A STUDY OF BUILDING MATERIALS AND PROCESSES AND THEIR
INFLUENCE ON THE DESIGN AND CONSTRUCTION
OF CONTEMPORARY SMALL HOMES

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A STUDY OF BUILDING MATERIALS AND PROCESSES AND THEIR INFLUENCE ON THE DESIGN AND CONSTRUCTION OF CONTEMPORARY SMALL HOMES

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By

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CHAPTER I

INTRODUCTION

From the time of the very first colonies in the new world until the present date, Americans have depended on the forest for their shelter. The stockades which enclosed the settlement and those which protected the more remote outpost against the hostilities of the red man were built of the long straight timbers of the lofty trees which had stood on the very land that had been cleared for the fort.

The log cabin is a symbol of the rugged freedom in which the early colonist lived. It may have been inside or near the stockade, or it may have been a lonely cabin in the edge of a clearing deep in the wilderness and miles from any settlement, but regardless of its location the log cabin held to the same general characteristics. The walls were of hewn logs, the roof was of split wood shingles, and the floor was likely to have been dirt, or in the more extravagant cases, it too may have been of hewn logs called a puncheon floor. Even the interior, probably, was furnished with split log furniture. This was certainly a simple structure and not at all graceful, yet to the man who built it, the cabin was home and it was his. To our interest note that it was built with almost no other materials than wood.
Since timber was in great abundance and the demand for building materials increased with the building of the nation, it was then a natural thing for the lumber industry to develop into one of America's greatest industries. The manufacturing of lumber, first by hewing and then by sawing, was the first major industry established in what is now the United States. In accordance with the best historical reports, the first commercial sawmill in the United States was constructed at South Berwick, Maine in the year 1631. It is believed that a sawmill was erected at Jamestown, Virginia, as early as 1607. At least Captain Newport reported carrying "pitch, tarre, clapboard and waynscot" from Virginia to England in 1608.1

From the time when lumber was first produced in the new world and as a result of the fact that it was easily obtainable, a new process of building homes entirely of wood was originated. No longer was stone or brick used in the majority of the houses for the supporting walls, as had been the practice in some of the old countries to this time; instead, the English method of strong but light wood framing became a common building practice.

Since this beginning in our country, few changes have been made in the basic structural design of houses until recently. The outward design of our conventional homes has lasted for almost two centuries with only minor modifications such as the introduction of electricity and sewerage. People

1Nelson Courtlandt Brown, Forest Products, Their Manufacture and Use, p. 2.
have learned to admire the coziness of a Cape Cod house, the simple elegance of a Georgian house, the romance of the Spanish Villa, or the gracious dignity of a Southern Colonial house. They see in these styles that particular home of their dreams, or at least so they think, before giving much thought to the purpose a home should serve and the many disadvantages of a style designed for another era. Architects have had little worry and few problems in designing these definitely set styles with the construction methods remaining basically the same. As late as 1920 lumber sizes were not standardized throughout the United States. Through the efforts of the Forest Products Laboratory, a part of the United States Forest Service, architects now have standardized sizes of lumber from which they can make accurate details of the construction for any location.  

Statement of Problem

The problem of this study is to examine the methods and products developed for contemporary construction and to establish how they have affected the design of our present day small homes. During the past decade, with the industrial era in full swing and the great abundance of timber rapidly becoming exhausted, new products and synthetic materials have been introduced into the building trades. These materials have affected the design of our modern homes, even the structural design. Perhaps these materials have had as much influence

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2Adnah Clifton Newell, Wood and Lumber, p. 198.
in this change in design as our philosophy has changed our way of living, and our way of living has demanded a new arrangement of old utilities. With this vast amount of materials and procedures invading the business of building, especially since World War II, it is essential that those interested in designing or constructing a residence be acquainted with these products. The architect or builder needs to understand the new value of new products and materials in order that he might know their importance and practicability. This knowledge will enable him to determine their use and place in modern structure and design. In the past, architects had only to redraw the things which had already been designed. Today, the imagination of the designer is challenged by new methods of construction as well as new principles or ideas in planning and arrangement in connection with new products and modern, practical, conveniences. As the public has become enlightened about these new things, the architect has been obligated to change his drawing to meet the demands of his clients for these new products, and to conform with the structure, size, and range of these new materials.

**Purpose of Study**

The purpose of this study is to make an investigation of the most common new building materials and to determine how their uses are changing the design of modern small home architecture. To do this, the materials brought into production or in some way developed by manufacturers, have been divided into
chapters according to their place and purpose in the structure of a small home. The first chapter is the introduction of this study; however, the latter part of Chapter I describes, in short, the historical background of American building and architecture. Chapter II is concerned with the structural improvements of frame houses and covers termite and decay control preparations and notes the recent use of structural steel in dwellings. Recent developments in brick, concrete, and stone masonry construction, including the common practice of building brick and stone veneers today, is the subject of Chapter III. The exterior covering of siding and roofing for a frame-built house is the subject of Chapter IV. Chapter V takes up the interior finishing materials, wall and floor coverings, and prefabricated closets. These are presented and discussed in Chapter VI. Chapter VII gives the conclusions determined by the findings of this study. These conclusions will be concerned with how materials and processes developed by and for the building industry have changed the design of small homes.

Delimitations of Study

The study was limited to those products of the more prominent and more widely advertised companies, and those products of the smaller companies which have caused the greatest change in the designing of small houses. It is evident that with so many new building products available from both the large, nationally advertised companies, and the small local enterprises it would be almost an impossibility to name and comment
on each specific one. To list each new item would be impractical, for many are similar in design and purpose, and it would only necessitate the repeated description of the same or like devices.

The study was further confined to that choice of materials suitable for use in the building of dwellings in Texas and its adjoining states, since other sections of the country would require different building methods and consequently other building materials. For example, in Northern United States and Canada, where severe winters are prevalent, a house must have a roof to withstand a great weight of ice and snow in winter and to serve almost the opposite purpose from those found in the hot, dry climate of the Southwest.

Trade names will be used where the one company is the sole producer of the particular kind of product, but in the event several companies produce an identical product to be used for the same purpose, the technical name of the material will be used.

Source of Data

The data for the study were received from periodicals, professional literature, pamphlets, and other informational material printed by the representative companies, and direct correspondence with informed persons.

Definition of Terms

"Recent" is defined as being of late date.
"Small home" refers to the average American two- or three-bedroom home.

"Framed dwelling" consists of a frame or skeleton of light timbers (usually 2" x 4" material) on which the interior and exterior skins are attached.

"Solid brick" construction is a type of construction where both interior and exterior walls are built of solid brick.

"Brick and stone veneer" is a type of construction where the brick or stone form only the hull or skin of an ordinary framed dwelling. (A house of this construction is often mistakenly referred to as a brick house.)

"Building materials" are all materials used in building construction.

"Design" is the deliberate ordering or planning of space, matter or activity for a given purpose. 3

"Detail" refers to the construction method.

"Modern home design" is a method of design which disregards any formal period design and allows the design to grow out of the practical arrangement of the materials for the climate, location and the people it is to serve.

"Field Stone" is any stone which may be picked up on the surface of the earth or in the beds of creeks. In Texas the colors range from dark rusty brown to light cream.

"Building Stone" is referred to as a better grade of rock than field stone. It is quarried and usually cut into sizes

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suitable for building purposes. The colors vary in shades of light gray and cream.

"Ceramic" refers to those building products made of fired clay.

**Historical Background of American Architecture**

To approach a study of our modern building methods and materials without first glancing at the glorious grandeur of our American architectural history would be an unjust omission. One only has to stand within the walls of one of the extravagant Southern mansions to sense a bit of the romantic life of which they were the center a hundred years ago. The earlier colonist's home, however, was not so filled with comfort, charm, and elegance. The first dwellings of the pilgrims were far from being masterpieces of architecture. They were not even as good a shelter, in many cases, as the traditionally accepted log cabin which has been credited to them by popular, but mistaken, belief. Therefore, it should be proper at this time to fix the type of house or shelter the early colonist built on this continent.

Contrary to popular belief, the Swedes were the only immigrants who built log cabins for dwellings in the new world until after 1700. The log cabin in America was of Scandinavian and German origin, and did not spread much beyond the Delaware Bay until after 1718. This is brought out by Harold R. Shurtleff in his book, *The Log Cabin Myth*. 
The familiar log cabin of Andrew Jackson and Abraham Lincoln, a common type of dwelling construction in Scandinavia, Russia, Switzerland, and part of Germany for centuries past, was brought to the New World by the first Scandinavian immigrants in 1638 and, independently, by the Germans about 1710. Admiringly adapted as this type was to American conditions, the log cabin did not commend itself to the English colonists; the Scotch-Irish who began coming over in large numbers after 1716 seem to have been the first English speaking race to adopt it. From and through the Germans and Scotch-Irish it spread rapidly through the English Colonies, and by the American Revolution had become the typical American frontier dwelling from Maine to Tennessee.4

The colonists' first permanent houses reflected the varied backgrounds from which they came. This tendency to copy details of their homeland is described in an exhibition by the National Gallery of Art.

For like all colonists, they built what they best remembered, changing their methods only as changes in climate and materials demanded. The middle class Englishman in the north copied the heavy framed houses of English towns, continuing to develop the overhanging upper stories which had given added room in crowded towns but which were hardly necessary in the New World wilderness. Since wood was plentiful and the climate extreme, they soon added a covering of clapboards for extra insulation against heat and cold. Further south, formal Jacobean manor houses appeared on the great feudal estates. Much of the building around New York was to retain a Dutch flavor long after English rule intervened in 1664.5

The French who settled along the Mississippi River in the Louisiana Territory founded New Orleans in 1717 and introduced their own architecture which is still outstanding today. In Florida and the Southwest, the Spaniard added designs and details derived from his homeland to the flat-roofed adobe

5 National Gallery of Art, Houses U. S. A. 1607-1946. (exhibition)
houses of Mexico's Indians. The method of building used by the Spaniards was the first and only instance where the native Indian's method of building was used as a pattern for construction by the invading immigrants.

With the rapid growth of the colonies along the east coast after 1700, the log cabin became the typical home used by forest dwellers and pioneers. There were two common types: (1) the round-log house where the ends of the logs protrude past the corners of the building, (2) the "garrison" or "blockhouse" distinguished by the logs being squared and fitted together at the corners with dovetail joints, then trimmed flush with the wall. It may seem strange that such an adapted type of construction for location along the timbered region of the eastern seaboard did not spread far beyond New Sweden on Delaware Bay until well into the eighteenth century. However, if we consider that log building was a type of construction entirely foreign and unknown to the English, then it is easy to understand why they followed their own structural practices. It is likely they did not bring any plans with them, but it would be logical to assume that they would build what they remembered best.

The English type of building was a heavy-framed construction. Even as crude and inexact as their structures were, their method of building was unquestionably the forerunner of our wood-framed systems of today. Beginning with these combined types of houses and methods of building, they arrived
at a solution which was all their own. Albert Farwell Bemis describes the development of the American house thus:

A style of house developed which was wholly American. The chimney was the dominant factor. New England has a rigorous winter and it was to be expected that the fundamental center of the house should be, even more than in England, the hearth. No one, who has ever seen an old colonial fireplace, can have failed to be struck by its magnitude and strength and by the impression that it was the focus of domestic activity. Thus the houses were planned around the chimneys; and, since it was desirable so far as possible for every room to have a fire, we find one central chimney or two large chimneys, one at each end of the building.6

The importance of the fireplace in the design of the log cabin is evident in that it provided a simple method by which a pioneer, of the most remote location, could build a fairly efficient contrivance to harness fire for both heating and cooking. In the larger, more elaborate houses, the fire place was of no less importance. Though it was not always used for cooking purposes, the fireplace was necessary for heating each room and thereby became the center around which a plan was developed. This may have been an important factor in the evolution of the formal balance so predominant in colonial architecture.

The development of the later colonial architecture was perhaps influenced more by the English than anyone else, since they were the predominant people in the North American colonies after 1700. Their type of construction spread along the entire coast and became the basis for the wooden structures which prevailed in the country for the next two centuries.

