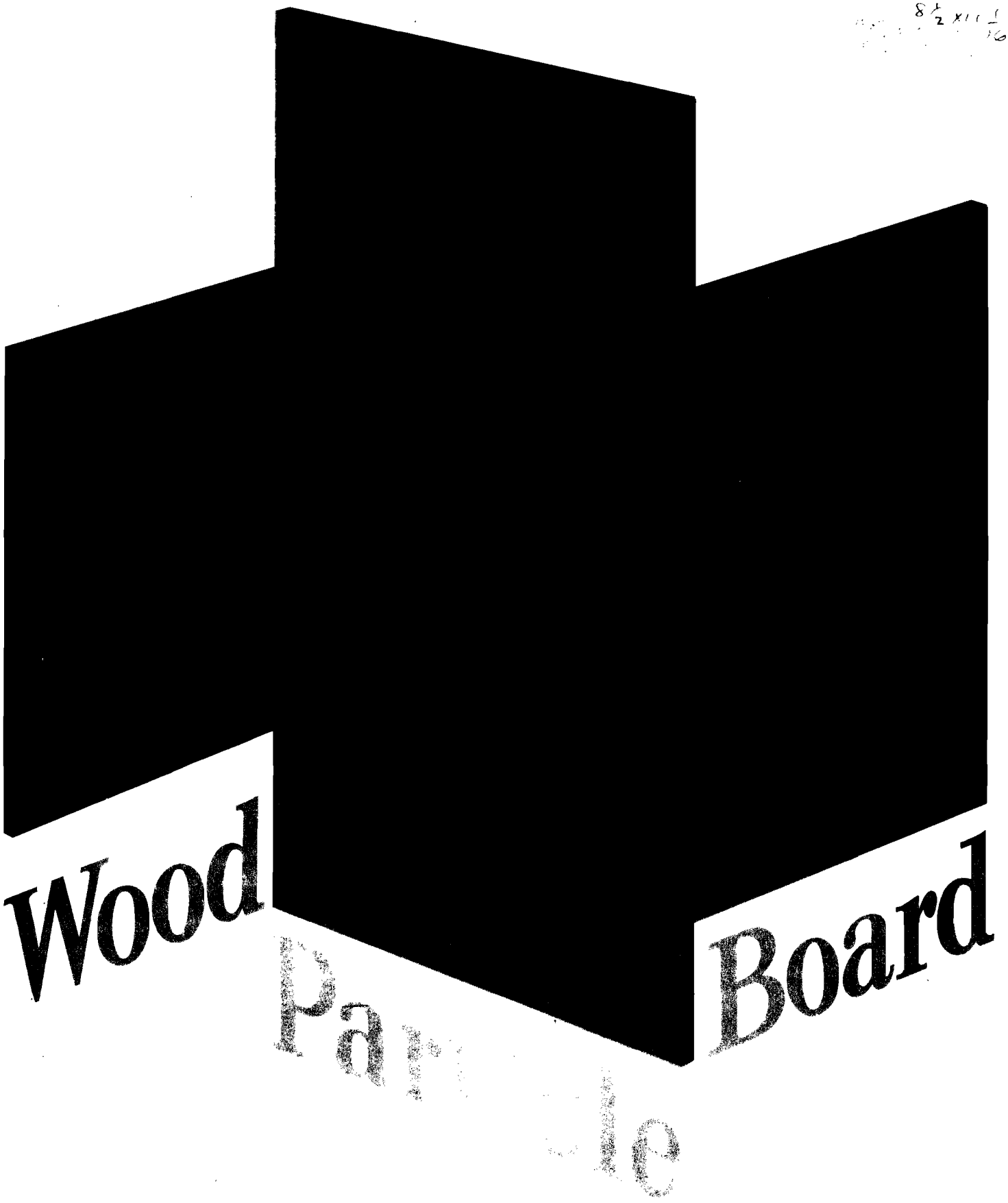

A MANUFACTURING OPPORTUNITY IN GEORGIA

BY TZE I. CHIANG • PREPARED FOR GEORGIA DEPARTMENT OF COMMERCE • ENGINEERING EXPERIMENT STATION, GEORGIA INSTITUTE OF TECHNOLOGY

Project B-140-8

WOOD PARTICLE BOARD

A Manufacturing Opportunity in Georgia

Prepared for
The Georgia Department of Commerce

by

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Foreword

This is the eighth formal technical report completed for the Department of Commerce as part of Project B-140, and the third to deal with products which can be made from wood or wood residue. Further studies of opportunities for manufacturing products using Georgia's extensive forest resources are planned as available funds permit.

The prospects for developing industries of this type are evident from the fact that two major companies have been actively interested in the report from the time the first draft was prepared the latter part of January. Certainly Georgia can expect continued growth of timber-using manufacturing operations.

More detailed information regarding specific location possibilities will be provided on request. Comments or questions regarding the analysis are invited.

Kenneth C. Wagner, Head
Industrial Development Branch

Acknowledgments

Many corporations and woodworking concerns have offered their time and information to help make this study possible and the results more rewarding. The writers wish to express their appreciation to the following persons and corporations: Mr. W. B. Bourne and Mr. Mahlor Day of Roddis Company; Mr. J. P. Burford, Jr. of U. S. Plywood Corporation; Mr. A. F. Clark of Lenoir Chair Company; Mr. J. R. Goldston of Dixie Chipboard Company; Mr. W. L. Irwin and Mr. Herbert Connelly of Poinsett Lumber Company; Mr. Edwin Jarrett of Gray Products Company, Inc.; Mr. W. McNatt of Dixie Plywood Company; Mr. H. G. L. Miller and Mr. R. C. Seavers of Miller Hofft, Inc.; Mr. C. S. Sutton of Sutton Woodworking Machine Company; and Mr. J. L. Story of Plywood Supply Company.

Thanks are due to Mr. Rufus H. Page and Mr. Joseph R. Saucier of Georgia Forestry Commission for their cooperation in suggesting two possible sites for a particle board plant and for sharing with us the prepublication results of their "Survey of Wood Residue in Georgia."

SUMMARY

Particle board has been the fastest growing product of the United States woodworking industry for the last three to four years. The impact of its growth is being felt in almost all wood-using industries. Currently particle board has distinct advantages over lumber, plywood, and hardboard in certain characteristics which will lead to its further expansion in the near future.

Particle board is widely used as a core material in cabinet work, furniture, fixtures, and millwork. Its use in subflooring, for interior wall, and for other purposes is increasing substantially. The future demand of this product is difficult to measure, due to the continued research and development projects under way in the industry.

The present production of wood particle board is highly concentrated on the West Coast and in North Carolina. The future trend of production is toward decentralization, due to high transportation costs and the product's diverse uses. Georgia is one of the two areas east of the Mississippi which can be recommended for a particle board plant.

The basic considerations in locating a particle board plant are the availability of raw materials and access to markets. Georgia provides the best wood materials--yellow pine and gum--for high quality flakeboard production. It also has an abundant wood residue supply for splinter or shaving-type board production.

What is more important, Georgia itself has a market potential of between 9 to 10 million square feet a year for particle board. A plant in central or southern Georgia would strategically accommodate a market covering Georgia, Florida, and Alabama. There is not a single particle board plant in these states. Such a strategic location would offer a freight advantage of roughly two cents a square foot over products from Virginia and North Carolina and four cents a square foot over products from the West Coast.

Two plant models are suggested. The first is designed to produce five million square feet of splinter-type board a year from wood residues, using the horizontal extrusion process. A total investment of $356,700 to $492,700 is estimated. The production cost per thousand square feet is estimated to range from $85 to $119, while the f.o.b. mill price per thousand square feet is $110. The profit on total investment will be -5% for one shift, 14% for two shifts, and 29% for a three-shift operation.

The second plant is designed to produce flake-type board from green, round pine wood by the multi-platen process. It has an annual capacity around 15 million square feet. The total investment is estimated between $1,556,000 to $1,988,000. The production cost per thousand square feet is estimated at between $110 to $157, with an f.o.b. mill price per thousand square feet of $138. The profit on total investment will be -6.8% for one shift, 10.3% for two shifts, and 23.7% for a three-shift operation.

