should be thoroughly cleaned. Either factory or on-the-job prepared paint can be used. Use either white or gray portland cement (depending on color desired). Hydrated lime up to 20 per cent of the cement can be added if desired. For the on-the-job mix the hiding power is increased by adding from 3 to 5 per cent by weight of titanium dioxide or zinc sulphide. Up to 1 per cent by weight of aluminum stearate may be added as a water-repellent if desired. For rough surfaces a small amount of fine sand may be added. If the masonry wall absorbs too much of the moisture from the paint, uneven drying may result.

Some of the newer buildings have a plaster bond inside the masonry wall under the plaster. This plaster bond may suffice for a while, but it is difficult to keep water that is in the wall from passing through to the inner surface. The place to stop water is at the outside of the wall.

Efflorescing is common in many walls. Wall stains from deteriorating lintels and copings may be removed by an acid wash. During recent years several schools have painted exterior masonry walls. This has added to their appearance. In most cases paint does not last long on exposed masonry units, and schools which have painted such walls may find that they will need to repaint frequently. Wall rehabilitation should be coupled with repair or replacement of leaky downspouts that may lead to wall injury.

ROOF CARE

Poor roof protection hastens complete deterioration of the inside of the building. There are many types of roofs and there is need for many types of repair services. In many instances roof remodeling becomes an essential part of a rehabilitation or a modernisation program. In some instances it is necessary to remove heavy domes or steeples or heavy slate surfacing to reduce excessive load pressures on old walls. Dormers, skylights, or high gables—some common causes of roof troubles—may need to be removed or repaired. Some of the common roof defects which call for immediate and frequent attention are buckling of sheet roofing, wind or storm tears, cant strips rotting out, breaking of roof at wall junction, rafter or joist sag with resulting roof pockets, flashing broken or loose, counter flashing out, downspouts choked, gutters leaking, or water backing up over the flashing. They result in roof leakage and building deterioration if not checked.

ROOF REMODELING

Repair and remodeling methods will vary with the types of roofs and local conditions. Steeples, domes, belfries, and dormers can usually be removed. Where heavy slate or tile roofs cause rafter sag or wall deflection more drastic remedies may be needed. In some cases it may be possible to replace the slate or tile with lighter asphalt or asbestos shingles. In other cases where the damage or the probabilities of damage are more serious, it may be necessary to remove the whole roof structure and replace with another, probably of the semiflat type. In replacing a pitched roof—usually with an overhang—with a semiflat roof, it may be possible to provide an extended overhang or eave and thus avoid the necessity for building up parapet walls.

REPAIR OF FLAT ROOFS

Flat or semiflat roofs, either asphalt or tar and gravel-covered, may need attention frequently. Many of the roof leaks originate around the edges either in the parapet wall or around the flashing. It may be necessary to install new cant strips at the junction of the roof sheathing and the parapet walls. When the building is not to be reroofed, flashing repairs can be made by lapping roofing material over the surface of the roof deck and extending it up the parapet walls. The flashing should be mopped on. It is usually preferable to extend the flashing into the parapet wall, or under the coping, or protect with counter-flashing. Counter-flashing should be of a noncorrosive material, preferably copper or aluminum, and should be securely fixed in the joints of the masonry parapet wall. It is preferable to have the flashing extend through the wall. When this is done, some means must be provided for tying the wall sections above and below the flashing. It is sometimes necessary to spot-nail roofing paper that has pulled loose from the sheathing. At other times it is necessary to remove roof blisters. In each case repairs can be made without having the nails exposed by slitting the roofing sufficiently to insert a new piece of roofing and mopping it down.

GUTTERS AND DOWNSPOUTS

In older buildings, gutters and exposed downspouts often cause much trouble. Some of the gutters and downspouts loosen at the joints, and some of them have rusted through. Outside or hanging gutters can be replaced, but it is much more difficult to replace in-the-roof gutters. Broken downspouts may permit water to seep into the walls and destroy the grouting between masonry joints. Downspouts with the outlets near the foot of the wall may cause wall leaks. Painting and surfacing of gutters usually give only temporary relief if they have already begun to rust. If paint is applied to a new downspout, it helps to prolong its life.

Some scuppers are so small that they do not carry off the roof water as rapidly as desired. In winter, freezing at the downspout head often causes water to back up on the roof, sometimes backing over the flashing where it enters the parapet wall to appear as leaks in the rooms below. One remedy here is to widen and increase the throat of the scupper and then to drop the downspout head slightly below the scupper chute so that water may flow over the downspout head when the downspouts are frozen. One other solution which relieves many of the problems arising is the installation of inside downspouts. These are not always easily installed after the building is erected.

PARAPET WALLS

Parapet wall leakage and roof leakage are often closely connected. What seem to be roof leaks may sometimes prove to be the result of seepage or infiltration through parapet walls. Water may enter the parapet wall from the top or either side. After the water enters the wall, control is difficult or almost impossible. Water entering through the parapet wall may appear as a wall leak or damp spot some distance below and perhaps at some distance to one side. Ceiling leaks even some distance away may originate from parapet wall openings. Inside binders or coatings may curb but do not always stop seepage, and the best means of preventing parapet wall leaks is to keep water out of the parapet walls.

Copings that are loose should be reset, and all copings should be well pointed. Exterior parapet wall surfaces may need to be repointed and all small holes closed. The inside walls are often faced with old or soft brick. These sometimes spall or deteriorate and it is hard to retain a water-repelling surface on them. It is desirable that the flashing extend up beyond any anticipated high-water mark. The exposed wall, if any, above the flashing should be coated with a waterproof composition or paint.

The flashing should fit closely to the parapet. Flashing that extends into or through the wall is desirable. Flashing through the wall is usually offset so that seepage is reduced. Rods are sometimes inserted to increase wall stability.

HEATING AND VENTILATING PLANTS

Heating and ventilating units in school buildings are subject to pressures, overloading, and wear. Repairs and the replacement of parts are frequently needed. It is not feasible to describe here the various types of repairs needed and the repair methods to be used in caring for the average heating plant. Heating plants generally deteriorate more rapidly than the buildings in which they are located, and it is usually necessary to remodel the heating plant one or more times during the life of the

building. The items listed here will apply primarily to rehabilitation or modernisation programs. However, some attention may be given to major repairs or replacements.

REHABILITATION VS. REPAIRS

It is not easy, or important, to determine whether a heating plant improvement is a regular maintenance task, a repair job, or a part of a general rehabilitation program. Sometimes heating and ventilating system defects are a matter of degree rather than the total absence of a needed service. For instance, small water pockets in steam lines, even though they should be eliminated, may be overcome temporarily by increasing the line steam pressure. Some common defects that should be considered in repair and rehabilitation programs are sagging lines and water blocks, poor circulation for other reasons, trap and pump failures, broken or warped grates, leaking or poorly adjusted pressure burners, cracked sections in cast iron boilers, fire wall deterioration, poor damper adjustment, leaking flues, air leaks in chimneys or breechings, broken insulation, defective air-cleaning service, poor service from control devices, and defective fan motors.

Complete rehabilitation or modernisation usually calls for extensive changes. Many of the older heating plants were designed merely to provide heat, with but little attention given to heat diffusion, temperature regulation, air cleaning, or economical use of fuel or manpower. Heating plant fire hazards are common. Some buildings have inadequate ventilation facilities; while others introduce and heat only outside air for room use. Many basement rooms are heated only with overhead pipes or radiators.