"It was the frame that distinguished the 'fair,' 'framed,' or 'English' house in fact, and in name from other forms of building construction." The skeleton of a timbered frame consisted of sills, posts, studs, plates, girders, joists, rafters, beams, and braces much like our frame houses of today except the English used much heavier timbers. The intervals between the posts and studs were then filled in with brick or with clay stiffened by sticks. This method of constructing a wall soon proved to be unsuited to the New England climate. The extreme and abrupt weather conditions caused rapid expansion and contraction in the masonry which produced cracks and lowered the insulation efficiency of the wall. This problem was overcome by the introduction of two relatively impervious skins—the plaster interior and the clapboard exterior. Eventually the brick disappeared altogether and there resulted a new and characteristically American system of wood construction. It was discovered, however, that weatherboarded walls would retain heat much better if they were filled in with an insulating material, usually grass, just as today we pump our walls full of rockwool. Thus, the New Englanders developed the wood-framed, clapboard-sheated structure which is today called "Cape Cod."

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7Sturleff, op. cit., p. 19.  
8Ibid., p. 19.  
9James Marston Fitch, American Building, p. 7.  
When trade was increased with Europe after the Peace of Utrecht in 1713, more and more settlers arrived and cities along the northern seaboard flourished. The demand for appropriate residences by the wealthy northern merchants and southern planters, together with the arrival of trained craftsmen and an increasing number of English books on architectural design and practice, resulted in many formal mansions. In many cases the owner acted as co-designer, "for some knowledge of Architecture was a part of every 'gentleman's' education."\(^{11}\)

As time passed, in Virginia and the Carolinas, the ceiling heights were raised and the windows increased in size in an effort to make the houses more comfortable during the hot, sultry, summer weather. "Here, too, we see the beginning of another American invention—one might almost say institution—the porch. This grew steadily in size and importance until it became the dominant aspect of upper-class residential structures."\(^{12}\) The veranda, as it was called in the South, became fashionable in Charleston and was designed with Georgian details. In New Orleans the balconies and arcades were ornamented with masonry and elaborate iron work of French and Spanish origin. These styles were ultimately to meet in the reactionary ostentation of ante-bellum plantation houses, with their slave-powered, peacock-feathered punkahs,

\(^{11}\) National Gallery of Art, \textit{op. cit.}, (exhibition).

\(^{12}\) Fitch., \textit{op. cit.}, p. 13.
twenty-foot ceilings, and continuous many-storied galleries.\textsuperscript{13}

From the colorful pre-Civil War days of the frock-tailed coats, top hats, and hoop skirts, when the South was strong, beautiful, and unbroken, until today's modern, hurried life, people have loved the charm and distinction of the southern mansion. Its pageantry is so embedded within us that today people still insist on copying these manor houses in a futile effort to capture some of the romantic grace and prestige they held years ago. If a thing is once beautiful, it is beautiful in any age, but through changes in custom and the introduction of new conveniences, it may, and often does become impractical.

Spanish influence on architecture had spread over all of Mexico and had become the theme of building in the Southwest by the time of the battle of San Jacinto. The Spanish ranch house with its open patio and low flat roof, like the adobe house from which it evolved, fitted well into the surrounding live-oak and mesquite country. Even today in Texas and the Southwest this traditional architecture lingers wherever cattle form the way of life.

As the nation swept westward it left in its wake the sod house found in the flat plains of the Middle West. With little timber and no means by which to produce it, the people built with the materials they had at hand—namely, dirt. The result

\textsuperscript{13}Ibid.
was the sod house, some of which are still standing today and in some cases still in use. A sod house is built of bluegrass turf turned up in the low flat land between hills with a twelve or fourteen-inch breaking plow. The sod is not fired, rather it is laid in place as it is plowed up, and the wall is trimmed until smooth after it is built. Turfs are about four inches thick and as wide as the plow will cut. The walls are double this width in thickness, thus, sod cut with a twelve-inch plow will produce a wall two feet thick. It is easy to understand how a house of this type would be, as is the thickwalled adobe house of the Southwest, well insulated against heat or cold. Blue-grass sod is specified because of its enormous mass of roots which hold the sod together and make it durable. In most cases, the outside of the house is left natural and exposed to the weather, while the inside may be plastered. Some houses have been plastered on the exterior surface to prevent deterioration.\textsuperscript{14}

California developed in the era of the gay nineties when the scroll and turned work of the "gingerbread" houses were in vogue. Later the Indian Bungalow was to come into popularity and has set the pace until the last decade.

Contemporary architects such as Frank Lloyd Wright, Carl S. Koch, Jr., John Funk and Marcel Breuer have been responsible for a new design for building called Modern Architecture.

\textsuperscript{14}Letter from Mrs. Rudolph Mohr, Gordon, Nebraska, July 8, 1949.
"Within the last twenty years an authentic new architecture has taken root in many countries." Architecture is an art. Science can guarantee the durability of a building but only the creative imagination of the architect can endow it with beauty. In modern architecture, beauty is derived from related forms of the structural materials. These may be either new materials or old materials used in new and ingenious ways. Through this process of design with a purpose, building becomes modern architecture.

CHAPTER II

PROCESSES AND MATERIALS THAT HAVE BEEN DEVELOPED
WHICH AFFECT THE STRUCTURE OF SMALL FRAME DWELLINGS

Insect and Fungi Control

It has been said that America was built on a frame of wood. Certainly wood is still the chosen material for small homes in America as it was in many of our architectural museum pieces. Although wood has always been the popular building material, in some of the more humid regions brick and stone were soon found to be the more practical building material for the great plantation manor houses. This was especially true in New Orleans and along the South Atlantic and Gulf Coast. The reason for the preference of brick and stone was that wood soon decayed or was destroyed by termites after continuous exposure to dampness. Even the durability of cypress succumbed to the severe climatic conditions. Brick and stone construction required skilled masons, and skilled labor was, as it is today, above the average home builder's reach. Therefore, the people in general continued to build with wood which would ultimately be destroyed.

In view of this serious problem, companies for years have diligently worked to produce a preservative to conquer the two arch enemies of wood—the termite, a small ant-like insect, and fungus, a microscopic form of plant life. Both are
extremely destructive, and although the battle against them is widening, they are still a great destroyer of wooden structures.

An illustration of the destruction caused by termites is given in a pamphlet by Donald K. Plummer:

Authorities on wood and its conservation say that while all sections of the country are infested by termites, they are particularly destructive in the South Atlantic and Gulf States, in the Southwest along the Pacific Coast. One investigator estimates that they cause a $40,000,000 loss in wood deterioration annually in the United States.¹

An interesting fact to note in relation to the termite's diet of wood is found in the same pamphlet. The author says, "while they live on the cellulose and lignin that goes to make up the actual wood substance, they cannot utilize their food directly. They are dependent on swarms of intestinal protozoa to digest it and break it down into sugars."²

Because of the termites' isolated condition, application of control measures are extremely difficult, especially when extermination is attempted by means of poison dusts and gases. Therefore, some method of prevention, rather than an extermination procedure must be used to control these destructive invaders. When it was realized that termites thrive in dark damp conditions and tended to avoid open air and sunlight, they began to build their houses with the floors raised well off the ground leaving the space underneath open so air could

¹Donald K. Plummer, Life Insurance For Lumber, pp. 2-3.
²Ibid., p. 4.
circulate freely. This practice discouraged the termite but provided a heating problem during the cold winter months. As solid wall foundations became a common practice, ventilation and light were reduced, and other steps had to be taken. The preventive measure which was to evolve is still used, as well as required by the Federal Housing Administration. To combat the termite a sheet-metal barrier was placed between the foundation and the wooden framing members of the structure with the inward edge overhanging two inches from the foundation wall and bent down at forty-five degrees an additional two inches. In theory the termites could never build a tunnel around this type of barrier, which was continuous around the entire foundation and on each pier and pipe underneath the house. But this method of termite control is not entirely foolproof. The fact that the termite can build his passage even without any other support would bear this out. Therefore, the other logical method to try would be to impregnate the lumber with some sort of chemical preparation which would be poisonous, or at least offensive, to these insects so that they would not even attempt to enter the treated members.

Though much has been written about the termite and his destructive power has been widely publicized, of equal or even greater significance, however, are the activities of the micro-organisms causing rot and decay in wood. This wood-destroying fungi start with one-cell plant bodies called

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4 Federal Housing Administration, Minimum Property Requirements: 1946, Form No. 2222, Sect. 409-B.
spores, which seem to be present everywhere in the atmosphere and easily get into the cracks, checks, or other openings in the wood. There the spores germinate under warm and humid conditions sending out threadlike substances that feed on the wood. The result is disintegration of the wood which can be noted by changes in color, and in late stages of rot or decay the wood becomes punky and crumbly.5

Railway, highway, telephone, and power line companies have long used creosote as a preservative for their timber and poles, but it is evident that its objectionable pungent odor would make it unsuited for use in residential construction. In regard to this need, chemical companies have been searching for a suitable and economical way to produce a process by which lumber can be made resistant not only to termites and fungi, but to water and fire as well. There are now chemicals which insure lumber, which has been properly processed, against either one of the destructive elements, but no one process is a "cure all."

A number of preservatives have been introduced, allegedly equal in their result, but slightly different in their processes and composition. For protection against decay and termites a number of processes are in use, all of which are claimed to be clean, odorless, and paintable. The only noticeable change is that the wood has a slightly darker color than it had originally. The most common procedure is to dip the

5Plummer, op. cit., p. 4.
lumber into a vat of cold or hot solution designed to ward off any attack of either termites or wood destroying fungi. The lumber is merely submerged in an open tank of solution for a minimum of five minutes (cold solution) for each inch it is in thickness; the time limit would vary, naturally, with different types of wood as one would absorb the solution more quickly than others. All lumber to be treated must be air seasoned or kiln dried to below twenty per cent moisture content. In general, the cold open tank method is the most practical and least expensive process as ordinary lumber may be treated on the job, and the results are successful under ordinary conditions. However, wood which will be subject to severe conditions should be treated by the hot and cold open-tank method. This process is accomplished by first dipping the lumber into a hot or boiling solution then submerging it in a cold solution. As in the first method the length of treatment depends on the type of wood and its thickness, but the heated solution penetrates much deeper and more rapidly into the wood.

A third method of vacuum and pressure treatment is recommended by manufacturing companies for maximum penetration and best results where extremely severe conditions exist. The pressure drives the chemical deep into the heart of the largest timbers making them suitable for bridges, docks, and other structures exposed to the most adverse situations. Although this method would seem to be the best, it would probably be spending unnecessary precautions in the practice of building average residential structures.
Different companies use different chemicals for preserving wood against decay and termites. Pentachlorophenol is used by The Dow Chemical Company, while E. I. Du Pont De Nemours & Company and the Protexol Corporation used chromated zinc chloride, and the American Lumber and Treating Company have developed their own product under the trade name "Wolamn Salts." Many companies sell the treated lumber directly out of stock, but in most cases it is considerably cheaper to do the processing right on the job and using local lumber that can be bought at a much lower price.

The great worth of this improvement is not too evident in any changes in the architectural design of small homes. However, the fact that insect and fungi resistant wood may be used close to the ground on low continuous foundations has allowed houses to be built almost at grade level without any great danger of decay or termite infestation. No longer are high front steps and open pier foundations necessary; even on houses without basements. Instead the houses of today may be built snugly to the ground with neat continuous brick, stone, or concrete foundations at a saving of materials and heating cost.

Water-Repellent and Fire-Resistant Preparations

In addition to the chemicals developed to fight decay and termites, other chemicals have been found, and treated

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6 Sweets Catalog Service, Sweets File—Architectural, Sect. 5 d/1-5 d/7.
wood materials have been placed on the market by the majority of chemical companies, which are successful in making lumber water repellent and fire resistant. A description of this procedure and why it is effective is given in a pamphlet by the Protextol Corporation.

Fire-retardant wood is chemically impregnated wood rendered permanently incapable of supporting combustion. When heat is applied to fire-retardant wood, it begins to decompose the injected chemicals into non-poisonous gases which are non-combustible and which serve to prevent the oxygen of the air from gaining access to the wood which is being heated. Hence, combustion is inhibited.

The process of impregnation is essentially the same as that followed in other pressure processes of wood preservation. The wood is sealed in large cylinders and the chemical solution is forced into the wood by a vacuum which has been drawn under high pressure.

Although this fire proofing procedure requires heavy and expensive equipment, the lumber products cost little more. An increase of only two and one half to four percent to the building cost is claimed by the different companies. Lower insurance rates alone are very likely to repay this additional cost, but there are other advantages of fire-retardant lumber. It has acoustical and insulating properties and provides an excellent base for paints and finishes, while its better nail-holding power keeps floors tight. Most companies maintain that processed lumber has definite moisture resistant qualities which

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tend to protect it against swelling, warping, and shrinking even when placed in a humidor for weeks.