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I. INTRODUCTION

This study treats a new wood product known as particle board. This product is also known as "chipboard," "flake board" and by other names, depending on the raw material used. Wood particle board may be defined as a composite product made of splinters, shavings, flakes or chips which are bonded by resin under high pressure.

Wood particle board manufacture has been the fastest growing segment of the United States woodworking industry in the last three to four years. Production capacities in the United States rose from 75 million square feet in 1954[1/] to 332 million square feet in April, 1957,[2/] and to 596 million square in 1958.[3/] The rate of growth in 1958 was an average of one new plant per month. Only the history of plywood development in the early 1930's can be compared with recent wood particle board expansion. There are over 60 plants engaged in its production; at the present time, however, none is located in Georgia, Florida or Alabama.

Georgia has an ample supply of wood resources and borders both Florida and Alabama. A particle board manufacturer in Georgia could make use of the plentiful supply of wood residue. At the same time, he could serve the sizeable present market and be in a position to capitalize on the vast potentials particle board offers for the future.

Purpose of the Study

The purpose of this study is to evaluate information pertaining to market potentials, raw materials, and cost and return of production which may be useful to those who are interested in setting up a wood particle board plant in Georgia. Although such a plant might serve several neighboring states, the marketing aspect of this study was confined to Georgia because of limitations of time and funds.

The specific objectives of this study are:

1. to determine the market potential of wood particle board in Georgia;
2. to determine the best type or most adaptable type of particle board to fit the market in Georgia; and

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1/ E. S. Johnson, Wood Particle Board Handbook, School of Engineering, North Carolina State College, August, 1956, p. 7.

2/ This figure was obtained from a private institution engaged in a particle board study.

3/ See Table 1.

3. to describe typical plant models and their manufacturing methods, and to suggest possible locations for plant sites.

Methods of Procedure

Three distinctive areas were explored: market potentials, raw materials, and engineering. Each is briefly discussed below.

1. Market Potentials. A preliminary market study was first made by interviewing the leading representatives of manufacturers and distributors of wood particle board in Atlanta. Later a detailed questionnaire was designed to obtain information on types of product, supply, demand, pricing, transportation, competing items, qualities of an ideal board, etc.[1/] The questionnaire was pretested and revised by interviewing a few large particle board users in the Atlanta area.

The revised questionnaire was sent to 438 possible users of wood particle board in Georgia. Included were manufacturers of furniture, cabinets, closet doors, flush doors, interior wall paneling, subflooring, sheathing, millworks, and fixtures. Of the 438 questionnaires sent out, 415 were delivered. After a period of four weeks, a total of 83 had been returned.

2. Raw Materials. Information on raw materials was obtained through correspondence with the Timber Engineering Company, Washington, D. C., and Forest Products Research Society, Madison, Wisconsin, and in conferences with members of the Georgia Forestry Commission, Macon, Georgia.

3. Engineering. Visits were made to five operating wood particle board plants in October, 1958, to study the actual operations and to compare the different processing methods. Included were Singer Company, Pickens, S. C.; Dixie Chipboard Company, Rural Hall, N. C.; Gray Products Company, Inc., Waverly, Virginia; Lenoir Chair Company, Newton, N. C.; and American Par Board Corporation, Black Mountain, N. C.

Information on plant design was obtained from top machine designers of particle board plants. Miller Hofft, Inc., Richmond, Virginia, and Sutton Woodworking Machine Corporation, Greensboro, N. C., were consulted particularly.

1/ See Appendix E.

II. TODAY'S PARTICLE BOARD INDUSTRY IN THE UNITED STATES

The development of wood particle board industry in the United States took place after World War II. A few plants were built according to German processing methods. Following the discovery of urea formaldehyde glue as binder eight years ago, the industry took a great stride forward. Newer and better types of flaking or chipping machines were made and improved processing methods were developed to adapt to the American market. These recent developments of technical "know-how" and machinery are responsible for much of the progress made in the wood particle board industry.

Pioneers of wood particle board production in the United States conceived of an all-purpose board equivalent to plywood or lumber. The same board was recommended as core material for furniture, doors, wall paneling, subflooring, sheathing, and many other purposes. After several years of marketing experience, this concept proved to be unpracticable. Wood particle board is characteristically different from plywood or lumber. The present manufacturing trend is toward several types of board, each suited for certain specific uses.

The industry has thus far concentrated its efforts on invading the core material market, which is probably the most lucrative area. A much larger market exists in the construction outlets; this area will be invaded more thoroughly as the production cost drops and technology of the industry improves.

Plant Locations and Tendency

There are 61 known wood particle board plants scattered over 19 states.[1/] (See Table 1.) These plants are highly concentrated on the West Coast and in North Carolina. (See Map 1.) The abundant wood resources and large scale operating units gave the west coast woodworking industry an initial advantage in developing any new product based on wood. In the East, North Carolina is strategically located in the center of the Atlantic area, close to both markets and resources. It has the advantages of wood waste supply in the form of sawmill slabs and is in a furniture manufacturing center. About one-third of the captive plants are located here and additional plants are under construction.

1/ A list of the particle board plants in the United States indicating location, plant capacity, type of operation, type of wood particle used, and board size is given in Appendix A.