PURPOSES OF HEATING AND VENTILATING SYSTEMS

Heating systems have been improved. The heating and ventilating systems are now designed to provide controlled temperatures within the ranges desired and to prevent too rapid fluctuations within these ranges. Ventilating systems provide for sufficient flowage of air to remove odors, to diffuse the heat, to carry off excess body heat, and to create a feeling of comfort for those in the building.

HEATING PLANT IMPROVEMENTS

Many improvements could be made in some of the existing heating plants. The suggestions which follow are not intended to be all-inclusive nor do they apply equally under all conditions and to all types of heating plants. Attention will be given to some of the improvements most often needed in school buildings, and in a few cases suggestions will be made for improvement procedures. The types of heating and ventilating services desired have been outlined in *Guide for Planning School Plants*²

² National Council on Schoolhouse Construction. *Guide for Planning School Plants*. 1933.

and elsewhere. The general purpose in major repair, rehabilitation, or modernisation programs is to improve existing systems or to replace them with others that meet modern standards of service.

HEATING PLANT LOCATIONS

It is often desirable to provide improved fire-resistive furnace rooms. Many furnace rooms are located under classrooms in basements where the furnace surrounded by combustible materials creates serious fire hazards. In some cases it is possible to enclose the present furnace room in fire-resistive construction. In many cases it may be desirable to relocate the furnace room out of the building. In such cases it may be desirable to locate the furnace room adjacent to the building to facilitate servicing and to be able to use the building wall as a brace for the new smokestack. The fuel room should be of fire-resistive construction. It should be adjacent to but separated from the furnace room by fire-resistive walls. Each should be located so as to facilitate the delivery of fuel and the removal of ashes and waste. Essential storage for other than solid fuels should be so located and designed that building and pupil hazards are reduced to a minimum.

MAJOR REPLACEMENTS OR IMPROVEMENTS

Obsolete heating plants may need to be replaced or remodeled to provide acceptable services. In some cases the heating plants are not worth remodeling or are too small or not easily adapted to provide the type of service needed. In some cases building expansion makes it necessary to replace or to make major changes in the heating plants. These changes often offer opportunities to modernize the whole system. Small localised hot-air units in small buildings or at various points in larger buildings may be replaced by controlled fan blast or steam or hot-water systems. Existing direct radiating systems may be replaced by or supplemented by conditioned air currents.

Many of the old buildings have one-pipe direct or indirect radiating systems. These may be converted into two-pipe trapped systems by realooping the radiators, adding the traps, and installing the return lines. Action of these systems can be speeded up even more by making them into vapor vacuum systems. Poorly shaped or small chimneys may need to be replaced. This is frequently necessary when the heating plant must be enlarged to care for building expansion and increased heating loads.

In some instances it may be desirable to convert local unit heating into a radiant panel-diffusing type of heating. This is often desired for special units such as kindergarten and primary classrooms. Such changes can be made without difficulty with hot water heating systems and can be made with steam systems. With the steam systems it may be desirable to install another unit to provide hot water for the radiant or panel

heating areas. Some schools have used condensate from the steam for such purposes. This has proved satisfactory but requires an adequate control system.

Another change that is needed in many buildings is the replacement of in-the-room propeller-blade-fan type of heating units. Many of these units are noisy and, although they provide some local air turbulence, do not always provide adequate air circulation for all parts of the room. It is usually possible to improve the service by installing silent-flow multi-blade fans so arranged that they handle volumes of air. They can be installed with ducts to draw the intake air from near the floor level and deliver it at a higher level. It is often desirable to increase the total air movement in the room and provide greater heat diffusion. However, it is usually far better to remove the fan unit from the room to make it an indirect heating unit drawing cool air from the room and returning the warmed air. Improvements of this type are frequently needed in auditorium and gymnasium units where groups of pupils assemble and where control of noise and heat diffusion may be important but difficult.

HEATING CONTROLS

Heating controls provide the nerves of the heating and ventilating systems. A number of the older systems have no automatic or mechanical control. Some have zone controls, and others may have a single location control that regulates the rate of firing. The value of each of these is limited. With the fuel control there is a lag between the change impulse and the consequent temperature change. The zone controls do not always provide for individual room variations. The preferred aim is the development of a system that provides positive control of each room for air circulation and for the rate and total range of temperature changes. Various types of controls may be used with satisfying results. It is desirable that the control system installed be easily operated and that it require a minimum of hand control or of repairs. The controls used should be sufficiently flexible to compensate for human radiation, wind pressures, and building exposure.

VENTILATION

It is not always easy to make major changes in ventilating systems in old school buildings. However, in numerous cases improvements can be made. Vent ducts which empty into attic spaces where they create added fire hazards and where the foul air may backwash into other rooms can be extended through the roof. Vent ducts can be brought together in the attic in a plenum chamber and a fan installed to provide a positive suction of air from the rooms. Special vents with separate exhausts and with suction fans should be provided for kitchens, laboratories, or toilets as needed.

Where building air is circulated through dirty corridors or in open passageways under floors and returned to the building circulation system, provision can be made to change the circulation route and/or to clean the air. There are several devices that may be installed to clean building air. Probably the most common method is washing either with a shower spray or by blowing the air through moist filtering screens.

AIR COOLING

Although the public elementary and secondary schools have not done much air conditioning, the possibilities from such service merit consideration. Some administrators feel that such service might pay dividends in added pupil comfort.

REPAIRS AND REHABILITATION

Many repair and rehabilitation improvements are needed in some of the older school heating and ventilating systems. Sagging steam lines permitting the formation of water pockets, and usually a source of line pounding, can be regraded and the pockets eliminated. Where the line cannot be regraded or sloped, bleeders can be put in to return the water to the return lines. Leaking smoke chimneys can be repaired or replaced.

Stoker feeding can be provided where needed. Where stokers are already in service, it may be desirable to provide for gravity or carrier feed lines from the fuel bin to the hopper. Furnace, boiler, and pipe insulation may be replaced or added. Circulating pumps should be provided for hot-water systems that do not now have them. Fire walls that do not give proper direction to the furnace draft should be rebuilt.

HOT-WATER HEATING

Attention should also be given to hot-water heaters. These are not necessarily a part of the heating plant, but they are often located in furnace rooms and hence are usually cared for as a part of the heating plant. With the introduction of more home economics, cafeterias and lunchrooms, and kitchens there is need for a hot-water system that will provide hot water up to 180 degrees temperature. This is much hotter than should be used for handwashing, lavatories, or showers. It is possible to provide temperature-reducing valves in the lines, but school officials do not usually wish to depend on such devices. Therefore it is often desirable to install one hot-water heater for lavatories and shower services, and a second heater to step up the temperature for dishwashing. Most of these hot-water heaters have escape valves. Numerous school officials also feel it desirable to remove the check valves in the intake lines so that any excess pressure that might be developed in the hot-water tank could be released backward through the water lines.

PLUMBING AND SANITARY SERVICES

In nearly all modernisation programs in old buildings it is necessary to give specific attention to the plumbing and water services. In some cases the plumbing fixtures are old and many of the toilets are located in dank odorous basement areas that are poorly ventilated.

TOILET ROOMS

It is often desirable to remove toilet rooms from basement areas and to provide one or more toilet rooms for each sex on each floor. In some cases it is possible to select classrooms—one above the other—that can be converted into toilet rooms. One of the older classrooms will provide space for two toilet rooms. By use of a room of this type the toilet rooms can be located back to back and the problem of locating sewer and soil pipes is simplified and costs are reduced. In many cases the wood floor joists in these rooms may be replaced with bar joists and concrete which will provide a base for an impervious floor. Locating small or individual toilet rooms adjacent to each classroom is usually not feasible in a modernisation or rehabilitation program because of space requirements and pipe locations. However, it may be possible to locate sinks and drinking fountains in the classrooms.