This scientific development of preserving wood by a process designed to make all wooden structures resistant to the destroying elements of fire, decay, and insects has been no doubt one of the greatest advancements for wooden building construction. Homes of wood may be built in locations previously regarded as unsuitable because of climate and regional conditions. It has paved the way for more permanent wooden structures, thus making for more economical building and at the same time boosting the rank of wood in the structural world.

Laminated Wood Framing

With great progress in fire proofing and preserving wood being made by lumber and allied industries in cooperation with the United States Forest Service and Forest Products Laboratory, another great product of wood has been introduced into construction. Laminated wood structural members have made their appearance as a successful and economical framing for use where great spans are necessary. The glued laminated wood arch has been used in Europe for over a third of a century. In America a stronger and more durable arch was made possible by the use of metal timber connections and strong durable water-resistant glues. In their advertising section found in Sweet's File, the Rilco Laminated Products, Inc. give the
comparative strength of ordinary bolted joints to those using split ring connectors.

The application of metal connectors effects the utilization of as much as 80 percent of the working strength of the wood. The safe lead on a ½ in. bolt in a 3 member joint (Douglas Fir lumber) is only 830 lbs. This joint using two, 2 ½ in. split ring connectors is good for 4750 lbs. Metal connectors are used at all joints, trusses and for anchoring arches and rafters. 8

An advantage of lamination is that it offers four times the strength of nailed lamination. One of the seemingly strange things of laminated wood trusses at least four by four inches will resist fire as well as exposed steel trusses, and a six by six inch wood truss will be superior to exposed steel trusses.

Laminated wood arches have opened up an entirely new field for timber in the construction industry and they can be patterned to conform to architectural design. Their purpose is for spanning great distances without objectionable central supporting members. Although they were not ordinarily designed for use in the construction of homes, it is only just that they be mentioned for their great contribution to the construction of churches, dining halls, aircraft hangers, warehouses, gymnasiums, and even bridges. 9

Steel Residential Construction

While the lumber industries were concerned with the problem of making wood a satisfactory permanent building material,


9Sweet's Catalog Service, op. cit., Sect. 3 b/7-3 b/11.
the Great Lakes Steel Corporation was busy working out a prac-
tical, usable method of adapting steel to the light framing
construction of residential buildings. The product they devel-
oped to replace the joist, stud and framing in general is
called "Stran-Steel." The patented characteristic that pro-
vides a way for ordinary materials to be nailed to the steel
structure is explained in a pamphlet published by the Great
Lakes Steel Corporation.

The distinctive feature of Stran-Steel is the "nailing
groove"—and exclusive Stran-Steel patent. Because of
it, fire-safe, economical and permanent steel construction
can now be applied to dwelling units and other types of
light-occupancy structures. The nailing groove is found
in all Stran-Steel joists and studs, which are made by
welding two pieces of specially formed steel together. In
the case of the stud, for example, two channel sections,
specially formed, are welded back to back, as shown in the
accompanying illustration. The small space remaining
between these pieces is just large enough to admit an
ordinary nail. Driven in this groove, the nail is curved
to the profile of the specially formed channels, and
clinched in a grip of steel, utilizing to the utmost a
holding power that cannot be duplicated with any other
type of building material. In this manner collateral mate-
rials are attached directly to the steel framework by ordi-
nary hammer-and-nail method.  

The producers of Stran-Steel list a great number of advan-
tages for their product. The greatest of these perhaps is
that steel is fungus, termite, and fire proof, thus making it
a definite competitive rival to untreated wood. Because of
its inability to absorb moisture it is protected against war-
ping, twisting and shrinking. Carrying capacities and strength
factors of steel can easily be determined as all manufacturing

10 Great Lakes Steel Corporation, Stran-Steel, p. 4.
operations insures uniformity and quality, whereas in wood, knots and uneven grain tend to weaken timber; therefore, no exact calculation can be made. Although steel is a different material than has been used formerly in residential construction, Stran-Steel requires no special planning and carpenters familiar with wood framing are well qualified to erect Stran-Steel framing using ordinary tools. The patented "Nailing Groove," a feature that was instrumental in adapting steel to frame construction, allows standard collateral materials to be used and attached by nails.

Some manufacturers have gone a step beyond framing only the structure, and have designed and are producing all-steel homes. The Detroit Steel Products Company has introduced Fenestra Building Panels. Panels of sheet metal are so designed as to interlock one with the other and may be assembled together to form a complete structure of floors, ceilings, roofs, and interior and exterior walls. Standard sections are sixteen inches wide and vary in depth from three to nine inches. These sections are hollow and may be easily fitted with insulating material which makes them an effective barrier to heat, cold and noise and prevents condensation. Other manufacturers have recently placed on the market production-made prefabricated steel houses. By this method they are able to build a number of different designs using interchangeable wall sections and roof assemblies, thus enabling the manufacturers to supply differently designed houses at the economy of assembly
line production. For this reason, they make excellent factory workers homes, tenement houses, and low investment rent houses.\footnote{Sweet's Catalog Service, \textit{op. cit.}, Sect. 3 c/1-3 c/5.}

However, houses built of steel have one great disadvantage. They are steel. People prefer the warm inviting individuality of a custom built home in the grace of wood, brick and natural stone to any machine-made tin building. The very nature of steel is cold, hard, and harsh. It would be difficult to determine whether it is the heritage of the people which rebels against steel as a building material of a home, or whether this feeling is justified by the fact that it cannot be easily and readily worked. But regardless of which case it may be, people seem to cling to the conventionally proven materials of wood, brick, or stone.
CHAPTER III

RECENT DEVELOPMENTS IN MASONRY MATERIALS THAT AFFECT THE CONSTRUCTION DESIGN OF SMALL DWELLINGS

Stone and Brick Veneers

Stone is perhaps man's oldest form of building material, at least it is the oldest material used in his permanent buildings. Before the discovery of America brick had become a common building material throughout Europe, and was especially used by the Dutch.¹ In America, with timber so readily accessible along the East coast and bricks not likely to have been imported because of the small sailing vessels of that day,² lumber became the leading building material from the earliest pioneer days.

By the time the thirteen colonies gained their independence, several brick plants had begun operation and brick houses became the rule rather than the exception in such cities as Baltimore and Philadelphia.³ To the South, on the great plantations, negro slaves produced the bricks of which many of the great manor houses and outbuildings of the plantation communities were built. As has already been explained

²Joseph Jackson, American Colonial Architecture, pp. 4-18.
³Ibid., pp. 84-102.
in the preceding chapter, brick was a much more suitable building material than wood because of the great resistance to termites and decay afforded by brick foundations and walls. From this beginning of a need for brick construction in the deep South, and the abundant use of brick by the wealthy of the larger cities of the North, brick homes became fashionable.

Solid brick homes proved to be extremely expensive and a type of cheaper frame and brick construction called brick veneer was introduced. This method, simply explained, is nothing more than a common wood frame house, which is as its name implies, veneered on the exterior walls with bricks. Therefore, a house may be built at a much more reasonable cost, yet achieve the same appearance and approach the same degree of fashionable distinction as the more costly solid brick houses. The brick veneer method of construction has been widely accepted by home builders. Solid brick houses are seldom constructed today. This is particularly true in the Southwest.

Rock and field stone were later substituted for the bricks in veneer construction. This afforded a house still much cheaper than the brick veneer, especially in the case of houses located in the country and where the rock was available for the quarrying and hauling.

Two methods of laying ordinary field stone veneer are in common practice. One method used on a great number of farm
houses and some city dwellings, is to fit the irregular flat rocks together with concrete mortar in a vertical plane parallel to the exterior wall. This manner of using field stones in veneering is commonly used in remodeling old and dilapidated farm homes as it requires little skill and can be quickly built. The fact that a farmer and his neighbors can erect an adequate house at a minimum of expense, as well as solving the painting problem, has greatly advanced the popularity of this type of construction in the country. Since it is used in connection with the cheapest house constructions, flat field stone veneering has never gained high esteem among architects.

Another type of veneer using field stone is made by cutting four-inch slabs into random lengths and widths, then laying them flat like bricks. This type of construction requires a more skilled stone mason to cut and build this type of masonry and consequently is more expensive. More cut-stone veneer homes are found in the urban districts and only a slight representation is found in the better suburban homes. The prominent ranch homes built of rock usually are constructed with solid masonry walls.

Since stone veneering has recently gained much popularity in the Southwest, a number of quarries have been opened in Texas. It is not uncommon to find flat uncut stones stacked along the highways and offered for sale at a reasonable price. Quarries have been developed and cutting machinery has been
installed in locations where good quality stone has been found. The stone is quarried; then sawed into slabs four inches in thickness on the job, and is laid similar to bricks.

The quality of the stone is determined by the texture and color. Austin stone, whose name is derived from the capital city of Texas, is quarried near Austin and is perhaps the best known and most widely advertised of any stone quarried in the state. The stone is of a light cream color and has a very fine grained texture which makes it a favorite for stone-veneered homes. This light color, combined with the stone's porous composition is a disadvantage in one respect. The part nearest the ground soon becomes dark and discolored, especially in dark soil, due to the rain splattering the dirt against it. Tunkstone is a commercialized stone found in north central Texas. It is distinguished from Austin stone in that the color is in different shades of gray. Tunkstone is a shale formation and is, therefore, not as smooth-grained as Austin stone, but it has the advantage of being darker and does not show discoloration as readily as does Austin stone.

Another Texas product is Como stone, a natural limestone cut from the hills around Comanche, Texas. This stone has natural colors ranging from white cream to buff.

Only three quarries have been mentioned, but there are many other quarries throughout the entire Southwest. Texas is not dependent on other states for building stone, although people desirous of richer colors than are found in native
limestone do import stone from other states for the more expensive homes. However, their desire for something distinctive and different rather than architectural beauty, may be the incentive for their importing materials. Natural materials are always in good taste, while imported stone may not fit so well in a different environment.

Crab Orchard Stone is one of the most popular of the imported masonry materials. It is described in one of the company’s advertising pamphlets as follows:

Crab Orchard Stone is a beautifully colored, hard stratified quartzite from the mountains of Tennessee. It lies in the quarries in separate strata usually from 3/8 inches to 6 inches in thickness, with a few ledges from 6 to 22 inches. It can be furnished in any dimensions up to the limit of transportation. It is used for many different purposes, among them being veneer, roofing, flagging, treads, coping, wainscot, exterior and interior wall surfaces, decorative panels, rubble, ashler, etc. The beds are nearly true and straight, and the surfaces, even though smooth do not become slippery with wear, or when wet. U. S. Bureau of Standards rates Crab Orchard Stone highest in non-slip value. The stone is fine-grained, dense and almost impervious.  

Perma-Stone

One of the latest developments in building veneers is a revolutionary process of molding an imitation stone veneer directly on a prepared wall. This product is called Perma-Stone. Because of the tremendous cost of quarrying, transportation and erection, stone has generally been limited to persons of wealth. The Perma-Stone Company of Columbus, Ohio developed this process in an attempt to produce a more

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4Crab Orchard Stone Company, Inc., Crab Orchard Stone, Monograph A. I. A., File No. 8-B-6.
economical product than native stone, yet one which would give the appearance of a cut stone building. Perma-Stone is a stone-like concrete veneer, moulded while in pliable condition directly on a prepared wall where it quickly hardens. This preparation is composed of aggregates, portland cement, crushed quartz, pure mineral color, metallic hardener and water-proofing ingredients. Perma-Stone is not a load-bearing material and can be permanently secured to walls of wood or steel and bonded directly to block, concrete, tile or used brick. It requires no expensive footings, and will not burn, decay or require expensive upkeep. The hard surface is water repellant and termite-proof and remains remarkably clean under conditions where other materials become unsightly. Discoloring near the ground line, as was stated previously is an objection to Austin stone. A certain degree of insulating value is gained by the prevention of wind infiltration indirectly by means of the dead air space between the Perma-Stone and the wall.

Although Perma-Stone may readily be used on new buildings, the fact that it requires little or no extra foundation makes it especially adapted to remodeling old dwellings as well as places of business. Perma-Stone has been used as an economical interior decoration, and may be applied to almost any structure and any type of establishment.  

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Brick

Brick, though it has been replaced by other materials in some cases, still holds a high rank in the category of building materials. The first brick kiln was established in the United States as early as 1637.⁶ It has been the principal building material used in construction of business houses, hotels, and other public buildings of the larger cities in the United States for over a century. Today, combined with steel, brick is used more than ever. The fundamental process by which brick is made has remained practically unchanged, but many changes and improvements have been made in the ingredients and exterior finish of brick. A description of how the different varieties of bricks are produced is given by Alfred B. Searle.