Table 1

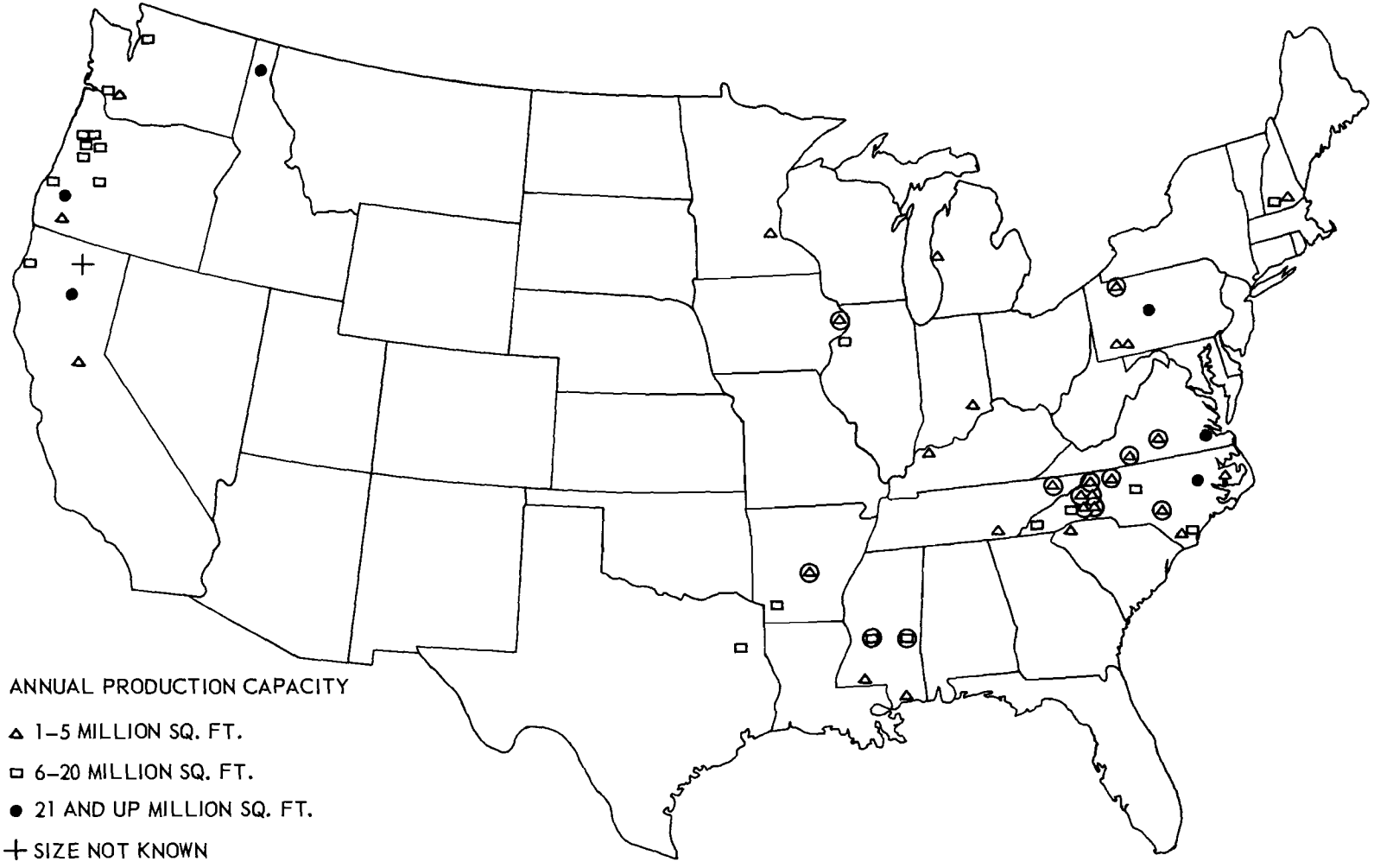
Particle Board Plants by State, 1958

State	Number of Plants	Annual Capacity (Million Sq. Ft.)
Arkansas	2	9.00
California	4	63.25
Idaho	1	40.00
Illinois	1	18.00
Indiana	1	5.00
Iowa	1	2.50
Kentucky	1	2.25
Michigan	1	3.00
Minnesota	1	3.75
Mississippi	4	24.25
New Hampshire	2	9.75
North Carolina	14	118.40
Oregon	9	120.50
Pennsylvania	4	34.00
South Carolina	1	5.00
Tennessee	2	8.00
Texas	1	10.00
Virginia	3	35.00
Washington[a/]	4	41.87
(Location not indicated)	4	43.00
Total	61	596.52

a/ Includes one plant for which no capacity is given.

Source: Compiled from Master Chart in Appendix A.

MAP 1
PARTICLE BOARD PLANTS IN THE UNITED STATES, 1958



SOURCE: Table 1

There are several areas in the United States without any particle board manufacturing or with only a limited amount of annual capacity. (See Map 2.) Two areas east of the Mississippi are worthy of consideration for further development of the particle board industry: The Great Lakes States and the Southeast. The Great Lakes area has neither major nor high quality flakeboard manufacturing but it is a major market for furniture and building materials.

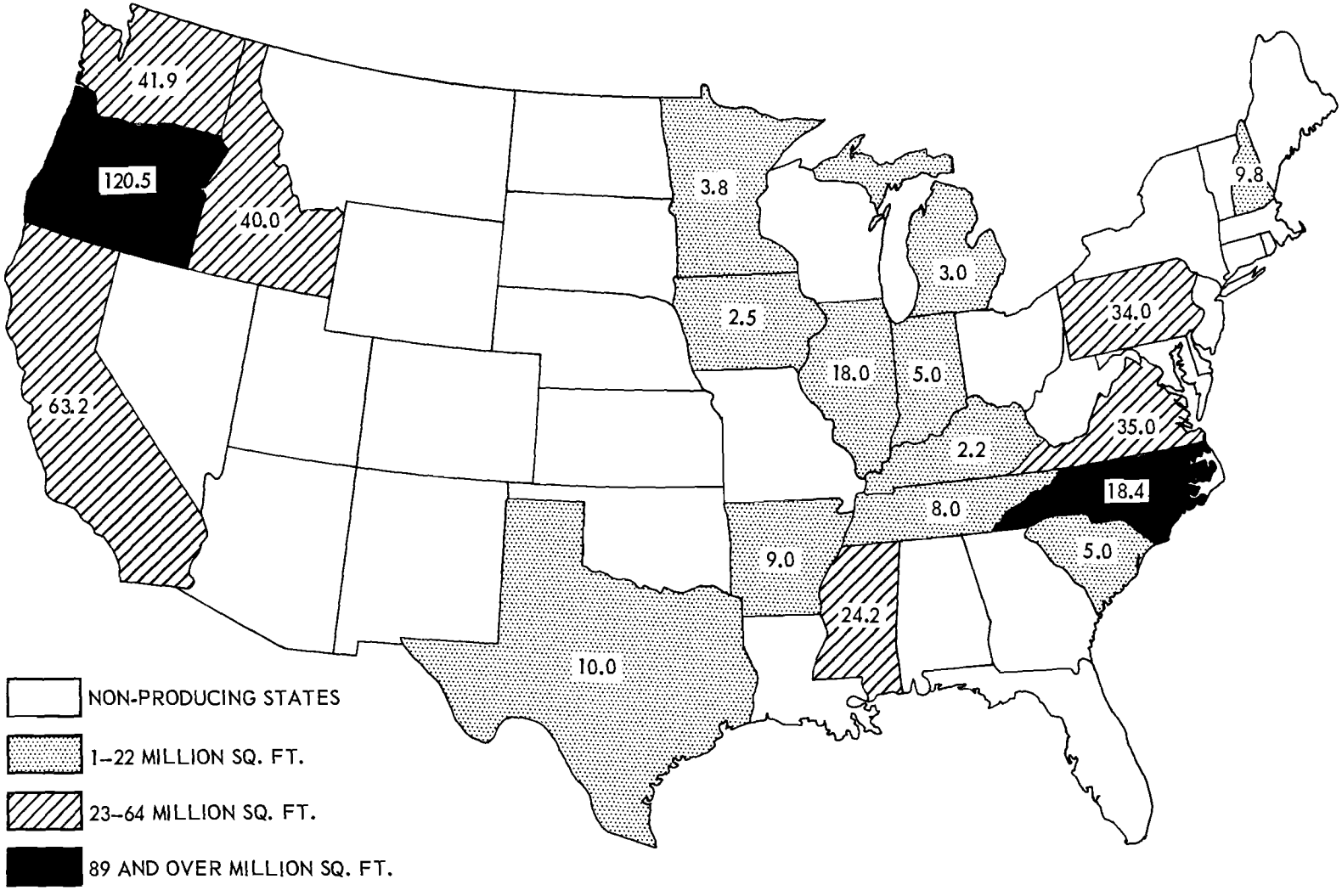
Although raw materials and labor costs are a little higher, a particle board plant located in this area would enjoy a big market and an advantage of lower freight costs over the East or West Coast. The second area lies in the section of the Southeast which includes South Carolina, Georgia, Alabama, and Florida. This area has the advantage of an extensive raw material supply in the form of pulpwood or woodwastes from sawmills. Although this area is not a major center of manufacturing and marketing of furniture and building materials, it does have a substantial amount. A particle board plant located in south Georgia could serve this area with a freight rate advantage over the boards shipped in from North Carolina, Virginia, and the West Coast. On the basis of 3/4-inch thickness and 50-pound boards, this advantage would be roughly two cents per square foot over products from Virginia and North Carolina and four cents per square foot over products from the West Coast.

Increasing transportation cost and diverse uses of particle board will cause the industry to scatter rather than to concentrate in a few states. The board can be made from a great variety of wood species, which provides different localities a further opportunity to establish particle board plants.

Comparative Plant Size and Tendency

Plant size or capacity has always been one of the major economic considerations for potential investors. Two critical points--unit cost of product and market potential--emerge as the focus for evaluation. It is commonly known that up to a certain point, the larger a plant is, the lower the unit cost will be. It is important to determine the adequate plant size and optimum operation which will guarantee a profitable investment.

MAP 2
STATE CAPACITY FOR PRODUCING PARTICLE BOARD, 1958



SOURCE: Table 1

Table 2

Plant Capacity of Captive Particle Board Plants
in the United States
(Million Square Feet)

Annual Capacity	Number of Plants[a/]	Total Annual Capacity	Average Annual Capacity
1 - 4.99	6.8	19.20	2.81
5 - 19.99	8.5	57.25	6.74
20 and above	---	--	--
Total	15.3	76.45	4.99

The average size of the non-captive plants is a little over 12 million square feet a year. Nine of these plants account for almost half of the industry's total capacity (Table 3). It is quite probable that these large plants were built to serve a national market, while the small and medium-sized plants were built to serve a local or regional market.