Many of the old toilet rooms that are to be retained need remodeling. Ample illumination, preferably with some direct sunlight, is desirable. Ventilation separate from the building ducts should be provided. The floors and walls should be of impervious materials. Door shields should limit direct view from the corridor. Inside arrangement should facilitate pupil service. Lavatories should be located between the other fixtures and the exit. Mirrors should be provided but not placed over lavatories. Bookshelves should be provided. Hose bibs and drains facilitate cleaning. All toilet stall, wall, and ceiling surfaces should be smooth to facilitate cleaning. In many cases it will be possible to develop new toilet rooms without providing the utility corridor back of the fixtures. With ample pressure and large enough feed lines it is possible to set up desirable toilet rooms without using this added space.

FIXTURES

Many of the plumbing fixtures are unattractive, undesirable, and in many cases not properly placed. Vertical stream bubbler fountains—sometimes in toilet rooms; high lavatories serving only cold water; trough urinals—often too high; or slate urinals with absorbing surfaces; toilet stools too high for the pupils and usually of a type difficult to keep clean; and in many cases a lack of cleaning supplies are not conducive to modern sanitation or to pupil health protection. It is preferable to provide floor-level vitreous urinals. Stools should be of the extended-lip,

large-water seal type and of sizes adapted to the height of the children using them. Fountains should be of the angle stream, anti-squirt, head-protected type. Lavatories should provide both hot and cold or pre-tempered water from one spigot and should be set low enough to permit pupils to wash without having water run down their arms.

OTHER FIXTURES

Additional and replacement plumbing fixtures are needed in many buildings. Many of the older kitchen sinks should be replaced by modern sinks with aprons and special devices for clean-outs, etc. Laboratory lines may need to be relaid. Acid-resisting sinks should be provided in areas where needed. A flat sink is often used in a laboratory workroom. In addition, many schools are finding it desirable to provide a sink with counters in each of the elementary classrooms or at least in the primary rooms. It may also be desirable to provide drinking fountains in the classrooms, and in many instances it is desirable to provide toilet stools in rooms converted for kindergarten or primary classes. Custodians' slop sinks with $\frac{1}{2}$ -inch supply lines of each hot and cold water are needed on each floor. Drains should be provided in toilet rooms around areaways and below grade entrances and on other floors at or below grade level where drainage may be necessary. Special plumbing should be provided adjacent to auditoriums or other units used by the public during the evening.

SHOWERS

There is an increasing demand for satisfactory physical education dressing room and shower facilities through nearly all grade levels. In many instances it will be necessary to convert existing rooms or to erect new rooms to provide the area needed. Presumably a secondary school with 800 pupils participating in physical education a minimum of three times a week would need space for at least 2,400 pupil-hours of physical education per week. Each of these pupils participating in physical education will need locker space. Since there probably will be only 25 to 30 available periods per week for physical education this would mean that about 100 pupils would be engaged in physical education during each period in the various gymnasium units or on the grounds. If these 100 pupils are to take showers and dress without wasting time, adequate shower and dressing rooms will be needed. The shower rooms should have impervious surfaces and should be well ventilated and lighted. Shower water should be controlled so that the maximum temperature of water delivered through the shower heads will not be above about 115 to 120 degrees. Locker areas for gymnasium clothing should also be well ventilated. It is desirable that this whole area be provided with positive ventilation.

WATER SUPPLY

It may be necessary to give some attention to the water supply lines to and in the building. In many cases old galvanized pipe has rusted until it is not safe, and in some instances small pipes may be partially filled with lime and other water deposits. The supply main leading to the building should be large enough to provide the pressure needed for all fixtures and for fire hose if installed. If as many as three or four fire hoses are installed, it may be desirable to provide at least a 4-inch main into the building. Building mains leading to flushometer or automatic flush fixtures should be of sufficient size to provide the waterhead needed. Building lines near open areas should be protected against freezing in cold climates.

ELECTRIC SERVICE

The electric service in school buildings requires frequent repairs and many adjustments. It is not easy to separate those tasks which might be labeled repairs from those which might be thought of as modernization or rehabilitation. There is need for remodeling the electric service in most of the older school buildings. This is also true of many buildings that have been in use only a few years.

WIRING CHANGES NEEDED

Many of the older buildings are wired with knob and tube wiring usually through open attic spaces. In many cases the wires are sagging and are hazardous. In some cases water runs down the intake wires and rots the insulation around the building wires. A large number of these buildings are wired with light wiring, some of it not larger than #14. Only a few of these buildings have the outlets needed for today's building services. Increased demands for electric service, including electric stoves, power motors, and more illumination, have placed more load on the electric service than circuits are designed to carry. Probably more buildings today need improvement in the electric service than in any other one phase of the building service. In some instances it is not desirable to attempt to use the existing wiring, but the old wiring should be pulled and new circuits installed. These circuits should be in conduit or at least in armored cable. Wiring should be large enough to carry the loads. Probably no circuit lighting should be less than #12 wire. Heavy duty circuits should have larger wiring. The wattage per circuit should be limited. In fact it is desirable to attempt to limit classroom lighting circuits even with #12 wires to about 1,000 watts per circuit.

Intakes should be protected. Where it is possible, the intakes should be in a ground cable. Where cables are not feasible, high wires approaching the building from a sheltered spot and with proper intake anchors and

loops should be provided. Building wiring panels and switches should be located where they are accessible to servicemen, but are not open to pupil contact. Panel boxes should be equipped with dead front faces, and the fuse sockets should be labeled for size.

LIGHTING

One of the major problems of electric service is that of lighting. Recent trends in lighting standards and demands have materially increased the wattage needed. In many instances old fixtures have been or should be abandoned and new fixtures installed. It is important not to add fixtures that will overload the wires. In some instances fluorescent lighting has been installed to obtain more illumination without increasing the wiring. In other instances new wiring is needed regardless of the type of fixtures used. It is not desirable here to attempt to outline the type of fixtures that should be installed or the illumination that should be provided in modernization programs. It is desirable to indicate that improved illumination does not come alone from buying added fixtures. The whole illumination project should be studied as one unit. This means that the wiring, the types of fixtures, the location of fixtures, the furniture finish, the wall and floor finish, and the natural lighting available should be considered.

SPECIAL AREAS

Special attention should be given to the illumination in certain areas such as the audio-visual rooms, the home economics clothing laboratories, the library, and various other units. In many cases, it is also necessary to remodel or revamp the stage lighting facilities. Gymnasium units are often underlighted. Shop lights often produce a glaring effect, particularly on moving machinery. These should be given attention in a modernization program. Then, too, home economic food laboratories often use electric stoves which require special wiring.

SPECIAL SERVICES

Other electric services in the building may also need attention. Public address systems should be installed where needed. The wiring for such systems should be separate from wires providing light or power. Intercommunicating telephone systems may also be desired. Many schools are finding it desirable to wire for television. A majority of the older school buildings need additional outlets in nearly all rooms, and special or heavy-duty outlets in some rooms where light power machines or audio-visual equipment is installed. Shops are generally abandoning the overhead line-shaft power units and are installing new machines with integral or attached motors. Of necessity wiring must be adapted to these new units of service.