Building bricks are made from almost all of the commoner varieties of clay, either alone or mixed with some material to confer special properties on them.

Bricks are made from a mixture of chalk, cinder dust and clay; this forms a mixture which is less plastic than the original clay. The chalk provides one ingredient which combines with the clay and forms a fusible bond, whilst the cinder dust forms a fuel which is mixed so intimately with the clay that it secures the brick being heated more intensely than if the whole of the fuel were external to the brick. The result is a brick of great strength compared with the quantity of fuel with which it is fired.

Red bricks are made from clays rich in iron oxide; buff bricks are made from clays which contain less proportion of this oxide. Glazed bricks are made of fine clay and are afterwards glazed by dipping them in a suitable slip which, in the kiln, fuses and produces the glaze.⁷

⁶ Shurtleff, op. cit., p. 112.

Through the imagination of well trained contemporary architects, old materials are taking new forms. The modern conception is to allow the natural building materials to be exposed instead of plastering over them or otherwise concealing the structure. Even ceiling beams have been left showing without destroying the beauty of the building. In many cases such things actually add a pleasing flavor to the structure. Brick is an important factor in this type of architecture where beauty is derived from related forms of natural structural materials in harmonious colors rather than from some superficial covering and decorations. Although architects and interior decorators may find enough design in the pattern formed by the smooth brick of a wall, face bricks have been treated in different ways to create different textures. The most common method is to score the face of the bricks with a comb-like tool while the clay is still in a pliable stage. After the brick has been fired it is left with a very rough, lined surface.

Other properties of brick which affect the appearance of a wall are the color and the shape of the units. The color of brick is naturally determined by the clay and even changed by adding different ingredients to form a dye, or by using ingredients in combination with different temperatures in firing. The usual brick size in the United States (there is no exact standard size) is approximately 2 1/4" x 3 3/4" x 8 1/2". Other sizes in bricks, such as the longer and thinner Roman
bricks, may be purchased for use where special effects are desired.

The Acme Brick Company of Fort Worth, Texas produces a brick which closely simulates stone masonry. Other brick products of this company are described as to their texture and color in Sweet's File.

Acme Face Brick is produced in five expressive textures: smooth, sand finish, ruff or rug, vertical, and velour or matte carried through a complete line of shades, giving an almost unlimited choice of color and texture. The light shades range from white through light cream, ivory white, old ivory, manila, golden buff, manganese, clear gray, light grayish buff, light tan, and into the brown shades. The shale and red clay face brick range from coral red through medium, dark red, and ox blood into the lightly flashed red-heart, light gunmetal, light brown, ilive, dark brown, chocolate, and black. These fascinating colors and textures in face brick or weatherproof materials will withstand the ravages of time and the elements.

The brick companies even try to simulate old, and even hand-made brick, for those who wish to build a period type of home as near in appearance as possible. These bricks are also mentioned in the Acme Brick Company's advertisement found in Sweet's File.

Acme Sand-Moulded 'Colonials' meet artistic requirements for brick of velvety texture, mellowed color tones, good quality and rare old-fashioned charm. Their quaint irregularities and freedom from artificiality express in color and texture the picturesque beauty of the hand-fashioned brick of Revolutionary times. Shades range from salmon-pinks through wine reds to soft browns, moss-gray greens, bronze, gun-metal and polychromes—a veritable palette of color with which to create harmonious timeworn effects.  

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9Ibid.
Paver’s bricks are distinguished by their smooth hard surface and uniformly smooth rounded edges and corners. Produced in the darker colors of red brown, olive, and black, they are ideal for use in driveways, terraces, terrace walls and steps.

Floor bricks are hard, strong vitreous units with a satin sheen which may be waxed and polished to a high gloss just as varnished wood floors. They may be purchased in the colors of red, brown, olive, buff, gray and even pink, and are impervious to moisture, abrasion or impact. Designed for interior floors, they are slightly thinner than ordinary bricks. Their standard thickness is 1\(\frac{1}{2}\) inches, while the sizes range from 4 x 8 inches to 12 x 12 inches.\(^{10}\)

Interior decorators and modern architects are taking advantage of this appropriate and economical method of flooring for both interiors and exteriors. Pavers and floor bricks make attractive, long-lasting flooring which may be placed on the ground. Floor bricks can be polished as any other floor in the house, while pavers brick may be exposed to the weather untreated without any danger of damage by sun, wind or rain, termites or decay. Brick floors make possible a smooth, richly colored terrace surface in modern design for our outside living of today.

\(^{10}\)Sweet’s Catalog Service, Sweet’s File-Architectural, Sect. 4 d/1-4 d/7.
Clay Tile

Another popular building material of ceramics closely related to brick is tile. It, too, is a product of clay and is fired and finished much in the same way as brick. Structural face tile can be used for single unit structural walls or for veneering work and offers all the advantages of brick. Tile is permanent, light in weight, economical to use in building because its larger size and ease of handling permit rapid construction, and it is economical in maintenance. One great advantage tile has over brick, besides being in larger units and light weight, is that it is hollow, thereby producing a trapped air insulated wall. This feature also insures the wall against water penetration and capillary attraction.

Tiles are produced not only in block form, but in all types of forms required for a complete structure. However, when an entire structure is built of tile, it is used in combination with reinforced concrete. After the tile is set in position, reinforcing rods are laid in the channels provided, then they are filled level with cement. This produces a reinforced concrete beam inclosed in a tile shell. Several types of tile beams are available and have been proved stronger than wood.\footnote{Acme Brick Company, \textit{op. cit.}, Sect. 4 d/l.} Tile construction is rigid and permanent, decay and termite proof, fire and wind resistant, and economical in cost and maintenance. These advantages, plus the insulating value provided by the dead air space between the outside and inside
walls, constitute a type of construction competitive to wood building practice in small structures, but one which has not been widely accepted for small home construction.

Brikcrete and Dunbrik

Other masonry building products closely simulating clay tile and brick have been recently introduced. They are Brikcrete, produced by Brikcrete Associates, Inc., Grand Rapids, Michigan and two products, Dunbrik and Dunstone, produced by the W. E. Dunn Manufacturing Company, Holland, Michigan.

These materials, though they may appear as common bricks in the finished building, are not ceramic products, but a compressed concrete mixture. Brikcrete and Dunbrik are formed and compacted on precision machines without any process of firing. Being formed cold eliminates any chance of distortion or shrinkage caused by the baking of clay, and allows exact measurements and rectangular shapes to be maintained in all the units. A specially compounded admixture is incorporated into the preparation during the mixing process. This admixture does two things: first, it gives the material its rich colorful beauty, and second, it makes the material unusually dense and highly water resistant.

Brikcrete is manufactured in the form of tile, and may be obtained in various shades of red, tan and buff.\textsuperscript{12} It is made in two sizes: eight inch for eight-inch thick exterior

\textsuperscript{12} Brikcrete Associates, Inc., Brikcrete, Monograph, Form No. BC-412--2-49--20M--KFC.
walls and four inch for interior walls and veneer work. The eight-inch thick unit has twice the face area of regular brick, and more than four times its cubic area. The four-inch thick unit has twice the face area of regular brick and twice its cubic area. Other comparisons with regular brick reveal that Brikcrete weighs only half as much per square and requires only one fourth as much mortar. Regular brick is solid and is a high conductor of outside temperatures and moisture into the inside rooms. Brikcrete is hollow and provides a dead air space, one of the best insulation agents known. This hollow wall construction also allows electrical conduits to be inserted easily. In addition to these, perhaps one of Brikcrete's greatest advantages is its economical cost. Brikcrete is around forty per cent less in price than face brick, and costs far less than its square foot equivalent in frame. Its light weight reduces the size, weight, and cost of footings and foundations.

Dunbrik is very similar to face brick in size and shape. Surplus bulk and unnecessary weight are removed by forming a recess on the underside. This recess lessens the dead weight of the finished wall and forms a secure anchorage in the soft mortar, eliminating the tendency of the brick to float or shift. This tendency to slide out of line is a common fault of ordinary brick. Dunystone is different from Dunbrik in that it is made in a variety of shapes and sizes to simulate cut stone.
Concrete Tile

Concrete tile construction is closely related to that of clay tile or Brikcrete. The concrete blocks are approximately of the same size, and of the same general shape as the other similar products. In fact, the only apparent difference in the two products is that one is made of fired clay and the other is made of cement. Even the building process of the two materials is similar.

Though concrete tile is cheaper and may appear equal to ceramic tile, it has some great disadvantages. It is not generally accepted as being as strong as tile or Brikcrete and in the areas where the top soil tends to shift, it is more likely to crack through the individual unit than other forms of masonry. Concrete tile masonry, like all poured concrete, does not offer the great resistance to water as does ceramic masonry. The completed concrete block building must be painted with a water-proof coating, or in some way treated, to protect it against water seepage due to its porous composition. In spite of these disadvantages concrete tile is being used more and more for small inexpensive buildings. It provides a cheap and easily constructed masonry material especially adapted for farm dwellings and out buildings. The details of this fire-proof, termite and rodent repellent construction is given by the Portland Cement Association.

Probably the most popular type of concrete masonry wall in present use is the regular cours ed masonry wall, suitable to both period and modern styles of architecture. Here the insulation is furred out from the inside wall
face to make familiar plaster walls. The exterior may be overcoated with any of a number of portland cement stucco textures, or given a finish of portland cement paint in a choice of colors.

For variation, some people prefer random ashlar patterns in concrete masonry. These are produced by laying up various sizes of units in patterns. Paint on the exterior produces a charming finish. When double walls of masonry are used, with the hollow space used as insulation, both the exterior and interior faces of the wall may be exposed concrete.

Reinforced Concrete

Molded reinforced concrete structures have been built in Florida, Texas, California and possibly in other Southern States. These buildings have slab floors, walls and even the roofs made of solid reinforced concrete. The construction of these buildings is done by first setting forms and reinforcing steel in place for the entire structure, then simply pouring the entire project at one time. Houses of this type of construction usually have a flat roof and it may either be of the built-up type or of reinforced concrete as the rest of the house. In Florida and South Texas, the flat reinforced concrete roofs are built so it is possible to keep them flooded with water as an insulating element against the hot blistering sun.

Aside from solid building construction, reinforced concrete has recently become one of the most popular building methods in solid slab foundations. This type of foundation is equally as good with walls of reinforced concrete, concrete masonry, brick, frame, and other types of construction. The one great disadvantage of slab foundation is that water, gas,
and sewerage piping is extremely difficult to change or repair once the concrete is poured. However, the introduction of copper piping has greatly reduced the need for repair.

A concrete slab foundation is fireproof and is impervious to termites and rodents. Tests have shown concrete slab foundations to have less heat loss with more uniform room and floor temperatures than conventional floor construction on piers. Radiant heating coils may be imbedded into the slab eliminating entirely the coldness of a concrete floor. The concrete may be finished, either natural or colored, and used directly as a floor, or any commonly used flooring can be readily applied to the slab foundation. Wood, asphalt tile, linoleum, terrazzo and carpeting, or combinations of these, have been used successfully. Wood is often cemented directly to the slab, or as in most cases the flooring is nailed to screeds embedded in or clipped to the slab. Concrete tile is applied directly to the concrete floor while the terrazzo finish is built integral with the slab foundation, and is ground before the walls and partitions are erected.¹⁴

Reinforced concrete slab foundations are ideal constructions for some localities. "Residence foundations over the expanding and contracting soils found in some areas of Texas have been recognized as requiring special consideration. The concrete slab foundation has proved to be a satisfactory solution."¹⁵ The soil may shift underneath the slab and the entire

¹⁴Portland Cement Association, Concrete Slab Foundations.
¹⁵Ibid.
house may move with it, but it will not be damaged by one part moving while the other part remains stationary as it would if conventional foundation wall construction were used.

The concrete slab type of foundation permits a house to be built near or flush with the ground and the floors to extend out into the garden as terraces or courts. In this arrangement the living area is not only confined within the walls and roof of a house, but it may flow outside. Thus, the gardens become an integral part of the living space and the plan of a modern home.
CHAPTER IV

THE CHANGES MADE IN SIDING AND ROOFING MATERIALS AND

THE EFFECT THEY HAVE HAD ON TODAY'S SMALL HOME

Wood Siding

The historical background of American homes related in Chapter I tells how the English frame houses, as they were built, were unsuited for the violent New England climate. The abrupt changes in temperature caused cracks in the brick and mud walls that filled the space between the heavy framing members. A sheathing of plaster on the inside and clapboard on the outside were soon adapted to the wall as a preventative against infiltration of wind and rain. Later the brick nogging disappeared altogether and the light frame construction as used today was developed.