Table 3

Plant Capacity of Non-Captive Particle Board Plants
in the United States
(Million Square Feet)

Annual Capacity	Number of Plants[a/]	Total Annual Capacity	Average Annual Capacity
1 - 4.99	11.2	33.67	3.01
5 - 19.99	17.5	156.90	8.97
20 and above	9.0	277.50	30.83
Total	37.7	468.07	12.43

The prime objective of captive plants is to turn wood wastes into low-cost core material for a plant's own use, although some do sell their excess products. On the other hand, non-captive plants sell their entire output on the open market. In order to compete successfully they emphasize making a finer product with a lower unit cost. A highly automatic processing method and large plant size are usually adopted to attain this purpose. The trend is certainly in this direction. Furthermore, only a large scale plant with an

a/ The fraction is due to the fact that some mills are operated to supply the open market as well as their own uses.

abundance of raw materials at hand could guarantee uniform manufacturing on a specification basis year after year. Ability to meet specifications is an important consideration for large users of particle board.

Integration and Diversification

The losses sustained by the forest and woodworking industries through wastefulness and lack of integration are tremendous. From sound tree to end products such as lumber, plywood, and furniture, wood wastes in logging and manufacturing processes reach as high as 50 to 70 per cent. Wood wastes in various forms create a disposal problem for many woodworking industries. These wastes may be given away, burned as fuel, or sold at a very low price.

There are many woodworking industries interested in particle board manufacture. The main concern is the same--fuller utilization of available resources. In fact, much particle board is produced as a part of the integrated operation of large or medium-sized furniture plants. The wood wastes from furniture plants are processed as particle board to be used as core material for such products as dinette tables, cabinets, TV and sewing machine cabinets, office and bedroom furniture. A low cost and quite suitable core material is thus produced. The average production cost of particle board under captive operation ranges from four to six cents a square foot. Most of the captive plants are highly efficient in operation.

Lumber manufacturers also are interested because they possess immense wood resources. Particle board manufacturers can use small-size wood logs or even wood wastes from planing mills without touching the major resources needed for lumber. Advantages may also be gained by utilizing a lumber manufacturer's existing distribution system to handle particle board sales. Particle board is used in about the same range of thickness as lumber and can be used for many of the same purposes.

Manufacturers of plywood may have the same interest in particle board production as lumber men. Wood wastes from plywood mills can be used either as wood raw material or fuel for particle board production. The production and distribution of particle board can be integrated into a plywood plant.

One large-scale and fully automatic particle board plant was put up by the West Virginia Pulp and Paper Company in 1958. The huge pulpwood resource possessed by the paper industry is more than sufficient to support the current pulp production. It is natural for paper pulp manufacturers to look for a diversified business which will give a return at least as great as from pulp.

Yellow pine and aspen pulpwoods are among the best materials for particle board manufacture. The yield from paper pulp processing is the same as from particle board manufacture--50 per cent of raw material. The rate of return for both products is approximately the same--$150 per ton of product.

The plastic and paper industries have reason to be interested in particle board too, since it can be produced in conjunction with products such as decorative laminates of printed papers, or veneered with plastic and distributed at low selling cost. These products are already on the market.

Among the existing particle board plants, most are either integrated or diversified wood manufacturing industries. As markets develop and the product improves, this infant industry may tend to be more independent in operation.

Competition

1. Inter-Industry Competition

Lumber, plywood, and fibre-type boards are generally considered as the competing items to wood particle boards.[1/] Two distinct elements, physical properties and comparative costs, must be considered in evaluating their respective advantages and disadvantages in different end uses.

Wood particle boards designed for varying end uses are made by combining special size and shape particles with glues. One of the greatest technical advantages of particle board over other materials lies in the flexibility of physical properties designed to meet a specific purpose. Another advantage is that wood particle boards, properly made, are a uniform product, whereas the natural variations in lumber and plywood caused by growth rings, knots, compression and tension, lightning scars, and pest damage result in unpredictable changes.

In the mail survey conducted for this study, 12 manufacturers and users of particle boards gave their opinions on various characteristics of different board materials. Table 4 shows the number of manufacturers who favored one material to another for a certain physical characteristic. Particle boards were favored for dimensional stability, lower warping tendency, and smoothness. Lumber and plywood were reported as better in screw holding

1/ Fibre boards have another general name--hardboards. There is some confusion about fibre boards and particle boards. Although they are both synthetic materials, particle boards are resin-bonded wood splinters or flakes, while fibre boards are made from disintegrated natural wood fibres pressed together either without or with very little resin binder.

ability, bending and breaking strength.[1/] The number indicating density under particle boards should not be interpreted as preferential. It merely indicates that particle boards are heavier than other materials. It seems that no one product is superior to the others at the present time. Particle board may be regarded as another type of lumber material which has its independent characteristics. The ultimate choice depends upon a given application and cost consideration.

Table 4

Preference as to Physical Characteristics Among Different Board Materials Indicated by Twelve Particle Board Users[a/]

Physical Characteristics	Particle Boards	Lumber and Plywood	Fibre Boards
Hardness	4	2	5
Smoothness	7	2	5
Dimensional stability	9	2	1
Relative water absorption	4	2	2
Screw holding ability	2	7	0
Warping tendency	9	2	1
Bending strength	0	7	0
Breaking strength	0	7	0
Density	7	0	0

a/ The numbers may not total 12 because in some instances users show an equal preference and in others no preference to the materials listed.

In the survey, manufacturers indicated that particle boards were less expensive for a given use than plywood. On 3/4-inch basis, particle boards had an advantage over plywood by four to eight cents per square foot. Generally, particle board from 1/2-inch to 1 1/2-inch in thickness can be made to sell at prices which are less than current prices of finished lumber plywood. The concensus of opinion was that particle board, with its uniform quality and custom-made panel size, requires less tooling for end use. Total costs are therefore reduced. Since there is a wide selection of wood particle boards available on the market, however, it is not practical to compare the cost of each with lumber and plywood.

1/ Laboratory tests for screw holding ability may well be more demanding than the actual requirements of manufacturing.

The competition between particle boards and fibre-type boards is not as great as between particle board and lumber and plywood. Fibre-type boards are rarely made to exceed 3/8-inch because of the high cost of drying, while particle boards rarely are made less than 3/8-inch thick. Their applications are diverse too. Fibre boards are used primarily for construction work or wherever hard-wearing surfaces are desired. Particle boards are used as core materials more than in construction.

2. Intra-Industry Competition

There are more than 40 non-captive particle board plants in the nation. Products of these plants vary as to raw materials, qualities, and appearances. Due to the lack of standard grades, the exact commercial values of the various products are difficult to compare. Even after the testing of various products, results are still controversial to many people in the business. At the present time the degree of competition among products is therefore somewhat uncertain.

The particle board industry was raw material oriented initially. The central aim of most manufacturers was simply to transform wood wastes into salable products. The marketing area was limited to a 200 to 300 mile radius around the plant location because of bulky and low-value products. However, the first high-quality board, produced on the West Coast, was well accepted in the eastern markets. Customers were willing to pay almost twice as much for this shaving or flake-type board for its smoother surface, greater strength and uniformity. With this stimulation, manufacturing of flake-type boards on the East Coast has increased steadily in the past few years. Now it is a common practice for most of the new non-captive plants to select materials, to use prepared wood flakes and automatic processing methods. The industry is gradually turning from raw material orientation to market orientation. Those who cannot catch up with the tide of progress may have to pay the heaviest price in our present economy. It seems that the competition among the high quality flake-boards is just in the beginning stage. Although the manufacturing of high-quality boards requires twice as much initial investment as lower quality boards, it will pay off in the long run.

It should be noted by potential investors that a well-made all flake particle board can be used for any quality of furniture without crossbanding, whereas other splinter-type boards do require crossbanding. Whether the cost of crossbanding will offset the cost of producing a more expensive coreboard remains to be seen. Among the existing plants, 51 per cent produce flake and shaving-type boards, 45 per cent make splinter-type boards, and four per cent

manufacture sawdust boards (Table 5). The trend is from splinter-type boards to flake and shaving-type boards for the non-captive plants. The captive plants produce splinter boards exclusively.

Table 5

The 1958 U. S. Particle Board Plant Capacity
Classified by Type of Wood Particle Used

	Total Plant Capacity	
	(Million Sq. Ft.)	(Per Cent)
Splinters	273.25	45
Flakes and Shavings	302.76	51
Sawdust	20.50	4
Total	596.51	100

III. WOOD RAW MATERIALS OF PARTICLE BOARD

Particle boards can be made from a great variety of wood species or wood residues. The selection of wood raw material is based on the type of boards to be produced, the raw material available, cost considerations, and the permanency of raw material supply.