CLASSROOM MODERNIZATION

The classrooms or working areas are the heart of the school-plant program. Frequent rehabilitation is necessary in many classrooms. Periodically, it may be desirable to provide a complete modernization of existing classrooms. Numerous existing classrooms can be made to provide acceptable space and facilities by a complete remodeling and renovation program. In some rooms new floors should be installed, in others new cases for storage and in many of the old classrooms new lighting facilities are needed.

ROOM REMODELING

Space problems are not easily handled in some of the older classrooms. Many classrooms more than 25 years old are large enough to be adaptable. Many others erected during the past 25 years are small and have window fenestration that makes expansion difficult. Newer teaching methods may require more space than can now be provided in some old rooms. In some instances it is possible to remove partitions and to make two rooms out of space formerly used for three rooms. In other cases it is possible to remove cloakrooms and thus to increase the floor area of classrooms. Classroom heating may be changed to provide positive air circulation and to assure that the air is properly diffused in the room. New ventilation facilities can be provided to exhaust foul air. Working spaces can be improved. The addition of a sink with a workbench and perhaps of an aquarium may be desirable in many rooms. It is not possible to put toilet stools in all rooms, but it is possible to provide drinking fountains in some rooms. Blackboards can be removed and replaced with chalkboards having acceptable reflecting qualities. In some instances it may be possible to resurface existing boards. Acoustical furniture of various types can be replaced with modern equipment and furniture. If this is not possible, it may be feasible to resurface and renovate the furniture in the room. Complete renovation and redecoration should be considered an essential part of the rehabilitation and modernization of most classrooms.

FLOORS

Floors in school buildings have utility value in providing a footing for travel and for the location of equipment, and also play an important part in establishing the tone of the room. The schoolroom or school area that has good floors has the first part of a complete assembly for an attractive room. It is almost impossible to develop attractive rooms that do not have satisfactory floors. The floors are subjected to more wear than most

other parts of the building. In some areas of the country quantities of sand or gravel are carried into the building where they cut floor finishes and surfaces and make it difficult to maintain satisfactory floors.

It is difficult to obtain the type of floor desired in most school buildings. Probably the most common preference for school floors would be a light-colored hardwood. These woods are now scarce. The prices are high, and schools often find it necessary to resort to other types of floor surfaces in most of the building.

Floors in many of the older buildings have been mistreated and abused. Wood floors were permitted to wear until the nailheads showed through the wood. Some wood floors have been subjected to alternate oiling and neglect. Some of them which were laid without proper seasoning have shrunk and have large cracks between the boards. Some masonry floors sanded or checked and became unattractive.

REJUVENATION OF WOOD FLOORS

One of the major tasks in rehabilitating old school buildings to make them more serviceable and to help provide desirable modern facilities is the renovation or replacement of old floors. If the floors are of wood construction, it is not too difficult to renovate the floors provided they are not so badly worn that sanding and resurfacing are impracticable. If the wood floors can be resurfaced, it is usually desirable to sand down to a smooth even surface. Then, if necessary, the floors should be filled and resurfaced with a suitable surfacing material for the type of floor and the activity to be served. In most cases this involves sealing and perhaps waxing. If the floor is used for physical education or gymnasium activities, the penetrating sealing coat should be followed by a surface seal containing bakelite which builds up a surface on top of the wood.

In some instances, it is necessary to relay the wood floors. It is sometimes possible, but usually is not feasible, to relay old floors that have been taken up. During recent years there have been many cases where old worn wood floors are covered with a mastic. In a few cases troweled-on mastic has been used. In most cases a composition covering similar to asphalt or rubber, usually in tile form, has been used. These do provide more attractive surfaces, but unless they are properly shielded by underlayers of heavy paper, the irregularities of the boards will show through the composition covering. In some places it has been difficult to hold the composition tile in place on the floor. In some instances dry rot may develop in the boards under the mastic finish.

MASONRY FLOOR REPAIRS

Masonry floors are supposed to have long lives. This does not always hold true. Concrete and terrazzo floors may break down if not properly proportioned and hardened when laid and if not protected while in use.

Sometimes the use of certain cleaning compounds will destroy the cement or grouting around aggregate particles, and the floor begins to sand. When this starts, each bit of sand picked up on shoes becomes an abrasive and may be ground into other parts of the floor by hard soles. In some cases where floors are not too badly deteriorated, it is possible to preserve the surface by using a good masonry sealer. Cheaper sealers such as sodium silicate can be used, but the endurance of such seals is limited. If the masonry floor is badly worn, it may be necessary to provide a new surface. This is not easily done in the case of terrazzo, but a new surface on concrete can be provided if the bed or floor can be sufficiently roughened to provide a bond. In some cases it will be necessary to score the old floor, and in other cases irregularities may be created by acid etching. The new surface, usually of neat cement, should be applied only to clean floors and to floors made sufficiently moist that neat cement will not check in drying.

Some other masonry floors of tile which are too badly worn to be used may be replaced. In many cases, it is possible and desirable to smooth a rough masonry floor and then to apply a surface of linoleum or asphalt tile.

REPLACING COMPOSITION FLOORS

In many schools it is necessary to relay or replace the composition floors used in the buildings. Asphalt or rubber tile floors may usually be laid in small sections wherever needed. Some of the flooring like battleship linoleum may need to be completely replaced. It is possible to make some improvements by renovating composition floors, but, in general, replacement is essential when floors become worn and unattractive.

STORAGE

Adequate storage spaces are important in the utilization of building capacities, in the appearance of the interior of the building, and in building protection. Many buildings do not have adequate storage areas, and much of the storage is not particularly well adapted to the program that is to be offered. It is possible to readapt the storage and to add materially to the modernization of the school plant.

GENERAL STORAGE

General building storage should be provided for equipment, furniture, and supplies temporarily out of use but which should not yet be moved to a central district warehouse. Central storage space should also be provided for stocks of new supplies. This storage space should be accessible to a logical part of entry for the building. The amount of space required for this storage space will depend to a great extent on the school system.

of handling supplies. If a central warehouse is used and if deliveries are made to each building daily or weekly, the amount of storage space required in each building for incoming supplies will be small. However, if shipments are divided and stored in buildings as received, then the storage space in each building should be sufficient to care for the incoming supplies.

STORAGE FOR COMBUSTIBLES

Storage for fuel should be segregated and should be of fire-resistive construction. It is often feasible to provide storage for fuels outside the building. Custodial supplies, paints, varnishes, oils, and other flammable materials, as well as some of the materials like paper which are highly combustible, should also be stored in fire-resistive areas. It is desirable that these areas have sprinkler protection.

PHYSICAL EDUCATION STORAGE

Specific attention should be given to the storage of equipment used in certain special activities. Where the gymnasium is used occasionally for mass assembly purposes and is equipped with movable or folding seating, facilities should be provided for storing these seats. The practice of stacking them around the walls or in the corridors is not conducive to good housekeeping. Physical education equipment, particularly track equipment, is usually difficult to store. Dry space should be provided for poles, for hurdles, and for other equipment used during only a part of the year. Suitable mothproof dry storage areas will be needed for football uniforms and equipment during the part of the year when they are not in use. It is usually preferable to have physical education paraphernalia in a small exercise room. If such equipment is used in the gymnasium, there should be space for storing it when not in use on the gymnasium floor.