Clapboard siding was first made by splitting long pine logs, which were straight-grained and clear of knots, into thin slabs. Shingles for roofing were made from short cedar logs which were much easier to obtain and split. Since shingles were easier to make than clapboard siding, they were used to cover exterior walls as well as roofs. Shingled exterior walls became a popular type of construction and are still used on some of our present-day houses.

Machine sawing was begun in Maine in 1631 and in New York in 1633. The introduction of power sawed lumber greatly
reduced the grueling hand labor of carpentry. Both the English and the Dutch were accustomed to pit sawing. This method was a slow and drudging task accomplished with a long, straight hand-saw operated by two men, one above the surface of the ground and the other in a pit below the log. Sawmills were known in England, but were outlawed for fear of unemployment among the sawyers. In America, handsawing proved to be far too slow and costly. Thus, the sawing of lumber was mechanized.¹

The sawmills in the beginning, however, did not produce smooth planed lumber; instead, they produced only rough-sawed, inaccurately dimensioned material. All finishing lumber, including clapboard for the more expensive homes, had to be smoothed by hand. Carpenters spent the cold winter months in their workshops dressing down the finish lumber and clapboards to be used the following spring and summer months in building a house.

Later new planning and molding machinery made possible the smooth and specially shaped lumber for building. Siding was perhaps affected more in this way than other wood products. Clapboard siding could be produced so that each piece was straight, smooth, and tapered on one edge until thin. Shiplap could be cut by a machine and a number of different profile variations were developed in the material that was to be used for siding. The grooving or beading of siding resulted in

¹James Marston Fitch, American Building, p. 8.
more horizontal lines and afforded a certain amount of pattern on the wall.

Today the attention of modern architects has turned away from trying to derive beauty from surface ornament. Instead, they let the form of practical construction and basic materials create the personality of the house. Beading and painting in some instances are objectionable in modern design. The flat surface of natural wood grain and color may have beauty within itself, and should not be marred or hidden by unnecessary grooves or paint. Home builders are rapidly becoming aware of this new architecture which copies nothing for the sake of style, but is designed to take fullest advantage of the natural beauty of building materials and to use these materials in the most practical way possible. The production of siding from colorful and richly grained woods such as redwood and cypress has greatly aided the growth of this modern conception in architecture. Also, preservatives for these woods, which will not deteriorate by continued exposure to the weather, have insured the practicability of the use of wood.

Asbestos Siding

A comparatively new development in siding is the asbestos-cement type commonly referred to as asbestos siding. This all-mineral building product is made of asbestos and cement. This siding is formed into convenient sizes and applied to the wall in much the same manner as shingles. Asbestos siding has become very popular during its short history. The reason for
its increasing popularity lies in its many advantages over other siding and roofing materials for the average builder. Of these advantages, the fire-proof and insulating qualities of asbestos siding are probably the most outstanding. It is neat in appearance, can be bought in almost any desired color, and it requires no painting or upkeep. The initial cost is competitive to other siding materials, and it affords an excellent remodeling skin for old buildings. To people with only moderate incomes, asbestos siding has provided a durable and reasonably priced exterior wall finish.

Aluminum Siding

Aluminum was among the many things developed during World War II. "The war effort has transformed aluminum from a metal of scarcity and limited utility to a metal of abundance and extreme usefulness."² Today aluminum ranks as a major building material well adapted to a host of applications. Architects are challenged to take advantage of the building possibilities offered by aluminum and its alloys.

Aluminum siding is one of many products which have appeared on the market since aluminum has been produced extensively. This siding of aluminum is designed to appear like beveled wood siding. The aluminum clapboards are snapped together and nailed in place. The nails, driven along the lower edge, are then completely hidden when the next piece is

put in place. The Permanente Products Company of Oakland, California has this to say about its product, Kaiser Aluminum:

Kaiser Aluminum clapboard Siding and Roofing has a concave surface which eliminates sheen and wrinkles, and provides deep, attractive shadow lines. The curved face also gives maximum strength and complete rigidity. Due to its curved surface, this siding locks with a spring action, giving absolute weathertight security in any climate. 3

Aluminum siding is light weight and requires no special tools. The siding can be applied quickly and efficiently and helps to hold construction cost to a minimum. Aluminum is corrosion resistant, termite-proof, fungus-proof and allows the siding to continue down a wall to the grade line or to the surface of any porch or terrace without danger of deterioration.

Wood Shingles

Power sawing was also applied to the making of shingles soon after its application to lumber. Although power-sawed shingles do not have the lasting quality of hand split shakes, they can be produced cheaper, faster and in much greater quantities. Manufactured wood shingles are uniform and can be applied easier and faster than rough hand split shakes. The uniform size and smooth surface enable the carpenter to produce a neater and more weather-tight roof. Redwood, cedar, and cypress are the common woods from which shingles are made.

The amount of insulation gained from any wood shingle roof is not to be overlooked. "The insulating value of red

3Permanente Products Company, Kaiser Aluminum, Monograph No. 4-1-48-267M.
cedar shingles exceeds that of any other roofing material. There are several million tiny cells in every cubic inch of cedar wood and each cell is a minute cavity of trapped air insulation.

It is interesting to note that in the face of new and supposedly better adapted materials which are being produced by the building industries, wood shingles still are the most popular roofing material for the more expensive period-type homes. The principal reason for this continued use, possibly, is because shingle roofs were employed on period houses. Wood shingles were the chosen roofing for the early homes because they were a natural easy-to-obtain material. They blended well with all other building materials of various colors and created an interesting patterned roof. Wood shingles, because of their natural beauty and texture, could be adapted to modern architecture.

Asbestos Shingles

Despite their attractiveness and other desirable qualities, wood shingles are susceptible to fire. Johns-Manville and other companies have produced a new product within the past thirty-five years to solve this problem. The product is known as asbestos shingles.

Asbestos shingles are made of asbestos and cement, two practically indestructible materials. These shingles are

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4Red Cedar Shingle Bureau, Red Cedar Shingle Homes, Monograph RCS-4C-3-48.
fire-proof and have the permanence of stone.® The first asbestos shingles applied on roofs thirty-five years ago are still in good condition and do not show the slightest sign of deterioration. Prolonged dampness will not rot asbestos shingles, nor will the extreme heat of the summer sun cause them to crack. They are available in a variety of colors and are usually made to simulate wood shingles by a staggered horizontal shadow line and a deep grained texture. Wood shingles may be stained but this coloring soon fades; in asbestos the color is as permanent as the material.

Asphalt Shingles

A still cheaper roofing material than asbestos shingles is the asphalt type of roofing. This roofing was first produced in roll form and was not intended for dwellings. Roll roofing is made of long-fibered felt thoroughly saturated with asphalt and specially blended to insure water-proofing and insulation against wind.

From roll roofing came the asphalt shingle so widely used on modern homes today. They may be purchased in a variety of shapes and colors. Different interlocking systems have been devised by some companies to prevent winds from loosening or blowing off the shingles. A coating of mineral granules was added to the top surface of the material for fire protection, and simulated wood grain and wood colors have been introduced

to give the finished roof an appearance of wood shingles. The result of this development is that a house may be covered with an attractive roof at a very reasonable cost. Architecturally, the pitch or slope of the roof has been decreased as compared with the wood-shingle roof. The life and efficiency of a wood-shingle roof are directly related to the angle of its pitch; the greater the pitch the longer the roof will last and the less leaks are likely to occur. In no case is it advisable to build a wood shingle roof with a pitch angle of less than six inches of rise in twelve inches of run. Whereas, with asphalt shingles, the recommended pitch is five inches of rise in twelve inches of run, and they may be used satisfactorily on a roof as flat as three inches of rise in twelve inches of run. 6

Metal Roofing

Lead was perhaps the first metal used for roofing purposes. Some roofs of medieval, Gothic churches were covered with this pliable, easily-worked, but extremely heavy material. Copper has replaced lead because it makes a lighter and more rigid roof.

Copper roofs are constructed of copper sheets (in general it is recommended that 20" x 48" sheets be used) which are locked together in a process known as the pan method. In the pan system the ends of the sheets are locked together in a

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6Sweet's Catalog Service, op. cit., Sect. 8 a/10-8 b/6.
flat seam, and the edges are locked together in a standing seam. Both joints are constructed so as to permit expansion and contraction without buckling or distorting the roof. Copper roofing may be used on any roof with a pitch greater than two and one half inches in twelve inches of run.

Because of its corrosive resistance quality, a copper roof will likely outlast the building which it covers. Roofs of copper which were built more than a hundred years ago are still in good condition today. Although it was originally designed for commercial buildings, architects are taking advantage of the extreme durability of copper roofing and are adapting it to modern home construction.\(^7\)

Since World War II aluminum has been introduced into the building industry as a roofing material. It may be applied to roofs in the same manner as aluminum siding is applied to walls, or it may be applied in a manner much like that of copper roofing. Aluminum has the advantage over copper in that it is extremely lightweight and thus requires no extra bracing for the roof structures. Also, the bright surface of aluminum will reflect the sun's rays producing an insulation against heat, and it is well adapted for use in the Southwest.\(^8\)

**Built-Up Roofing**

Among other materials or systems which were first developed for commercial buildings, then later adapted to residences

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\(^7\)Ibid., Sect. 8 c/l-8 c/7.

\(^8\)Permanente Products Company, *op. cit.*, Monograph No. 4-1-48-2674.
by architects, is built-up roofing. Built-up roofs are designed for near-flat roofs. The process is a simple one, consisting of several layers of asphalt saturated felt bonded together with hot coal tar pitch and surfaced with slag or gravel.9

The adaptation of this type of roof for modern residential structures has come as a radical change from the conventional gable or hip-roof type construction. The demand by people for, and the carpenters' familiarity with the conventional type of roof possibly are the reasons for the poor reception of flat roofs. But, despite its slow and uncertain acceptance by the public, the built-up roof is one of the greatest factors which has changed the design of small homes. This type of roof permits complete freedom in the pitch of the roof plane. The flat roof is adaptable to a house of any shape giving the architect complete freedom of exterior shape and interior arrangement, while on the other hand, gable and hip roofs decidedly limit the shape of the house and thereby restrict the arrangement of the interior. The built-up roof is practical and inexpensive and it does away with the wasted space and material built into conventional roofs. At the same time, it produces a durable cover which will last as long as any other roofing material with the possible exception of metal roofing.

Reinforced Concrete Roofs

In Florida and South Texas, reinforced concrete houses have proved a satisfactory solution to tropical building problems. A description of this solution may be found in the October, 1948 issue of the Architectural Forum. It is as follows:

Foundation walls and roofs are all monolithic concrete slabs (walls—6 in.; roof—7 in.) poured in modular steel forms, thus eliminating beams and expensive framing. Unlike porous cement block, this concrete mixture is completely dry; mildew-and-bug-proof; hurricane-and-fire resistant. It appears to be a near perfect answer to Florida's many tropical building problems, including the ever-present threat of termites which make wood construction a questionable practice. 10

The concrete roof may be supported by the walls of concrete, or in a slightly different design, the roof may be supported by columns. In the latter system, the walls are non-load bearing because an isolated system of columns support the slab. This type of construction allows maximum flexibility of interior partitions.

It is interesting to note that a completely new idea for insulating has been incorporated in the roof of the reinforced concrete house. In one type, the concrete roof is insulated and surfaced with Vermiculite, a porous, spongy material, and sprinklers are provided to wet it from time to time. For the other type, a somewhat different method has been worked out.

10 Henry R. Luce, "Concrete Home in Florida Is One of Eight Prototype Houses Designed to Solve Regional Building Problems," The Architectural Forum, XXCIX (October, 1948), 103.
This method is given in the same article which discusses reinforced concrete houses in *The Architectural Forum*.

The concrete slab is surfaced with a membrane waterproofing topped by 6 in. of shell sand. A water level of 3-4 in. is maintained in this layer of surfacing. This not only cools the interior, but keeps walls and roofs at a uniform temperature, thus preventing cracks between members which would appear if they were heated at different rates.\(^{11}\)

Concrete slab roofs are adaptable to any part of the Southwest where there is little snow and ice and long, dry, hot summers prevail. Though the slab roofs are not too prevalent, what few there are provide their occupants with temperature control comparable to air conditioning.