Three major types of particle boards based on different sources of raw materials are currently being sold: flakeboards, shaving boards, and splinter boards. Flakeboards are manufactured from flat flakes of controlled thickness and length. Solid wood is the main raw material entering the process; it is usually best to flake this in a green condition. If all given engineering and raw material conditions are the same, and only the type of wood particle varies, the quality of flakeboards may be superior to either splinter boards or shaving boards (see Table 6). Shaving boards are based on shavings from planing mills or other woodworking operations. These reasonably long shavings with undamaged parallel fibers running their length make a very good raw material. Splinter board is made from either logging waste such as culls, tree tops, limbs, and thinnings, or manufacturing waste such as slabs, edgings, and scraps. All these varieties of board can be made in both the single-layer (homogeneous) type and the three-layer (sandwich) type. The latter is made by using low quality, coarse material as the inside layer or center of the board.

Table 6

Physical Properties of Different Type Particle Boards Tested Under the Same Experimental Conditions

	Board Type		
	Splinter	Planer Shavings	Flake
Specific Gravity	0.50 - 0.80	0.50 - 0.80	0.50 - 0.80
Modulus of Rupture (psi)	1500 - 4000	1500 - 4000	2000 - 6500
Modulus of Elasticity (psi)	150,000/450,000	150,000/400,000	300,000/650,000
Hardness (ASTM) - Lbs.	1000 - 3000	1000 - 3000	1000 - 3000
Screw Holding Power - Lbs.	250 - 500	250 - 450	250 - 450

Source: H. C. L. Miller, "Multi-Platen Press Manufacture of Particle Board," a background paper prepared for the International Consultation on Insulation Board, Hardboard and Particle Board. Geneva, Switzerland, January 21, 1957 to February 7, 1957.

Johnson stated[1/] in his handbook regarding the procedure and effects of pretesting wood raw materials that prior to a selection of wood material, analysis should be made to determine whether the available residue will produce a useful or marketable board at a competitive cost. This necessitates the manufacture and testing of sample boards, using the proposed material, under laboratory conditions. These sample boards will clearly indicate what type of production board can be made. Testing and evaluation will reveal the properties attainable, and will give an indication of the facilities required to produce the board. Suppliers of particle board manufacturing systems[2/] either have access to, or possess laboratory facilities of their own for making and testing sample particle boards at a nominal fee.

Wood raw material cost is one of the most variable of the factors applied in determining the rate of return for a particle board plant. Since the type of wood material and source of supply varies from plant to plant, production cost varies too. An analysis of wood cost affecting profit (before taxes) on investment is shown in Figure 1. On the cost curve $9.47/M[3/] indicates yellow pine slabwood, $18.30/M represents aspen cordwood, and $0.00/M denotes raw material self supplied. Profit on investment on 3/4 inch thick board is shown to be 38% with wood cost at $0.00/M, 30% at $9.47/M, 24% at $18.30/M and 20% at $24.75/M.

An ample and permanent supply of raw materials is another consideration of setting up a plant. Such a supply should, of course, be assured before considering an investment.

Woods Suitable for Particle Board Manufacture

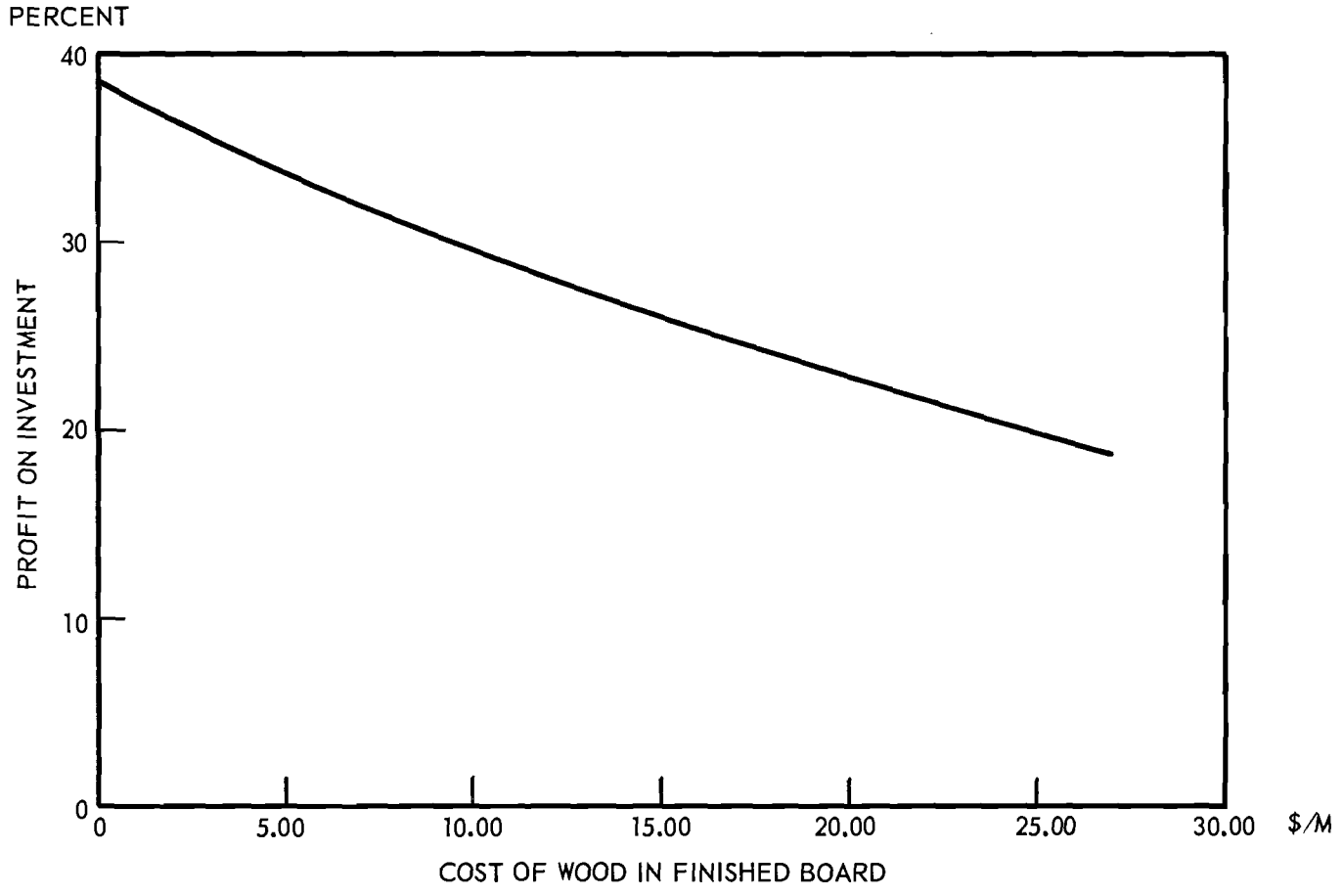
Four types of wood--pine, aspen, gum, and willow--are recognized to be superior raw materials for flakeboard manufacture east of the Mississippi. The density and color of a wood specie, together with particle type and resin treatment, have a profound influence on the qualities and appearance of a board. A list of wood species used for particle board manufacture in North America is given in Appendix B.

1/ E. S. Johnson, op. cit. p. 72.

2/ Miller Hofft, Inc., Richmond, Virginia, charges $2,500 for a contract service which includes making and testing of sample board, recommending machinery, and analyzing the economics of a plant.

3/ M denotes 1,000 square feet.

FIGURE 1
THE RELATIONSHIP BETWEEN COST OF WOOD AND PROFIT ON INVESTMENT
FOR A PARTICLE BOARD PLANT



SOURCE: Unpublished material from a private business firm.

Available Wood Raw Materials in Georgia

Wood raw materials currently used for particle board can be classified into two kinds--round cordwoods and wood residues. Round cordwoods are generally used for high quality flakeboard, while wood residues are used for splinter board or shaving board. The availability of wood raw materials in Georgia for particle board production can be seen from the forest inventory shown in Table 7.