CLASSROOM STORAGE

Classroom storage is often neglected. Many schools now have free textbooks, and some have workbooks and other materials of odd sizes which do not fit readily in bookcases. The teacher is supposed to teach good housekeeping practices as a part of her daily instruction program. Facilities for storing room supplies and equipment and pupil supplies and equipment are essential factors in good housekeeping. Where needed, there should be ample space for the storage of flat art drawings, provision for temporary storage of projects on which pupils are working, shelf or other storage for books used by all pupils, and a space where each pupil can segregate his own supplies and equipment. Wrap storage creates numerous problems. In the secondary schools where pupils move from class to class it is customary to provide wrap storage outside the class-

room, usually in lockers located in the corridors or in locker alcoves. There is no general agreement on the best method of storing wraps in elementary schools. Some teachers prefer to have them in the corridors, but perhaps the majority of the teachers prefer to have them in the classrooms. Some of the older buildings have large cloakrooms. In many cases, it is possible to remove the partition between the classroom and the cloakroom and to install some suitable in-the-room storage facilities. This usually makes it possible to increase the room size with little or no impairment of service.

SPECIAL-ROOM STORAGE

Specific attention should be given to storage facilities in special rooms and for special activities. Home economics units may be equipped with suitable storage for equipment and supplies. In addition, it is often desirable to have storage space for the partially finished garments in the clothing laboratories. In many cases, home economics laboratories are combined units. In such cases it may be desirable to provide temporary storage for some equipment not in use. The cafeteria and lunchroom services also require special storage facilities. With the introduction of the lunch program in many schools, it is a common practice to find supplies of incoming materials like potatoes piled in sacks around the kitchen or corridors. Many of the schools do not have suitable dry verminproof storage spaces for foods. Likewise many schools do not have adequate cold storage for the supplies. The same principle of special-room storage applies to various other areas. Commercial departments should provide storage for manuals and various pieces of equipment. Shops should provide adequate storage for all tools and equipment and in most cases accessible storage facilities for partially finished projects.

Many of the older buildings do not have adequate storage facilities for the pupil and school records. It is possible in most of these buildings to provide fire-safe walk-in vaults of ample size to protect all pupil and school records. If the offices are on the first floor, this may not be difficult. If the offices are above the first floor, it may be necessary to build solid supporting walls from the ground level to the vault.

ACOUSTICS

Changes in construction materials and methods, increased noise disturbances caused by the school program, and added impacts of noise from the outside make it necessary to give increased attention to the control of noise in school buildings. Some of the older buildings erected with lime mortar plaster and soft surfaces did absorb a considerable amount of sound. Newer buildings with hard floors and hard wall plaster finish fail to absorb many of these sounds. In addition changed

programs and new activities create many more noises in school buildings. Classes of school pupils lined up in regimented rows, feet firmly on the floor, chins up, facing the teacher while she imparted knowledge, created far less noise than does the modern class where some of the pupils may be conferring with other pupils, some are making things, and other pupils of the class may be engaged in various activities. The modern program also has many activities which are specifically noise-producing. This is particularly true of the shop activities, physical education, music, typing, etc. Some of these activities have been introduced into buildings not designed for them.

NEED FOR CONTROL

Sound control is a phase of school plant modernization that should receive specific attention. Sound control can be effected by location and/or treatment. By location is meant the segregation of certain noisy activities from other rooms or of certain rooms from general noises. A modernization program may include segregation by relocating certain units, such as the music classes. It may mean the segregation of the music rooms by treatments that prevent the transfer of noise through structural member or ducts and by installing sound blocks between these units and other activities. The use of certain locations within the building may make it necessary to provide positive ventilation controls in order to maintain a comfortable environment in these rooms during any part of the year without having to open windows that might permit sound to be transferred to other rooms.

It may be necessary to segregate heating fans from the ducts they serve by installing nonconducting canvas connections. It may also be necessary to replace the noisy propeller-blade unit heaters often found in shops and gymnasiums with out-of-the-room multi-blade silent flow fans.

The remodeling program may include a segregation of shops so that noises do not bother the pupils in other classrooms. The same principle of control applies to the physical education class and in reverse order to the library rooms.

SOUND ABSORPTION

In the building, treatment for sound control usually consists of applying sound-absorbing material to the ceiling and walls. In most schools today, fiber board and other absorbing materials are used, and a few schools are using acoustical plaster. The school official should understand that sound control does not necessarily mean sound deadening. It is possible so to treat a room that it has a depressing effect on the pupils. There are instances where not all of the ceilings should be covered with sound-absorbing materials, and there are other instances where the

sound-absorbing materials may be needed on the walls. Noises in corridors, toilet rooms, shower rooms, and swimming pools are often difficult to control. In the swimming pools the moisture present makes it difficult to maintain any fibrous absorbing materials. In the toilets fibrous materials may become odor-absorbing, yet the noises may become obnoxious if not controlled. School corridors are subjected to noises in varying degrees. The corridor treated to subdue the noisiest tread of class movements might be depressive when these noises were not present. The total remodeling program should give specific attention to the acoustical treatment of buildings. No school is completely modernized that does not have adequate sound control.

FURNITURE AND EQUIPMENT

Although it is frequently desirable to replace obsolete or worn equipment and furniture, it is sometimes possible to repair and renovate it for extended service. An adequate rehabilitation program may aid in preserving the utility values of school furniture and equipment for a period of years. It is essential that the school have furniture and equipment adapted to the type of program offered, to the age and size of pupils taught, and to the general needs of the school. These are some of the vital tools of education without which the children cannot do the most efficient work.

ABANDONMENT VS. REHABILITATION

There are no generally accepted criteria to determine when a piece of furniture or equipment has passed its period of usefulness and when it should be discarded. Some general principles, such as lack of safety, lack of comfort, and lack of controls that permit accurate adaptation to the instruction program work, can be applied. However, there is a wide range between efficient service and totally inefficient service. At some place in this range it will be desirable to abandon equipment that still has some usefulness. At other times it will be desirable to remodel and repair equipment.

Program and procedure changes may make it necessary to change the equipment. For instance, there was a time when home economics classes were taught in rooms set up with the equipment in a rectangular position with the pupils working on the outside of the rectangle. This was later changed to what is known as a unit type of cooking. The older types of benches were abandoned and stoves were used in place of the bench hot plates. Similar changes are found in the shops. A few shop teachers still put much of their time in a training type of activity such as making footstools. However, most shops now offer a more varied program, and different equipment is needed. The same is true with the physical edu-

education program. A number of schools now have gymnastic equipment stored somewhere in the building. With a larger amount of attention being given to free activities, the various machines, horses, etc., have been moved out of the general gymnasium areas and put into corrective rooms. Similar conditions or curricular changes have affected the program and the types of tools and equipment needed in many parts of the building. One other change that has called for a different type of equipment is in teaching methods. As the teachers abandon the regimented pupil arrangements in classrooms and develop a freer type of activity in teaching, they no longer need the fixed seating once used.

REFINISHING SCHOOL FURNITURE

It is anticipated that the local school custodians will do minor repair work on seats and equipment as the need arises. It is also anticipated that the school repair shops will make major repairs on seats and equipment insofar as possible at various times throughout the year. There is also need to give attention to a program of refinishing existing school furniture. We are giving attention today to lighting in schoolrooms. This lighting can never be made effective so long as the room surfaces are permitted to absorb too much of the light brought into the room. Many of the schools are now equipped with dark furniture, dark seats, and dark equipment which provide too much contrast between the immediate seeing task and other surfaces within the range of vision. Manufacturers indicate that it will not be possible to replace all of the existing school seating with a new type of seating for a long time.