\(^{11}\)Ibid., p. 107.
CHAPTER V

DEVELOPMENTS IN MATERIALS WHICH AFFECT THE INTERIOR DESIGN OF SMALL HOMES

In the development of new structural systems many new interior building materials have been introduced. World War II was responsible for the development and production of new materials which have become common building materials. Also, architects are using old materials in new and interesting ways.

Good architects are quick to grasp the possibilities of new products which offer advantages over conventional materials used in home construction. Materials which were once considered suitable for exterior use only are being used now inside the house with great success. Brick, stone, and natural wood are used extensively in modern houses to give them unity inside and out, a feature that conventional houses seldom have. Floors and walls of brick and stone flow from the inside to the outside of the Modern house. This is not a new idea. It was used in some of the best early colonial houses. This method of construction, however, is adapted to modern architecture, not because it is Colonial Style, but because it is practical in structure and design. Floors and walls built of brick or stone are decorative and have the advantage of requiring no maintenance.¹

¹George Nelson and Henry Wright, Tomorrow's House, p. 22.
Flooring Materials

Wood has always been the most common flooring material used in the American house. Edge grain pine and hardwoods have long been popular as a surface flooring for conventional houses. Manufacturers not only produce unfinished hardwood strip flooring of oak, beech, pecan, and maple, but they also produce factory-finished strip flooring, either in random width planks or prefabricated wood in blocks. This pre-finished flooring needs only to be waxed and polished after it is applied and is ready for use.

The floors in bathrooms and kitchens are continually subjected to dampness. A type of flooring which is both waterproof and easy to clean is necessary. Ceramic tile was one solution to the problem of water proofing, but proved to be too costly for inexpensive homes. Linoleum was developed for use in homes where the cost must be held to a minimum. Linoleum floor covering soon found its place in kitchens and bathrooms and has become a universal flooring. This water-proof floor covering is made by laying on a burlap or canvas backing, a mixture of solidified linseed oil with gums, cork dust, or wood flour, and pigments. Linoleum provides a floor surface which is easy to clean, and can be purchased in almost any color, either solid or figured, to blend well with any color scheme desired.

However, linoleum flooring was susceptible to hard wear and had to be replaced often. Companies were encouraged to produce a waterproof flooring material which would have
long-wearing qualities, and at the same time would not be above the budget of the average home builder. To supply this need, magnesite, mastic, and asphalt tile were developed. Asphalt tile is by far the type most widely produced. A floor of asphalt tile, subjected to normal home wear, should last more than fifteen years.\(^2\) Asphalt tile has been projected beyond the bathroom and kitchen into the workshop, game room, and the play room of the modern house, because it is easy to clean.

Cork has long been known for its high insulation and shock absorption qualities. These qualities, in addition to the natural texture and neutral color of cork, make it an ideal wall and floor covering material. The resilient, non-slipping nature of cork makes a safe and comfortable flooring, easy to walk and stand on.\(^3\)

Ceramic tile, brick, and stone are used by modern builders for terrace and porch surfacing. Architects are extending them back inside the glass walls where they become the floors of sun rooms and living rooms. Other places such as entrance halls, where excessive dampness from dripping rain gear and wet overshoes would be detrimental to other floors, ceramic tile, brick, or flat stone have been used as a practical and decorative floor.


Wall and Ceiling Materials

Not many years ago it was generally assumed that all interior walls or ceilings should be finished in one of two ways. The more expensive homes, which were built of solid masonry or frame, were finished inside with plaster which was either painted or papered. In the less expensive frame dwellings the interior walls and ceilings were first covered with sheathing and then covered with canvas and paper. The latter method was especially prevalent in the Southwest.

Today a long list of materials are available to architects and builders for finishing interior walls and ceilings. First came the dry sheet materials which are inexpensive and may be applied to a wall or ceiling in a very short time. Several different types of wallboard are produced by companies such as the Celotex Corporation, Certain-Teed Products Corporation, and the United States Gypsum Company all of Chicago, Illinois, and the National Gypsum Company, Buffalo, New York, and the Johns-Manville Products of New York City. These products range from wood fiber processed into homogeneous insulating board, and gypsum rock panels, to acoustical tile designed to absorb noise.

Structural insulating board is made from wood fibers processed into sheets one-half inch thick. To meet the needs of interior construction the insulating board is pre-formed into a variety of shapes, including interlocking blocks for ceilings, beveled shiplap-type plank for interior walls and large
4' x 8' sheets of general purpose board to cover large areas quickly and economically. This may be painted or papered as desired. Some insulating boards are prefinished at the factories in soft pastel colors and are ready for immediate use with no further decoration. No effort has been made to camouflage insulation board to imitate rock, wood, or other building materials, and for that reason it can be adapted to modern architecture where economy is essential.

Perhaps the most popular of the wallboards is gypsum board or "sheetrock" as it is known to carpenters. Gypsum wallboard comes in smooth solid sheets and is made of a special mixture of crushed gypsum rock molded between sheets of long-fibered paper. This fire-proof material is equally suitable for walls and partitions and may be sawed and nailed like lumber to the studs and joists of old or new construction. Gypsum board will not warp or buckle, and is vermin-proof, resistant to moisture and climatic changes. Along the edges of each panel is a slight recess about one inch wide. The purpose of this recess is to receive a fiber tape and a kind of plaster called joint finisher. The fiber tape and finisher are applied to the joints after the wallboard has been nailed in place and produce a smooth wall with no evidence of the concealed joints.

Walls of gypsum wallboard may be decorated in many ways. Paint, calcimine, plaster texture, and wall paper have been applied successfully. Some companies produce gypsum wallboard with imitation tile indentations for wainscot in kitchens and
baths, and in imitation wood-grain finishes for paneled construction in offices, dens, living, and recreation rooms where a wood panel effect is desired. Gypsum wallboard offers today's builder an economical method of building fire resistant interiors which may be finished in keeping with modern taste.4

Companies have developed acoustical materials designed for office and commercial buildings where noise is objectionable. The sound-control material usually serves three purposes. It reduces sound, insulates against heat, and produces a pleasing texture for an interior finish. Sound-control material is usually prefabricated into square shapes composed of wood and cellular fibers, mineral filaments, or gypsum base plaster. The mineral and gypsum-base sound absorbing products are also recognized as fire-proofing materials. The fiber-like material is further treated to absorb sound by being perforated with small holes or slots.

Architects are emphasizing the need for acoustical control in homes and are adapting sound-control products to modern houses. Possibly the average person never thought of acoustical design in connection with his home. Nevertheless, sound control can be a vital factor in improving livability and in establishing a greater degree of privacy. The smaller the house, the greater the need for this completely neglected

4Sweet's Catalog Service, op. cit., Sect. 12 a/1-12 a/4.
factor in house design.\textsuperscript{5} Masonry and storage walls are natural and satisfactory barriers of sound. Distance alone will greatly reduce noise. However, ordinary ceilings and walls of bathrooms, bedrooms, and corridors have been effectively conditioned by the use of sound proof materials.

Recently with the advancement of plastics many new hard-finished wallboard products have been added to the great variety of materials available to architects. These products are made in sheet form from wood, plastic, and asbestos. They may be applied to walls, floors, ceilings, and counter and table tops.

Plywood was perhaps the first of these materials to be developed. Plywood is built up of thin layers of wood glued together with the grain of each layer at right angles to that of adjacent layers. This gives the construction additional strength and reduces warping.\textsuperscript{6} These fabricated wood sheets are usually made of fir and are manufactured in sheets of standard sizes and in various thicknesses. Fir plywood is sometimes faced with a thin veneer of more expensive wood such as walnut, oak, gum, or mahogany, and is used for paneling. Plywood is suitable for both interior and exterior application and is well adapted to prefabricated construction.

Masonite is another of the more popular wallboard materials. Masonite is made by the Masonite Corporation, Chicago,

\textsuperscript{5} Nelson and Wright, \textit{op. cit.}, p. 143.

Illinois, and a description of the product is given in Sweet's File as follows:

Masonite products are scientifically manufactured boards made entirely of exploded wood fiber. They possess many of the better characteristics of wood but are without grain and other defects found in wood. In the production of these scientific wood products clean wood chips are exploded into fiber under high pressure steam. The product thus produced is known as ligne-cellulose fiber. The explosion process produces fine woody fibers of varying lengths coated with lignin, which is the natural binding agent of the wood.\(^7\)

Masonite is widely used as a wainscoting in bathrooms and kitchens. Several companies have given Masonite a permanent hard and flexible synthetic glazed finish which completely seals the pores so that moisture and dirt cannot penetrate the surface. This glazed surface makes masonite exceptionally easy to keep clean. These wall panels are available in a variety of patterns and colors and due to their waterproof quality they make excellent walls for showers.

Marsh Wall Products, Incorporated, Dover, Ohio, produces Marlite wood-veneer panels. These panels are made of a masonite base surfaced with genuine wood-veneers. Marlite wood-veneer panels are available either pre-finished ready to be installed, or unfinished to be finished after they are in place.\(^8\)

Asbestos Flexboard is another wallboard made of asbestos and cement by Johns-Manville Products, New York City. This

\(^7\)Sweet's Catalog Service, *op. cit.*, Sect. 13 1/6.

\(^8\)Ibid., Sect. 13 1/4.
fire resistant wallboard may be purchased in natural gray, or in a number of mixed colors. One type has a high glossy baked-on finish. Immune to wear and moisture, Flexboard is a dependable surfacing for floors, walls, and ceilings. It has been successfully used for outdoor dance floors, since weather exposure does not damage it.9

One of the most successful counter and table top surfacing materials is Formica. Although this type of surfacing has been made since 1913, it has become widely used only recently. Formica is a synthetic material manufactured by the Formica Insulation Company, Cincinnati, Ohio, and is described in Sweet's File as follows:

Formica is made with phenolic, urea and melamine resins cured under heat up to 350 degrees fahrenheit, and 1100 lbs. or more pressure to the square inch. This produces a hard, dense, homogeneous sheet with a combination of characteristics not found in any other type of material. It is non-porous and does not absorb stains. It is chemically inert and will not spot by reaction with mild acids or alkalies. The colors are usually stable under the effects of ultra-violet light. There is a cigarette proof grade, unspotted by lighted cigarettes, cigars or matches, for use on horizontal surface.10

Formica is produced in more than seventy standard colors and in a wide range of textures. One unique variation from the common plastic board introduced by the Formica Insulation Company is the imbedding of genuine wood veneer to give it an actual wood texture. A description of this product is given in the same article:

9Ibid., Sect. 13 1/3.
10Ibid., Sect. 13 1/2.
Realwood Formica is a Formica sheet incorporating a genuine wood veneer, thus giving the plastic sheet the grain of actual wood. The result is a laminated, plastic sheet with the durability and resistance to stains of a plastic and appearance of a wood. The clarity and beauty of the wood finish has never been equalled by any other process.

Those synthetic materials are primarily produced for table, counter and bar coverings, but with their waterproof quality and hard polished surface they are suitable for bathroom and kitchen walls. Realwood Formica provides the only method whereby walls subjected to excessive moisture can be successfully finished in actual wood texture. As a result of this material, bathroom walls and furnishings can be built with the warmth of wood, yet have permanent resistance to moisture.

The United States Plywood Corporation of New York City has devised a new method of applying wood for interior decoration. Their product is called Flexwood and is described as follows:

Flexwood is genuine wood veneer cut to 1/35 of an inch, glued under heat and hydraulic pressure to cotton sheeting with a water resistant adhesive. A patented flexing operation alters the cellular unity of the wood to produce a limp, pliable sheet which may be applied by hand to any dry, smooth, hard surface, flat or curved. Columns, round or square, can be completely wrapped with Flexwood. Sharp corners and fluted pilasters are treated as easily as plane surfaces. Dry plaster, steel, Fir plywood, hard wallboards, tile, marble, asbestos, glass, etc., make perfect backgrounds for Flexwood. Sheets may be hung horizontally or vertically.

More than forty woods are available in the form of Flexwood, and are more reasonable in cost than thin solid wood or

11 Ibid., Sect. 13 1/2.  
12 Ibid., Sect. 13 1/8.
plywood. Flexwood is easy to install. An adhesive is brushed on the background and the back surface of the Flexwood and the material is applied in the same manner as wallpaper. A skilled paper hanger is well qualified to apply this product.