1. Round Cordwoods

Reviewing growing stock of all timber (Table 7), one discovers that pines[1/] and gums[2/] are the dominant species in this state. Flakeboards made from these two species are recognized as the best among the high quality boards on the market. Other species such as cypress, yellow poplar, hickory, ash, and cedar are also acceptable materials for particle board manufacture, though their stocks are not particularly plentiful in Georgia.

Pines are the major pulpwood source of economic importance in Georgia. Longleaf-slash pines are highly concentrated in the southeastern part, while loblolly-shortleaf pines are distributed in a corridor stretching from southwest to northeast in the middle part of the State. (See Map 3.) The production of pine pulpwood in Georgia, which in 1956 was the highest among the southern states, is also concentrated in these two areas. They are the logical places in which to locate a flakeboard plant.

The geographical distribution of gums combined with cypress and oak is shown on Map 3. These species are concentrated in the Okefenokee wildlife refuge and along the lower part of the Altamaha, Ocmulgee, Oconee, Flint, Ogeechee, and Savannah rivers. The major supply of gum and cypress in the State also comes from the two areas supplying pine pulpwood.

Georgia's forest area is the largest in the South and the second largest in the nation. It exceeds all states in the area of privately owned forest land. Timber growth in Georgia is twice as fast as in the northern states. These facts indicate the potential of the forest product industries in Georgia.

Among the 159 counties in the State, 10 forestry districts were set up by the Georgia Forestry Commission. Each district contains 15 to 16 counties

---

1/ Includes longleaf, slash, loblolly, pond, shortleaf and Virginia pine.

2/ Includes black, tupelo, and sweet gum.

Table 7

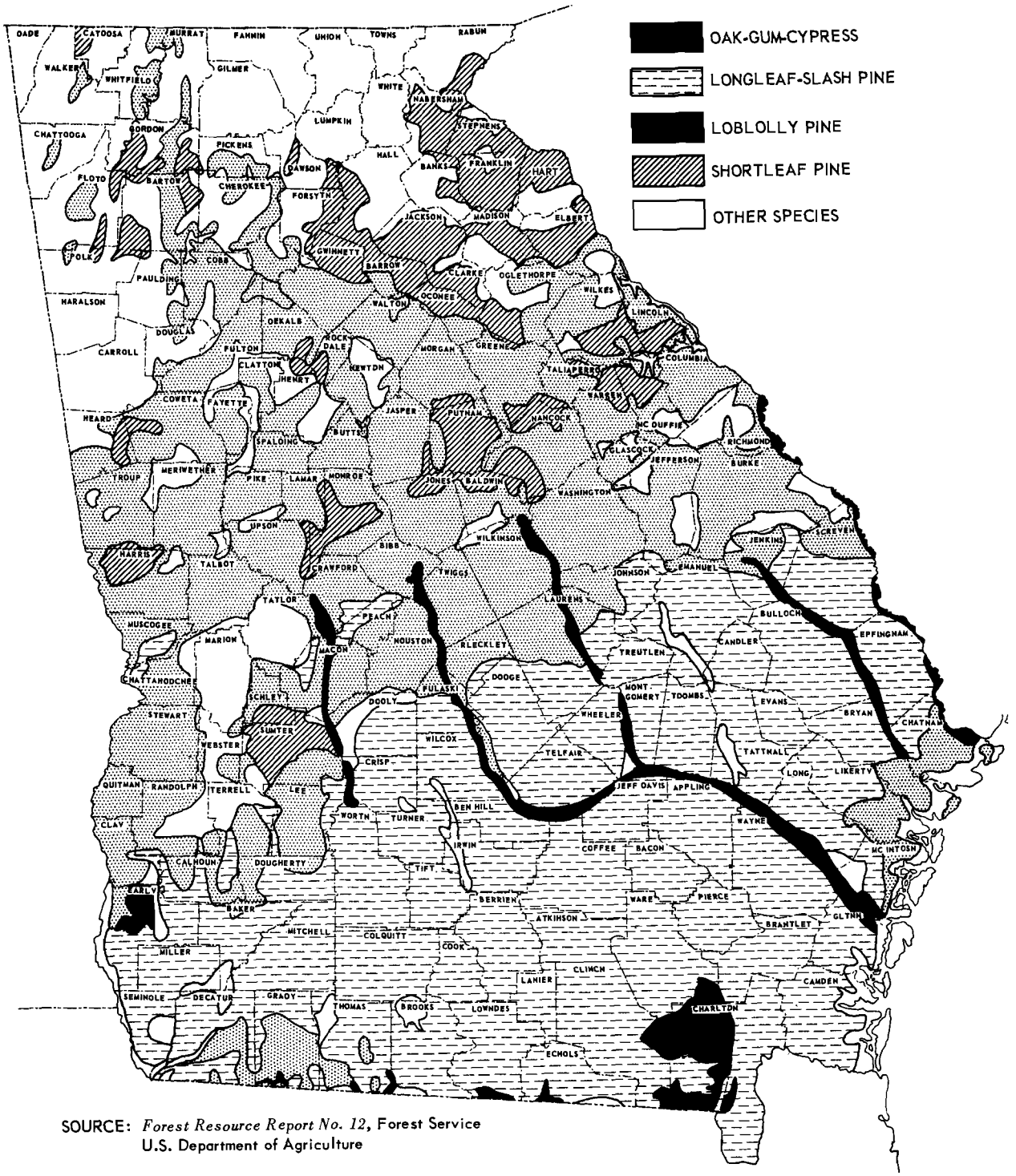
Net Volume of Growing Stock by Species in Georgia[a/]

Species	Volume (thousands of cords)
Softwoods:	
Longleaf	16,836
Slash pine	33,910
Loblolly pine	30,609
Pond pine	2,060
Shoftleaf pine	16,315
Virginia pine	1,392
Total (Dominant Species)	101,122
White pine	375
Hemlock	90
Cypress	5,767
Cedar	91
Total softwoods	107,445
Hardwoods:	
Black and tupelo gum	15,688
Sweet gum	10,490
Yellow-poplar	5,059
Soft maple	2,693
Other soft hardwoods	2,567
Total (Dominant Species)	36,497
White and swamp chestnut oaks	4,176
Other white oaks	4,129
Northern red, swamp red, and shumard oaks	1,746
Other red oaks	11,664
Hickory	3,942
Ash	1,629
Dogwood, Persimmon	524
Other hard hardwoods	2,733
Total	30,543
Total hardwoods	67,040
All Species	174,485