One of the major problems in refinishing old furniture is the removal of existing finish. This finish is often of shellac and varnish. Many of the surfaces of seats and equipment are curved, hence it is not easy to remove the finish on these curves with sanders. It is not usually easy to disassemble and reassemble seats. At one time it was recommended that the old finish be taken off by a paint or varnish remover. A paint or finish remover will remove the lacquer or varnish, but will not always draw the stain out of the wood. For this purpose sanding is necessary. At one time it was recommended that seats be dipped into a strong alkaline solution to remove all paint and varnish. Since many of the seats have glued joints, there is danger that the hot alkaline solution will disintegrate the glue.

If the seat could be taken apart, the finish could be removed quickly with the use of a planer. Since the seat may not be taken apart easily, it is usually preferable to use a 3-inch belt sander. A good operator soon learns to use this sander so that he takes off the varnish and stain without leaving excessive rough spots on the desk top. For this purpose the first sanding is usually done with 1½/0 paper and the finish with 2/0 paper. The belt sander does not provide a good tool for cleaning the

curved surfaces or the edges of the seats. Cleaning these surfaces may not be vital, and it may be desirable to omit sanding them. When the seats are in use, they are not normally exposed to the direct view of the pupil. If they are not sanded, the edges of these surfaces can be finished in some opaque enamel of a light color that approximates the reflectivity of the light finish. The metal parts of the seat can be cleaned of rust and dirt and enameled as suggested above for the curved parts of the seats.

It is possible to use the methods outlined above for sanding plywood or solid piece desk or table tops. The sanding does not usually extend to the depth of the first ply. However, in either the solid board or the plywood it is necessary to be assured that the sanding does not extend below the points of the screws extending up from below. The usual sanding takes off not more than $2/32$ to $4/32$ in thickness. After this finish has been removed by sanding and the surface has been made fairly smooth, the new finish should be applied as quickly as possible; otherwise the wood may be dirtied by use or may absorb or give off moisture leading to checking. Also any parts of the stain that might have been down in the wood will be sealed in by the new finish so that they will not rise to cause a discoloration. It is desirable to surface only those units that can be refinished with the undercoater at least on the same day.

Several types of finish may be used. There have been several experiments in the use of color in the finish. In the finishing of desk tops, color has been added to overcome the variations in the appearance of the wood surface. Experimental tests seem to show that whenever sufficient stain is provided to reduce or eliminate the color variations in the wood surface so much stain has been used that the reflectivity of the surface has been materially reduced. For instance, a clear wood surface having a 40 per cent reflective factor might be reduced to 10 or 11 per cent if enough stain were added to hide the wood variations. One common practice in finishing furniture is to provide a shellac sealer coat to be followed by a synthetic varnish coat for the finish. It is possible to use clear lacquer, but lacquer is most easily applied in factories. Lacquer should not be used over old varnish. This is important where the lacquer extends over the edges of the seat or onto the surfaces which are not sanded.

SUGGESTIONS FOR FINISHING *

- (1) Determine whether pieces of furniture should be disassembled.
- (2) Examine surfaces of furniture to be renovated; determine whether surfaces can be sanded and whether some filling will be needed.
- (3) Some materials needed will be white shellac, synthetic varnish, and enamel for the wood and metal parts. Experiment will indicate the desirable amounts of each to use.
- (4) All surfaces should be cleaned and rust spots removed.

* For detailed instructions on procedure see Shaw, F. J. Suggested Method for Refinishing School desks in Light Finishes, School Business Affairs, May 1928, p. 5, 7, 8.

(5) For those surfaces that are to be renewed in natural color use a 3" belt sander with vacuum attachment. Sand parallel with the grain if possible. Use repeated light cuts and do not attempt to use the belt after it has become gummed with varnish.

(6) Brush on the undercoat of white shellac with the grain of the wood. Dry from 3 to 5 hours, sand lightly, brush on a coat of semi-gloss synthetic varnish, and permit it to dry in a clean location.

(7) Brush coat of synthetic enamel on edges and surfaces of wood parts not surfaced and also on metal parts. A second coat may be needed.

(8) Some specific materials needed will be:

3"-wide belt sander with vacuum bag

1½/0 and 2/0 paper belts and 4/0 sandpaper sheets

Bristle brushes for applying enamel, shellac, and varnish. Use small brush for edges. Note brush must be cleaned thoroughly when changing from shellac to varnish.

White shellac undercoat and synthetic varnish finish coat.

Semi-gloss light beige enamel for wood and metal having a reflection factor of from 20 to 25.

Thinners and cleaners as needed.

Furniture may be refinished in such a manner that it will provide the surface needed for a long number of years and so that it adds materially to the appearance of the room. When refinishing is done by the local staff, the costs are not excessive.

TERMITES

There are several types of termites, but the ones with which school officials are more concerned are the subterranean and the dry-wood or nonsubterranean types. The dry-wood or nonsubterranean type is found along the southern border of the United States, up the Pacific Coast near San Francisco, and up the Atlantic Coast to near Norfolk. The subterranean type is found in nearly all parts of the United States except small segments of territory near the Canadian border. Most of the termite damage in school buildings in the United States is caused by the subterranean type of termites.

The subterranean termites maintain nests or communities in the ground usually outside the building and invade the building from these outside sources. They avoid light and enter or leave the buildings through closed passages. These passage lanes may be through pieces of wood which are in contact with the ground or through tubes the termites build up the foundation walls. In a few instances termite tubes built directly from the ground might reach wood close to the ground. One important factor in the control of subterranean termites is that they do not survive in the building without access through their closed passages to the moist earth.

CONTROL

There are several means of controlling or limiting termite damage. One of these is by a type of construction that prevents termite invasion. A second is the destruction of termites that have invaded the building, and the third is preventive measures through the use of repellents.

Prevention.—One of the best methods of preventing termite invasions in new buildings is by a type of construction that eliminates or reduces the possibilities of such invasions. Buildings with concrete foundations and with concrete floor slabs deter termite invasions. However, some foundations of built-up masonry blocks or units provide ready means of access. Monolithic foundations and floor slabs may have cracks that furnish access routes for the termites. Concrete or other solid masonry foundations do not necessarily prevent termite invasions since the termites may build tubes up the foundation walls to gain access to the wood construction above. In some cases, wood forms or imbedded nailing strips or pieces of wood left under the building make it easy for the termites to develop routes into the building.

In areas where termite damage is prevalent, many owners treat the wood used in the floor and other areas next to the ground. Several types of treatment are available and in some instances it is possible to purchase wood that has been factory treated. Most of the treatments consist of a wood impregnation of chemicals which repel or retard termite infestation. Another method used to prevent invasion is that of capping or shielding foundations and piping extending from the ground upward to the main part of the building. When the foundation consists of hollow blocks or other masonry units, a solid concrete cap placed over them helps prevent the development of the entrance tubes. Metal shields extending out and downward from the tops of foundations and piers and similar shields around pipes help to prevent the development of the access tubes.

Extermination.—Some attention has been given to the destruction of termites in the building by the use of chemicals. Such methods of extermination have much more value if the chemical serves as a repellent to prevent infestation. Another method used to destroy the termites in the building is to break the entrance tubes or passageways. Unless these are rebuilt, the termites that are in the building soon die.