The application of Flexwood is not limited to flat surfaces as are other wood products. Flexwood can be applied to curved surfaces either with the grain or across the grain and will take any wood finish, except those finishes containing penetrating oils. Flexwood's greatest use is in the interior decoration of commercial buildings, but it may be used in a house where the cost of construction and materials must be held to a minimum.\(^{13}\)

Prefabricated Storage Walls

Along with progressive architecture, the inadequate and conventional closet has given way to well arranged storage walls. These storage units may cover an entire side of a room, or they may be built as a non-load-bearing wall between two rooms and designed to serve both rooms. One side may open into a bedroom with built-in vanity, drawers, and sections for hanging full-length dresses and suits. The opposite side may form one side of the library space and contain book and utility storage, writing space, and possibly a radio and record player.

Prefabricated storage units are being made by several companies. Storage units of this type are finished to blend

\(^{13}\text{Ibid., Sect. 13 1/8.}\)
with modern construction. These prefabricated units may be purchased in a number of different arrangements with drawers, shelves, or storage space with sliding doors. When the backs of the units will be exposed to another room, they are finished with a textured surface to form a solid wall. This unique product allows the architect to specify certain ready-built storage units of production-line economy to serve his clients with the advantages of organized storage. While, at the same time, the units add a practical and useful material to the design of the house.

Glass

Glass factories in America were erected long before the Colonies gained their independence in 1776. After 1870 the production of glass was industrialized and large plate glass windows were possible. The projection of the use of plate glass in the design of small homes from its original use in commercial buildings has been brought about by modern architects. Concerning the modern use of glass, Nelson and Wright state as follows:

Big, well designed windows are the trademark of modern architecture. They are the means of bringing together the outdoors and indoors in an integrated visual and functional pattern that makes living in modern houses an exciting new experience. Made possible by modern developments in building technology, they can be used to reduce fuel bills and increase comfort. In one form or another, they are applicable to every building problem,

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14 James Marston Fitch, American Building, pp. 9-100.
and modern architects seem able to go on discovering such new forms and new applications indefinitely.\textsuperscript{15}

Air conditioning and insulation plus the development of better glass have paved the way for the extensive use of glass walls and stationary windows. In the air conditioned house there is no reason for movable windows. However, for the modest home where stationary windows are employed, an all-year air conditioning unit would prove too expensive. The problem of ventilation for such cases has been solved by the ingenious introduction of louvers, screened on the exterior side and fitted with a panel, which can be put in place during the winter season to exclude the cold.

Plate glass is the most common type glass used for walls of glass or stationary windows. It is "a completely transparent glass made by grinding and polishing the two surfaces of a glass blank with the objective of making them flat and parallel and providing clear vision with minimum distortion."\textsuperscript{16} Polished plate glass may be purchased in thicknesses ranging from one eighth to over one inch in thickness, and in the standard colors ranging from medium and dark blue, peach, golden, and standard green. Tempered plate glass is highly resistant to breakage due to strain or thermal shock, and the heat absorbing qualities absorb heat without interfering with with the transmission of visible light.\textsuperscript{17}

\textsuperscript{15} Nelson and Wright, \textit{op. cit.}, p. 151.

\textsuperscript{16} Sweet's Catalog Service, \textit{op. cit.}, Sect. 7/2.

\textsuperscript{17} Ibid., Sect. 7/3.
The Mississippi Glass Company specializes in rolled light-diffusing glass, scientifically designed to distribute illumination. The various patterns of rolled figured or textured glass provide the architect with an almost unlimited source of decorative possibilities. Also, figured glass assures privacy without impairing the passage of sunlight. This factor makes diffusing glass ideal for use in bath or dressing rooms. Another variation of this type of glass is structural corrugated glass. The corrugations in structural glass make it an extra strong and pleasantly different material. Corrugated glass is especially adapted to semi or full floor-to-ceiling partitions. Practical uses, as well as decorative uses, have been found for corrugated glass by modern architects. It is an ideal screen for entrances, an interesting background for plantings, waterproof wall shower stalls, and a translucent material for room partitions.\textsuperscript{18}

Jalousie windows are a new and different approach by manufacturers toward the design of windows. A jalousie is simply a system of louvers which is operated similarly to the typical venetian blind for controlling light and air. This kind of blind has been used for many years in tropical climates where necessary ventilation must be combined with weather protection. The Casement Hardware Company of Chicago, Illinois, has substituted glass for the conventional wood slats and incorporated a convenient controlling mechanism to produce a practical window.

\textsuperscript{18}Ibid., Sect. 7/3.
The greatest advantage of jalousie windows is that their louver-like construction permits full window air flow even in a heavy rainstorm without the danger of rain blowing inside. This advantage makes jalousie windows suited for sleeping quarters and kitchen and bathroom windows. With obscure glass slats, they can be partly open, yet still offer privacy for bath and dressing rooms. Glass jalousies have also been installed in doors. Where light is not necessary, wood slats are supplied in regular glass jalousie frames to provide a controllable louver for ventilation purposes only.

Along with other materials designed for insulating purposes is a glass product called Thermopane, manufactured by the Libby-Owens-Ford Glass Company of Toledo, Ohio. Thermopane is a transparent, insulating glass unit. It is composed of two or more panes of glass separated by one-fourth or one-half inch of dehydrated captive air and sealed at the edges. Thermopane is fabricated to ordered sizes at the factory and may be obtained in either double- or triple-pane units. The double-pane glass reduces the heat transfer to approximately fifty per cent, and the triple-pane glass reduces the heat transfer to as low as thirty-five per cent. (This heat transmission value was determined at zero degrees outside temperature and seventy degrees inside temperature.)

19 The Casement Hardware Co., Win-Dor, Monograph No. 1002-49.

glass holds the room temperature is given in Solar Houses as follows:

Thermopane slows down such heat losses, yet permits entry of solar heat as a plus. Such heat enters through the glass on a short wave length. This ray strikes and warms objects within the room. The re-radiated ray now is of a longer wave length and is not transmitted through the glass, and thus is absorbed, trapped and utilized.21

In developing Thermopane the Libby-Owens-Ford Glass Company has eliminated condensation, a common fault of plate glass. This advanced idea in glass allows the architect complete freedom of its use in design without creating a problem in air conditioning. Through the use of Thermopane, the visual area of a room may extend indefinitely while the climate of the immediate area behind the glass may be comfortably controlled.

Glass block is a relatively new masonry product made of glass. An introductory statement of glass block is found in What Is Modern Architecture? published by the Museum of Modern Art, and is as follows:

Glass brick is most suitably used as a wall which admits light, yet excludes cold, heat, glare, and noise. More than any other new material, glass block has been stupidly misused as a "modern" mannerism with disregard for its practical advantages.22

Glass block is a hollow, partly evacuated block made of clear, pressed glass hermetically sealed at the time of manufacture. These blocks are laid much like brick in mortar and

22Museum of Modern Art, op. cit., p. 11.
create a highly textured, light-transmitting panel of high insulating value. Glass blocks are made in a wide variety of texture designs. Correctly used, this glass masonry material can add decidedly to the exterior and interior design of a house. Some of the blocks are made to redirect the sun's rays upward toward the ceiling purposely eliminating dark areas. With the proper use of glass block a room may be flooded in sunlight while the occupants enjoy privacy. Glass block has been used as a means of diffusing light in entrance halls, stairways, bedrooms, and bathrooms. Closets are made bright by the application of glass brick for their exterior wall, and the dark kitchen counter tops can be lighted by a horizontal band of glass blocks. Decorative partitions can be constructed of glass brick to separate living areas, and an easily maintained utility room built with glass block walls give plenty of sunlight. Glass block is truly a modern material of practical building value.
CHAPTER VI

HOW THE DEVELOPMENT OF PREFABRICATED CABINETS AND THE
IMPROVEMENT OF AUTOMATIC KITCHEN AND UTILITY DEVICES
HAVE CHANGED THE PLANNING OF KITCHENS AND UTILITY
ROOMS AND HENCE, THE OVERALL DESIGN OF OUR HOMES

The arrangement of the modern home is divided into three
general areas. These areas are designated as sleeping, liv-
ing, and working. The sleeping area is usually the determin-
ing factor for the rest of the house, especially in moderate
houses where mechanical air conditioning is too expensive and
not a practical investment. The sleeping area is given the
choice location for the best utilization of natural resources
in air conditioning. From the sleeping area the remainder of
the arrangement is made. The working space is ordinarily
placed at the opposite end of a house from the sleeping area
and the living area is placed between the two.

Utility rooms and kitchens have not always been considered
units to be housed under the same roof with the sleeping and
living quarters. Many of the plantation mansions had their
kitchens separate from the main house and connected only by a
covered walk. The task of laundering was done at an even more
remote location on the plantation community. In the less
extravagant houses, the cooking was done in special fireplaces
and the washing was done outside or under a shed. The clothes
were boiled in an iron kettle over an open fire and scrubbed by hand in wooden tubs. The drudgery of the essential and inevitable tasks of cooking and washing has been transformed into a pleasant duty with automatic machines placed in the kitchens and utility rooms.

Improved Kitchen Utilities

Few women realize that Benjamin Franklin was in any way responsible for the early beginning of their laboratory-like kitchen of today. Benjamin Franklin invented the first commercially successful stove at Philadelphia in 1744, scarcely 200 years ago. The importance of the stove is given by James Marston Fitch as follows:

To begin with, it was prefabricated. Using the most modern material of his time—cast-iron, Mr. Franklin was able to turn out on a mass-production basis a stove which could be readily assembled from a minimum number of standardized parts. It was lightweight, self-contained, efficient, and relatively cheap. From this early innovation of the indefatigable Franklin, all modern stoves and most air-conditioning are linearly descended. For heating purposes, these stoves marked such an advance over the fireplace, both in terms of efficiency of conversion and efficiency of heat distribution, that they soon outstripped it. For cooking purposes, of course, their advantages were even more pronounced.¹

The invention of the stove launched a new era in house planning and as its efficiency exceeded that of the fireplace, it soon replaced this conventional source of heat. More important to the housewife, the stove was likely the first major improvement toward the contemporary well-planned functional

kitchen. Later came stoves adapted to the use of kerosene, natural gas, and electricity. Recently with the development of butane and propane gas, stoves have been adapted to these fuels for suburban homes where natural gas is inaccessible.

A recent development in stove design has been introduced by the Thermador Electrical Manufacturing Company of Los Angeles, California. Instead of having the top cooking unit and the oven combined in one appliance, the Thermador built-in electric range is made in separate units. The cooking top may be installed right into the counter while the oven may be placed elsewhere in the room at a more convenient location and at a height which eliminates stooping and low-level lifting.\(^2\)

Gas and electricity led to the development of many variations of the stove, one of which was the hot water heater. This invention afforded running hot water for kitchens and bath rooms and has become a practical installment and is economical enough for universal use. Other than inducing one more appliance to be housed in the kitchen, or elsewhere, water heaters did not make any noticeable change in house design. They were indirectly responsible for later making changes with the introduction of dishwashers and automatic washing machines.

The built-in cabinet has changed the interior design of the kitchens. The kitchen cabinet has changed from a separate movable piece of furniture to an integral part of the construction and design of the kitchen. The contemporary kitchen is

equipped with either a custom-built cabinet or prefabricated factory-built units which may be assembled into almost any desirable arrangement of continuous counter and storage space. The sizes of all kitchen equipment have been standardized so that stoves, water heaters, and storage units will fit together to form a continuous counter.

No longer is the kitchen planned as just another room, but is planned as a specialized, labor-saving workshop, entirely different from the rest of the house. Probably the most oppressing tasks in the long list of kitchen chores are dish washing and the removal of waste resulting from food preparations. Fast, automatic dish washing machines thoroughly wash, rinse, and spin dry in five minutes all the dishes used by a family of four in a day. Sinks may be equipped with an attachment for rinsing dishes when only a few are washed and for cleaning fresh vegetables.

Garbage disposal units have eliminated the unpleasant task of emptying the garbage pail. Of these units there are two types. The most common type is a mechanical unit installed under the sink drain opening and built into the waste pipe. All food wastes, including paper napkins, vegetable peelings, fruit pits, and even bones are ground into tiny particles and washed down the drain.3 However, in some cities the city ordinance forbids mechanical disposal units connected to the city sewer line. Fats, when cool, tend to collect and solidify,

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3 Given Manufacturing Company, Waste King Kitchen Pulverator, Monograph No. A34822-CF.
and sometimes completely clog sewer pipes. To offset this complication, another refuse-disposing unit has been designed to operate on an entirely different principle. The garbage is placed inside an insulated receptacle and is gradually burned into ashes by a small, continuous burning gas flame. The ashes fall into a removable container and may be easily retrieved and used for fertilizing purposes. Either of these methods installed in the kitchen are odorless, sanitary, and provide an efficient solution to the garbage problem.