a/ Sound wood and bark

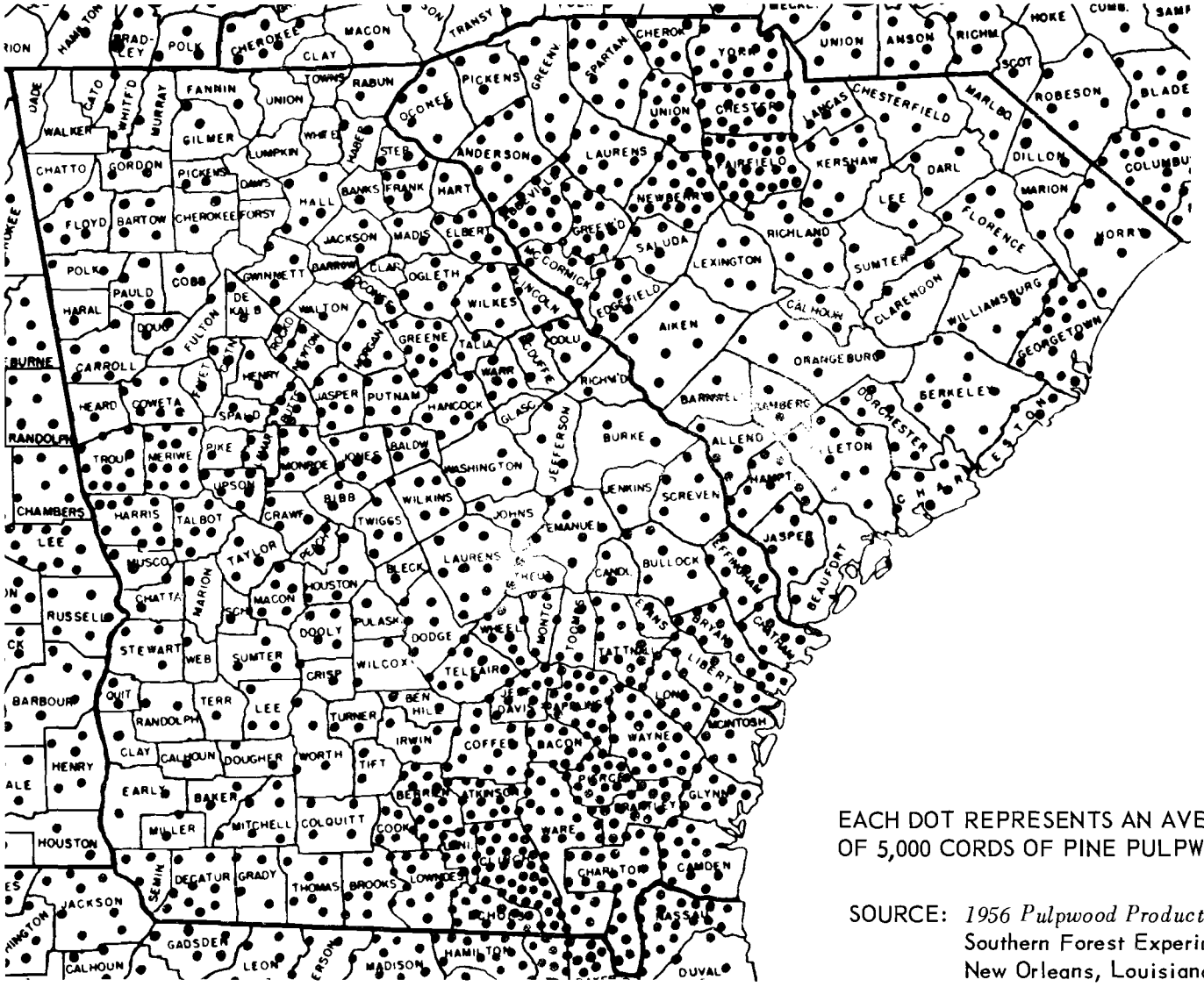
Source: J. F. McCormack, "Forest Statistics for Georgia, 1951-53," U. S. Department of Agriculture Forest Service, Southeastern Forest Experiment Station, Forest Survey Release No. 44, Asheville, North Carolina, November, 1954.

MAP 3
MAJOR FOREST TYPES IN GEORGIA



SOURCE: *Forest Resource Report No. 12*, Forest Service
U.S. Department of Agriculture

MAP 4
PINE PULPWOOD PRODUCTION BY COUNTY IN GEORGIA – 1956



EACH DOT REPRESENTS AN AVERAGE OF 5,000 CORDS OF PINE PULPWOOD.

SOURCE: *1956 Pulpwood Production in the South,* Southern Forest Experiment Station New Orleans, Louisiana

with a 40 to 60 mile radius. Map 5 shows the district boundaries and number of woodworking industries in each district. All counties in Georgia are listed in Table 8 by district.

The net volume of wood growing stock by district is shown in Table 10. Districts 1 and 8 have a greater volume of both soft and hardwoods than others. Districts 2, 3, 4, 5, and 6 have smaller amounts but are still logical areas for possible sites of flake-type board production.

2. Wood Residues

A statewide wood residue survey was conducted by the Georgia Forestry Commission in 1958. The results of this investigation indicate a total of 5,177,843 tons of annual gross wood residue produced and a total of 4,803,437 tons of wood residue available in Georgia in 1957.

Since wood residues are the main raw material source for splinter and shaving-type board manufacture, information about kind, volume, location, and price is essential in considerating plant location. This information is summarized by district in Tables 10 and 11.

Softwood residue is available in the greatest quantities in Districts 1, 5, and 8. However, prices in Districts 1 and 8 (which have several pulp mills) are somewhat higher. Therefore, Districts 4 and 5 seem to be the optimum choices for locating a splinter or shaving-type particle board plant for independent investors.

Hardwood residue is available in smaller quantities than the softwood residue in Georgia. Districts 1, 4, and 6 show a greater tonnage than the other districts (Table 11). In considering tonnage availability and cost of hardwood residue, Districts 4, 6, and 10 may be the best areas to locate a plant which could use these materials.

Potential users of wood residues are encouraged to contact the Georgia Forestry Commission, Macon, Georgia, for detailed information such as type, scale, and stability of the present producers and the distances to specific locations. Data regarding type, tonnage, and price of wood residue by districts in Georgia are given in Appendix C.

3. Possible Plant Locations

In the light of information substantiated by the Georgia Forestry Commission, two possible sites of particle board plants are suggested for independent investors: Thomaston and Albany, Georgia. The selection of these two sites was based on the consideration of wood raw materials, transportation, and

Table 8

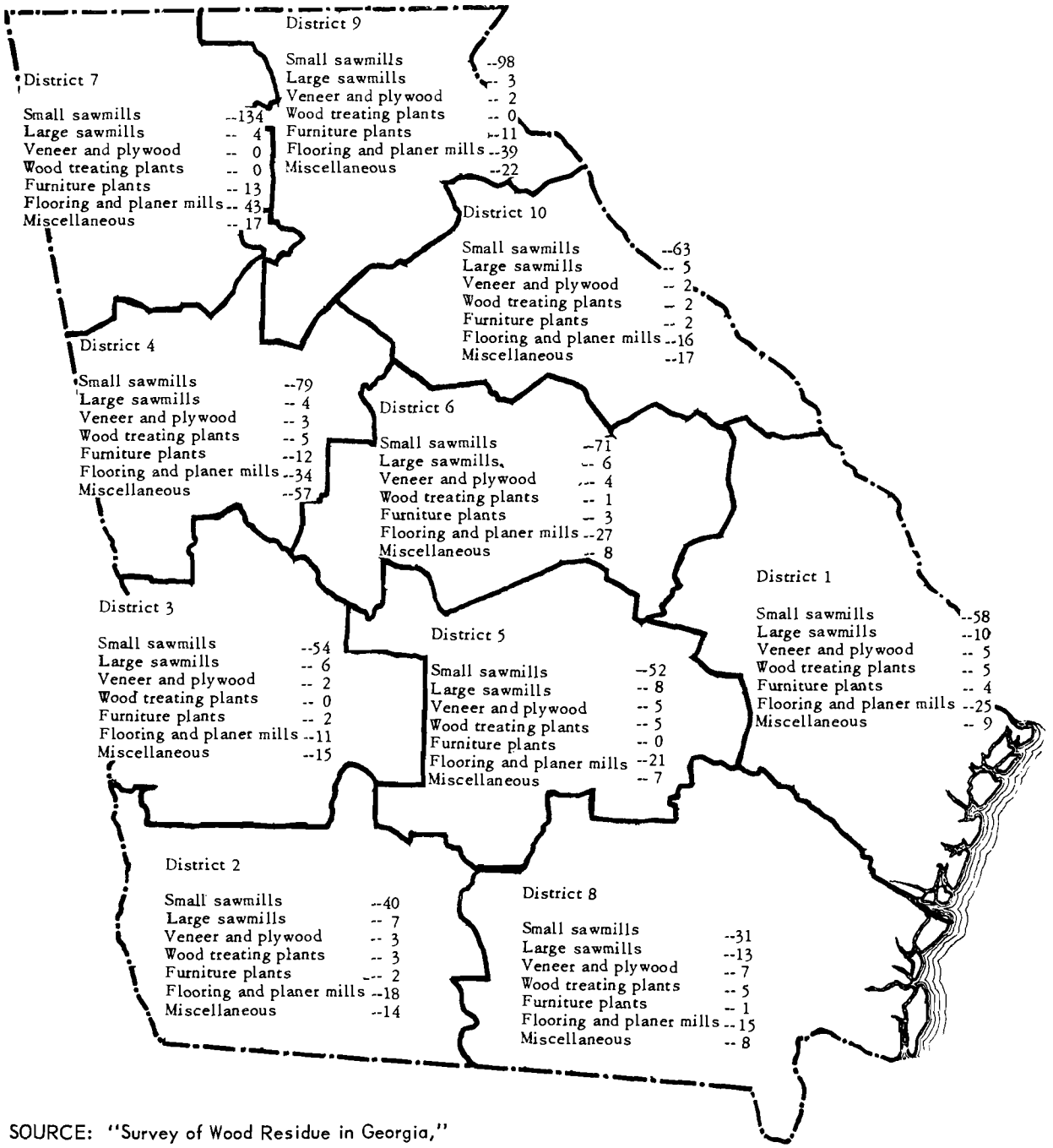
Georgia Forestry Commission Districts
(by counties)