Entrance prevention.—One of the easiest methods of termite control is the breaking of their passageways outside the building. This might be done in at least two ways. Often the termites use an old stump or other buried wood as a home nest or community. It may be possible to locate and to destroy these through the use of sodium arsenites or a mixture of coal-tar and kerosene. In many instances, it is possible to dig trenches around the building and to treat the dirt put back in these trenches with

some chemical repellent. Several such chemicals are available. Orthodichlorobenzene and paradichlorobenzene may be used at the rate of about 10 gallons per 100 square feet. The effect of such usage may be noticed for some time. Kerosene and creosote or even carbon disulphide may be used, but the period of resistance is somewhat shorter.

It is desirable to close all cracks where termites might enter through the foundations, to destroy any tubes built up the foundation walls, to eliminate possible nests, and to break contact routes between nests and buildings.

YARDS AND PLAYGROUNDS

School sites fail to render the service for which they are intended if they do not provide a suitable setting for the building, if they do not have esthetic appeal to the patrons and pupils, and if they do not provide the play and activity areas needed by the school and community. Adaptation of existing sites to a more complete school use may involve such things as fencing to separate the site from hazardous lanes or areas. It may mean terracing for slopes too steep for play usage. It may call for filling and surfacing of parts of the site to make it usable.

SITE LAY-OUTS

Space alone is not enough for a school site. The site should be planned. The walks and driveways should be laid out in such a manner that they permit easy access to the buildings but do not obtrude upon play areas. Where possible, drives and walks should be so laid out that they do not bisect play areas. They should be so arranged that there will be a minimum of traffic competition between vehicular traffic and pedestrians coming to or leaving the building or the playground. Play areas should not be located directly in the front of the building if feasible to locate them elsewhere. The site should be so planned that a beauty spot can be maintained, preferably at the front. Driveways and walks should enter or leave street or road traffic lanes at easy angles that permit incoming vehicles to leave and outgoing vehicles to enter the street traffic lanes with a minimum of hazards. Such entrances should not be masked by walls or shrubbery. The play area should be so laid out that any desired segregation of pupils by ages or of running and free-play game areas may be effected.

Some of the older hazardous playground apparatus, such as giant strides and various types of whirling rides, should be replaced with modern equipment less conducive to pupil injury. This equipment should be so located that pupils playing on the fixed apparatus will not need to compete for play space with those engaged in free activity games. Where feasible, trees should be provided but not near enough to the building to shade the windows.

PLAYGROUND SURFACING

There seems to be no one best playground surface. One that suits best for tennis is not satisfactory for baseball or for many running games. If space were available, good sod would probably be preferable to any other surface. Where space is limited sod will not stand up under the heavy wear; consequently some other surfacing is desired.

Many experiments have been made with different surfaces. Graded creek or river gravel has been used with fair results in some areas. It is preferable to crushed rock or chat. It has rounded corners and is a little darker in color. Mixtures of sand and clay are used in some places, and as long as a proper balance is maintained they provide good playing surfaces if not too wet or too dry.

A satisfactory surfacing for school grounds must be tempered to weather conditions. In dry weather it should not lead to excessive blowing of dust and grit. In warm weather it should not run or provide free tar or asphalt that might be carried into the building. In winter it should not heave or buckle. It should not be rough enough to cause excessive abrasions when children come into contact with it. It should not sand or release quantities of grit that may be carried into the rooms on the shoes of the children.

Many schools compromise by providing one part of the playground with sod or dirt surface. This part is used for running games and for large area games. Another part is surfaced with some type of hard surfacing material to provide an all-weather court for children to play.

One of the most stable surfaces for playgrounds is concrete. The initial cost of concrete is high; but, if properly laid, maintenance costs are low. It has little resiliency and is harsh on the body and clothing of the children coming into contact with it. Like other hard surfaces, concrete should be protected against ground heaving in colder climates. This protection is usually provided by an underlayer of rock aggregate.

During recent years several types of asphalt surfacing have been tried. One of these is known as asphalt soil stabilization. The liquid asphalt is combined with the surface soil which is respread on the grounds and rolled to give a dark, compact surface. The life of the surface depends to some extent on its depth. The amount of asphalt applied determines the cohesiveness of the surface. This and other types of soil stabilization using calcium chloride or various other preparations have promise, but further experimentation is needed.

The type of asphalt surfacing most commonly used is an asphalt concrete or an asphalt preparation over a bed of crushed rock and gravel. The crushed rock and gravel provide the base and help prevent heaving. The asphalt provides some resiliency at the surface. The depth of the underbed will depend on climatic or soil conditions. Usually 4 to 12

inches are desired. During recent years there have been some attempts to overcome the dark surface of the asphalt and its tendency to stick to shoes by rolling layers of shredded cork into the surface. In a few instances sawdust has been rolled on these surfaces. The combinations for some of these preparations as used in certain cities follow:

One brief specification—⁴

The stabilized base course—soil, crushed stone, gravel, with enough clay for binder. Mix emulsified asphalt uniformly to dampen thoroughly. Emulsified asphalt should be equal to Asphalt Institute grade SS-2.

Specification	Slow setting
Designation (Asphalt Institute Grade)	SS-2
Viscosity, Fural @77° F., Sec.	20-100
Residue by distillation	55 +
Settlement 5 days	- 3
Demulsibility, 50 cc, N/10 CaCl ₂	1.0 -
Sieve Test—Ret. on 20 mesh	- 0.1
Miscibility, 2 hr.	Pass
Cement mixing, % max. tests on Residue	2.0
Penetration @77° F. 100 g., 5 sec.	40-90
Solubility in CS ₂ (Pet asphalt) %	97.5
Solubility in CS ₂ (Nat asphalt) %	95
Ash	- 2
Ductility @77° F. CM	40

Take up soil to depth of 4" and mix in mechanical mixer with emulsified asphalt (not less than 3% of the total dry weight of the base materials). If necessary, reinforce soil with gravel, stone, and clay, or rock dust to give tight bond and dense base. At least 90% should pass 1½", 35-65% a ¾", and 15% a no. 200 screen. ASTM screening scale. Asphalt cement 15% of the amount passing 200 screen. Add enough water to make workable mix—spread to a loose depth of 4" to establish levels—then settle and roll with a 3-ton roller.

The leveling course is applied after base is dry. It consists of gravel, crushed rock, sand, and stone dust graded as follows:

<i>Sieve size</i>	<i>Percent passing</i>
¾"	90-100
½"	80-100
¼"	60-85
#10	40-55
#40	15-35
#80	10-20
#200	3-8

8 to 9% emulsified asphalt add and mix. First, place primer coat equal parts emulsified asphalt and water ¼ gal. to sq. yd. on base. Then apply finishing leveling course 1" and roll.

⁴ Schotland, Joseph H. *School Business Affairs*, December 1947, p. 1-3.

CORK SURFACING

On top of leveling course use mixture equal parts emulsified asphalt and water $\frac{1}{2}$ gal. per sq. yd. Blot (or cover) immediately with equal parts of sand and ground cork about $\frac{1}{2}$ lb. per sq. yd. Cork free of dust and grade:

<i>Sieve size</i>	<i>Percent passing</i>
#10	85-100
#20	30-34
#35	0-5
#80	0

Make second application of the cork and emulsified asphalt and roll so that average thickness is $\frac{1}{8}$ ".

Stands up well—but may need new applications of cork in heavy traffic lanes.