Ventilating fans have been installed in kitchens, laundries, and bath rooms, and have proved to be a good investment. "A suction fan just above the cooking range will take out all smoke, odors, and particles of grease that are always present in the process of cooking." 4 Unless grease and smoke are eliminated immediately, they will spread over the entire kitchen and form an oily film on all surfaces. A ventilating fan placed over the sink and in the laundry and bath rooms will remove the high moisture content of the air.

The neat arrangement of utilities, the clean appearance of porcelain equipment, and the attractive wall, counter and floor materials have made the modern kitchens presentable enough for the most critical visitors. This attractiveness of the modern kitchen may have been instrumental in the change of location from the back part of the house to the front, particularly when the logical room arrangement requires it. The

4Martin and Vivian Reade, That New Home of Yours—Build It Right, p. 70.
size of the kitchen also has been affected by the invention of mechanized appliances. Architects using the straight-lined compact appliances have been able to design smaller, more efficient kitchens. These smaller kitchens are more convenient and may be arranged to save a housewife many steps in the preparation of the family meals.

**Improved Laundry Units**

Laundry rooms and utilities have been neglected until recently. The conventional washing machine was only slightly advanced from the iron kettle, rub-board, and tubs. This non-automatic washing machine has only price in its favor compared to the fully automatic machines of today.

Conventional machines were messy and required the installation of tubs for rinsing. For this reason, the laundry was usually located in the basement or outside the house. In the Southwest where houses are seldom built with basements, the laundry was usually located in one side of the garage with a concrete floor installed to drain off spilled water. This arrangement was not convenient and the operation of the machine required constant attention.

Architects and manufacturers were encouraged to improve upon the inadequate laundry utilities and the automatic washing machine was developed. The automatic machine needs only to be filled, the timing dial set for the type of laundry, and the switch turned on. The housewife is then free to do other things because no other attention is necessary. Architects
saw in the automatic washing machine the possibility of installing it inside the house as a kitchen appliance. Messy floors are eliminated and the neat appearance of the porcelain unit fits in well with the modern stove, the refrigerator, and the water heater.

An investigation by Bendix Home Appliances, Inc., South Bend, Indiana showed that the majority of women preferred to have a laundry room, or utility room, adjacent to the kitchen with a separate outside door. Thus a utility room was added to the floor plan of the modern house primarily for laundry purposes. There are, however, many other uses for the utility room. In addition to making laundry work more convenient, the utility room is an excellent place for ironing and sewing and provides a practical location for the frozen food locker, and is a suitable place for the water heater.

This modern utility room is well planned for convenience and efficiency. Windows are made large to admit plenty of light, and ventilating fans or louvers are installed to rid the room of vapor. "Contrast this light, airy, cheerful and convenient laundry to the usual dark, poorly-planned makeshift laundry."\footnote{Bendix Home Appliances, Inc., \textit{Architects Handbook}, Monograph No. 35--D.}

Manufacturers and architects have combined their efforts in producing machinery and blue prints to make housekeeping an easier task. Their accomplishments have been responsible for \footnote{\textit{Ibid.}, p. 17.}
making the home a more pleasant place to work and a better place in which to live.
CHAPTER VII

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

This study was concerned with building materials and processes used in contemporary construction. The purpose of the study was to determine how these products of the building industry have changed the construction and design of small homes. The study was divided into six chapters according to the place and purpose of materials in the structure of the small home. These chapters are briefly summarized in the following paragraphs.

Chapter I introduces the study and gives a brief history of American building and architecture. The architecture and structural systems of the United States are traced from the time of the earliest colonies to the present day. It was found that the Swedes and the Germans were the only colonists who built log cabins for dwellings in the New World. The English type of building was a heavy framed construction and was the forerunner of the wood-framing systems used today. The Indian adobe type of construction was used by the Spaniards in the Southwest and was the only instance where the native method of building was used as a pattern of construction by the settlers. Brick, adobe, and sod construction were used only in locations where trees were scarce, or where conditions
were detrimental to lumber. Wood was abundant along the eastern seaboard and became the major building material for construction in colonial days and has remained the favorite building material for homes since that time.

Chapter II is concerned with the discussion of processes and materials which affect the structural members of houses. Termites are controlled by the termite shield, or by having the lumber impregnated with a chemical poisonous to the termite. Chemical preparations are designed to control both the termite and fungus in the same application, and other chemicals have been found which are successful in making lumber water repellent and fire resistant.

Steel and laminated wood structural members have been used as an economical framing method where large rooms require great spans and where columns would be objectionable. Some manufacturers are producing prefabricated steel houses. From the many interchangeable wall sections and roof assemblies, a variety of designs for economical small homes are available.

Chapter III presents a discussion of the recent developments in solid and veneer masonry materials and the effects they have had on the construction of small dwellings. Brick veneer houses with wood framing developed from the solid brick construction as a cheaper way of building. In different geographical locations, where suitable stone could be obtained, it later replaced brick. A revolutionary process for molding a type of cement in imitation of stone on any type of wall is one of the latest developments in veneer construction.
Different kinds of tile have become popular as building material within the past few years. Clay and concrete tile, Brikcrete and Dunbrik, are all variations of building tile widely used today.

Reinforced concrete is rapidly gaining recognition as a durable and economical building material well adapted to small homes, and is widely used for flat roofs, especially on houses where water is maintained for insulation purposes.

Chapter IV describes how the changes made in siding and roofing materials have affected the small home. Wood shingles have been replaced with fireproof asbestos and asphalt shingles which are cheaper. Metal roofing has become popular for contemporary architecture. Built-up roofs are recommended by modern architects for their economy and practicability. Reinforced concrete roofs are especially adapted to steel and concrete structures where water is used on top for insulation.

Chapter V gives the development in materials which affect the interior design of small homes. Wood flooring is being produced in prefabricated and prefinished strips or square units which, after application, need only to be waxed and buffed. Clay tile is now used as flooring material for entrances and terraces where it is likely to be exposed to excessive dampness. Cork, asbestos, and asphalt tiles are used for floor surfacing in kitchens, utility rooms, and work shops because they are easy to clean and are immune to hard wear.

Wall and ceiling materials are available in a wide variety of wood and composition materials. Gypsum wallboard and
plywood are the most common of these materials. Wood, asbestos, and plastic composition materials are found in a wide variety of colors and textures. Flexwood is a thin sheet of wood on a canvas backing which may be applied to any wall in much the same manner as wallpaper to produce the effect of solid wood walls. Acoustical materials are produced which actually serve three purposes; namely, to control sound, to insulate, and to decorate.

Glass is being treated in many different ways in the modern house. Larger sizes of plate glass are being used to form entire walls. Textured or figured structural glass is used for two purposes. First, the translucent qualities do not restrict light, but diffuse the rays so that the glass is a suitable screen for places where privacy is desirable. Second, the interesting textures lend themselves readily to interior decoration. Glass jalousies, a new movable louver type of window which admits light, permits circulation of air, and gives complete protection against rain, are now used in sunporches, kitchens, bath rooms and dressing rooms. Where privacy is desired the jalousie is fitted with translucent glass.

Chapter VI explains how the improvement of automatic kitchen and utility devices have changed the planning of kitchens and utility rooms and the arrangement of the whole house. Kitchens and laundries have received increased attention from architects and manufacturers during the past few years, and a number of progressive changes have been made.
The kitchen has been reduced in size from a large room furnished with movable cabinets to a smaller, fixed, more compact, efficient unit. The clean attractive appearance of the modern kitchen has allowed it, in some cases, to be moved to the front part of the house if the practical arrangement requires it.

The laundry room has changed in appearance and location with the adoption of automatic washing machines. The automatic machine has been either placed in with the kitchen appliances or located in the utility room adjoining the kitchen. This room, although created primarily for laundering, is often employed for ironing and sewing, and frequently contains the frozen food locker.

Conclusions

The changes in structure and design that have evolved from the use of new materials and processes are as follows:

Structural changes.--

(1) Steel framing members produce a frame stronger and more durable than untreated wood against wind, insects, and decay.

(2) Manufacturers of prefabricated steel houses have introduced a new method of mass production for construction by which small economical and durable rental houses are built. The assembly methods of prefabricated units have greatly simplified house construction.
(3) Stone and brick veneer construction, due to their lighter weight, have lessened the foundation requirements of the original solid masonry walls.

(4) Clay and Concrete tile, Brikrete, and Dunbrik are materials which are lighter in weight, larger in unit size, and more economical in construction cost than brick or cut stone. Because of the lighter weight, less foundation is required; and because of larger units, labor costs are reduced.

(5) Prefinished wood blocks, combined with bonding materials have made possible wood floors on concrete slab foundations. Asphalt, rubber, and asbestos tile are new durable flooring materials for bathrooms, kitchens, utility rooms, game rooms, and work shops.

(6) Gypsum board is an economical material which permits much faster construction. Masonite and plastic products are neat durable finished wall materials which have replaced the more expensive tile and inefficient oil cloth wall covering for kitchens and bath rooms. Plywood has made possible stronger and more easily constructed walls.

(7) Strong laminated wood framing members have eliminated the necessity for conventional braced construction for wide spans.

(8) Reinforced concrete has been introduced as an entirely different method of construction for small homes. 

Design changes.--

(1) Treated wood and steel are impervious to termites,
fungi, moisture and fire, and allow the architect to design houses closer to the ground.

(2) Fire-proof asbestos siding and aluminum siding, because of its resistance to termites and decay, allows the exterior wall to be dropped to the ground.

(3) Because of the use of preserving oils instead of paint, emphasis may now be placed on the natural color and grain of wood siding.

(4) Because of the water-proof qualities, fire-resistant asbestos and asphalt shingles have replaced the conventional wood shingle, and the pitch of roofs have subsequently been lowered. Metal roofing has allowed the roofs to be lowered to an even shallower pitch, and built-up roofing has allowed the pitch to be decreased to the very minimum for flat roofs.

(5) Reinforced concrete has permitted the use of flat roofs and cantilever construction. Greater freedom in forms may be obtained from poured concrete. The floor and foundation have been combined into one structural unit, in the concrete slab, and houses can be built flush with the ground level.

(6) Ceramic tile is used inside the house in entrances and rooms which open out on to terraces. The feeling of continued space is created by having the flooring continue past glass walls or panels out into open areas.

(7) The more expensive woods may be obtained in the form of veneer and produce the same effect as solid paneling, but at a lower cost.
(8) Acoustical materials have greatly improved the acoustical conditions in the modern home, and the patterns in these materials have given a new surface texture to the walls and ceilings.

(9) Prefabricated storage units have eliminated the necessity for movable pieces of storage furniture, thereby giving more free space and making cleaning easier.

(10) Laminated wood framing members have made possible large rooms without the use of supporting columns.

(11) Plate glass has enabled architects to design houses with large continuous surfaces, and even entire walls of glass. This use of glass not only admits an abundance of sunlight, but also creates the feeling of spaciousness without sacrificing the comfort of controlled climate.

(12) Glass block is another form of glass which has decorative qualities and is suitable for a wall which will admit light, yet exclude cold, heat, glare, and noise. Glass block is an excellent material for the exterior walls of bath and dressing rooms where both light and privacy are desired.

(13) Textured structural glass is used for decorative interior screens and partitions which offer privacy.

(14) Glass jalousies are used for sun porches and kitchens to admit light and free circulation of air, but will keep out high wind and rain. Translucent glass jalousies are used where privacy is essential.

(15) With improved kitchen utilities, architects have been able to design smaller, more compact, and efficient kitchens.
The attractive appearance of the modern kitchen has made it acceptable in any location in the house, and colorful, hand finished surfacing materials have made it a cheerful place in which to work.

(16) The automatic washing machine and the frozen food locker are largely responsible for the addition of a new room to the floor plan of the home. The dingy laundry of the basement or garage has been replaced by the utility room, usually adjacent to the kitchen. Other activities such as sewing and ironing have been moved to this room.

Recommendations

The following recommendations are made:

Many new materials and processes are being developed each year; therefore, it is recommended that a periodical study be made of the new products and their influence on architecture, and that this information be made more accessible to the public.

Those courses taught in consumer education should include an extensive study of the materials and appliances used in the construction and equipping of modern homes.
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