MISCELLANEOUS REHABILITATION**WINDOWS, DOORS**

In most instances the improvement of windows and doors is a matter of rehabilitation or repair rather than one of modernization. In many of the older buildings the windows are loose, in some cases there is a lack of adequate control, glass has been inserted without being back-puttied, and there is a lack of caulking. Many windows fail to provide the amount of natural illumination desired, but it is not always easy to change the structural openings of the building. Many old windows should be replaced. In some instances new window stools are needed. Masonry stools that are not properly pointed should be pointed or coated. Openings around windows and doors should be flashed and/or caulked. Wood sash may need to be weather-stripped. Fiber weather-stripping can be placed around a window, but the metal weather-stripping which is fastened to the window casing and which fits into grooves in the sash is preferable. It is best to have this applied by a skilled workman. Classroom doors and exit doors glazed with common glass at any point as low as shoulder height to the pupils may become hazardous, and it is usually preferable to glaze these doors with wired glass or with safety glass similar to that used in automobiles.

INSULATING BUILDINGS

Attention should be given to the insulation of existing buildings. It is easy to provide insulation when new buildings are being erected. Insulating material can be put on the roof slab before final roofing is laid. Air spaces, insulating blankets, and other means of controlling

rapid heat loss can be provided at the time the building is erected. It is not always easy to provide this insulation after the building is erected. Roof insulation can be applied only at the time when new roofing is applied. It is possible to provide fiber board surfacing for walls and ceilings that retard heat loss. It is also possible to use some type of a blanket insulating material in attics. The purposes of weather stripping and insulation are to prevent rapid and uncontrolled infiltration of cold air and rapid exfiltration of warm air without desirable controls. It is necessary to introduce some outside air into the classrooms. It is better to do this through controlled openings than to expect to accomplish it through numerous small openings or through walls where the infiltration cannot be controlled.

BUILDING HARDWARE

Proper maintenance of building hardware is often neglected. In many cases care involves only proper adjustment, but in other cases it means a complete change of hardware. Classroom doors having deadbolts making it possible to lock them against egress should be fitted with a type of hardware that cannot be so locked. Door checks and closers should be so adjusted that the doors are not permitted to slam, but that closing action is positive. Bracket-supported checks may need to be reset since they often pull loose. Exit doors should be fitted with panic bolt exit devices. They should be positive in action and should never be locked against egress. Storage closet doors should be fitted with thumb or spring latches to permit easy opening. Door pulls may be needed on doors. The locks to all buildings in a school system should be keyed so as to reduce to a minimum the number of master keys necessary. During recent years the introduction of removable lock cylinders has made it possible to adjust the locks and the keying.

PAINTING AND DECORATION

It is not possible to differentiate clearly between painting and decoration which should be considered a part of regular maintenance and the complete renovation of a building. In numerous cases previous neglect has permitted the buildings to become drab, unattractive, and not conducive to good school work. In such cases perhaps a complete redecoration should be considered as a part of a rehabilitation program.

The appearance of the building is an important factor in school morale, in pupil attitudes, and in public appreciation of the school. In addition painting and redecoration play important parts in the preservation of property values. The slogans of some paint companies, such as "save the surface and save all," are applicable to parts of school buildings.

Painting programs should be set up on a schedule so that repainting

of various areas shall be undertaken at regular intervals as a part of the maintenance program. Climatic and weather conditions will affect the desirable frequency of repainting: In some areas where smoke fumes are heavy or where there is an excessive amount of deterioration from salt spray or blowing sand, exterior or interior paint surfaces may survive for shorter periods of time.

In a complete redecoration program attention should be given to the painting of both exteriors and interiors. Exterior painting is generally limited to exposed wood or metal work. However, some schools have formed the practice of painting masonry. This has not been wholly successful. Paint peels from most masonry, particularly from brick, and the resulting surfaces partly painted and partly bare are perhaps less attractive than the original walls before painting. Painting on stucco and certain concrete surfaces has been more enduring. Interior painting usually applies to all of the wall and ceiling surfaces. Some school boards have attempted to paint masonry floors, but the results have not been wholly satisfactory. The paint usually wears off in traffic lanes and the floors are unsightly unless repainted frequently. During recent years there have been several attempts to develop a type of floor paint that would stand up under wear on concrete floors. Some have been more successful than others, but in most cases the impacts from heels and the grit cut the paint surface from the floor.

It is not desirable in this summary to discuss methods of preparing surfaces for painting or methods of painting. It is also undesirable to attempt to outline here the types of paint that are to be applied to schoolrooms or the colors that are preferred. The following paragraphs will give some indication of some color painting principles that should be observed for safety reasons. They will also point out briefly some of the factors to be considered in selecting paint.

Color in schools has peculiar properties. It serves as a constant reminder and speaks louder than words. It speaks a universal language. It may have a soothing effect, serve as an irritant, scream of danger, have a stimulating effect, or indicate safe conditions. Color is the partner of light and an important factor in comfort. It also serves as a marker of safety or danger.

The following general safety color schemes are generally accepted:

- Red to denote fire hazards or fire fighting equipment, such as sprinklers, fire alarm boxes, fire pails, or equipment.
- Green signifies safety—go ahead.
- Orange for alert, danger of equipment.
- White serves as a traffic line, a guide.
- Yellow (with its high visibility) to warn of danger from stumbling, falling, or striking—usually with alternate bands of a dark color.
- Blue, precaution, used for switch boxes, levers.

The previous suggestions on color do not justify the use of a riot of color. It is possible to overstimulate with color. The color scheme should be practical. It should be understood that red and yellow are termed the warm colors, and blue and green the cool colors. Spotlight buff or spotlight green are sometimes used to highlight parts of machines. Various combinations are used to highlight or stress elevation changes, stairways, or obstructions.

WINDOW SHADING

The total building redecoration and renovation program should include numerous other factors and surfaces in the building. Stringy or dark unattractive window blinds should be replaced. A majority of the older blinds are too dark in color and too heavy in weight. Some of the venetian blinds in use are barriers to instead of diffusers of lighting. Some of the window shades are top hung and cut out a major part of the light that might come through the upper part of the window. In most school-rooms light-weight light-colored translucent window shades should be installed. In many classrooms with double-hung sash these shades should be double-hung near the center of the window and should overlap or be shielded to prevent entrances of a streak of light between them. Dark shades may be needed in certain rooms. If they are installed they should be so planned that they can be fully retired and so that no dark surface will be exposed to the pupils in the room when they are retired. Heavy duck or dark shades for regular classroom use should not be tolerated.

CHALKBOARDS

This total renovation program will also require some change in blackboard areas. In all cases the dark light-absorbing boards should be replaced as rapidly as feasible. New boards light green or yellow now available give a reflection factor of from 20 to 30 per cent. It is realized that all schools may not be able to replace their blackboards immediately. Several companies are now experimenting with a light green surfacing material which is put on with a brush like paint. Some of these seem to offer promise of fair durability and have acceptable light-reflecting qualities. If these new surfacing materials prove feasible all schools can reduce the amount of light-absorbing chalkboard surfaces.

MISCELLANEOUS

Various other minor repairs will be necessary as a part of the renovation program. It is not feasible to attempt to outline here all of these repairs. It is desirable that the local officials go over their buildings thoroughly to determine what sash should be replaced before painting, whether new doors are needed, whether certain doors or windows would be damaged immediately by leaks that should be repaired before the

painting program is attempted. It may also be necessary to make corrections in the heating plant to prevent the discharge of quantities of smoke into the building. It is particularly desirable that measures be taken to eliminate much of the mud and dirt that is carried into the buildings by pupils and which contributes to the deterioration of painted surfaces and to unattractiveness in the school building.

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