District 1	District 2	District 3	District 4	District 5
Bryan	Baker	Chattahoochee	Butts	Ben Hill
Bulloch	Brooks	Crisp	Carroll	Bleckley
Burke	Calhoun	Dooly	Clayton	Dodge
Candler	Clay	Lee	Coweta	Houston
Chatham	Colquitt	Macon	Douglas	Irwin
Effingham	Cook	Marion	Fayette	Jeff Davis
Emanuel	Decatur	Muscogee	Fulton	Laurens
Evans	Dougherty	Quitman	Harris	Montgomery
Jenkins	Early	Randolph	Heard	Pulaski
Liberty	Grady	Schley	Henry	Telfair
Long	Miller	Stewart	Lamar	Toombs
McIntosh	Mitchell	Sumter	Meriwether	Treutlen
Screven	Seminole	Talbot	Newton	Turner
Tatnall	Thomas	Taylor	Pike	Wheeler
	Tift	Terrell	Rockdale	Wilcox
	Worth	Webster	Spalding	
			Troup	
			Upson	

District 6	District 7	District 8	District 9	District 10
Baldwin	Bartow	Appling	Banks	Clarke
Bibb	Catoosa	Atkinson	Barrow	Columbia
Crawford	Chattooga	Bacon	Dawson	Elbert
Glascock	Cherokee	Berrien	DeKalb	Greene
Hancock	Cobb	Brantley	Fannin	Lincoln
Jasper	Dade	Camden	Forsyth	Madison
Jefferson	Floyd	Charlton	Franklin	McDuffie
Jones	Gilmer	Clinch	Gwinnett	Morgan
Johnson	Gordon	Coffee	Habersham	Oconee
Monroe	Haralson	Echols	Hall	Oglethorpe
Peach	Murray	Glynn	Hart	Richmond
Putnam	Paulding	Lanier	Jackson	Taliaferro
Twiggs	Pickens	Lowndes	Lumpkin	Walton
Washington	Polk	Pierce	Rabun	Warren
Wilkinson	Walker	Ware	Stephens	Wilkes
	Whitfield	Wayne	Towns	
			Union	
			White	

MAP 5

GEORGIA FORESTRY COMMISSION DISTRICTS AND NUMBER OF PLANTS PRODUCING WOOD RESIDUE IN 1957



SOURCE: "Survey of Wood Residue in Georgia,"
Resource – Industry Series Number 1
Georgia Forest Research Council

avoidance of pulp mill location. A radius of 50 miles around these two sites would circumscribe a supply of wood chips for two large-scale particle board plants. (See Map 6.) The wood and wood residue supply around Thomaston and Albany is presented in detail in Tables 12, 13, and 14.

There are many possible locations in Georgia which may have no difficulty supplying wood raw material for a small or medium-sized plant. Certainly the assurance of a stable supply at a reasonable price is prerequisite to a final decision in selecting a specific site for a particle board plant. The ultimate location depends, of course, upon specific conditions affecting individual investors.

Table 9

Net Volume of Growing Stock by District, Pulping Species Group, and Tree-diameter Group[a/]

(In Thousand Cords)

District	Yellow Pines 5-12 inches	Yellow Pines 13+ inches	Other Softwoods 5-12 inches	Other Softwoods 13+ inches	Soft Hardwoods 5-12 inches	Soft Hardwoods 13+ inches	Hard Hardwoods 5-12 inches	Hard Hardwoods 13+ inches	All Species
1	8,396	3,704	456	293	3,745	2,779	1,333	1,323	22,029
2	5,680	3,078	436	165	2,326	1,045	1,216	1,080	15,026
3	4,539	1,646	74	46	2,590	1,735	1,044	880	12,554
4	6,456	1,011	5	4	1,640	918	1,771	1,344	13,149
5	8,413	3,042	208	113	2,512	1,593	681	1,386	17,948
6	7,430	2,080	98	34	2,610	1,683	1,678	1,469	17,082
7	4,622	713	85	44	713	641	3,746	1,511	12,075
8	21,619	5,385	2,523	1,328	3,666	1,994	582	779	37,876
9	4,437	1,128	148	227	746	644	3,776	2,813	13,919
10	6,898	845	18	18	1,756	1,161	1,268	863	12,827
Total	78,490	22,632	4,051	2,272	22,304	14,193	17,095	13,448	174,485

a/ Sound wood and bark.

Source: Compiled from Forest Statistics for Georgia, 1951-53, Forest Survey Release No. 44, U. S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station, Asheville, North Carolina, November, 1954.

Table 10

Estimated Volume and Reported Value of
Available Softwood Residue in Georgia, by Districts, 1957

District	Wood Residue[a/] Tons	Weighted Price Dollars/Ton	Number of Pulp Mills
1	298,737	$5.17	5
2	218,607	3.62	-
3	217,860	3.06	-
4	224,628	2.00	-
5	312,174	1.90	-
6	244,418	2.82	1
7	208,503	1.39	1
8	299,544	5.96	4
9	144,210	2.41	-
10	167,682	1.50	-
Total	2,336,363	$3.76	11

a/ Includes slabs, edgings, end trim, and shavings only.

Source: Compiled from Survey of Wood Residue in Georgia, Georgia Forest Research Council, Resource Industry Series No. 1, 1958.

Table 11

Estimated Volume and Reported Value of Hardwood Residue Available from Georgia Wood-Using Industries, 1957

District	Wood Residues[a/] Tons	Weighted Price[b/] Dollars/Ton
1	115,982	$4.10
2	36,843	0.89
3	15,370	1.82
4	107,376	2.18
5	69,163	5.05
6	115,601	3.33
7	61,247	1.42
8	30,726	4.24
9	43,805	2.15
10	78,647	1.37
Total	674,760	$2.87

a/ Includes slabs, edgings, end trim, veneer cores, veneer round up, veneer clip, and shavings.

b/ Weighted by volume.

Source: Compiled from Survey of Wood Residue in Georgia, Georgia Forest Research Council, Resource Industry Series No. 1, 1958.

Table 12

Volume of Sawtimber by County and Species Group
And Commercial Forest Land in Each County for Two Areas in Georgia[a/]

Area 1, 50 mile radius of Thomaston, Georgia, (See Map 6)

County	Softwood	Soft Hardwood (million bd. ft.)	Other Hardwoods	Commercial Forest Land (thousand acres)
Bibb	71.7	32.8	27.8	92.8
Butts	67.6	38.0	18.2	67.6
Chattahoochee	254.9	32.0	19.7	128.8
Clayton	34.7	11.8	12.9	43.7
Coweta	49.0	30.7	22.7	169.4
Crawford	124.9	30.1	26.2	145.3
Fayette	22.9	31.1	15.1	66.9
Harris	199 .7	31.4	25.6	247.0
Henry	58.8	9.4	56.3	98.4
Jasper	231.8	61.3	39.9	178.9
Jones	296.0	32.0	30.7	98.2
Lamar	48.5	8.9	8.4	69.0
Macon	74.8	150.1	68.3	134.9
Marion	58.2	69.6	29.0	175.3
Meriwether	66.1	6.4	146.3	233.4
Monroe	95.8	32.7	32.0	206.6
Muscogee	145.5	22.3	8.7	92.4
Peach	36.4	19.2	10.9	37.6
Pike	31.3	22.0	5.3	68.2
Schley	20.9	28.1	11.8	64.4
Spalding	30.1	25.5	16.0	63.2
Talbot	97.5	17.8	7.4	212.3
Taylor	53.3	55.4	28.0	168.0
Troup	91.3	57.0	17.0	204.9
Upson	90.7	17.2	54.3	154.1
Total	2,353.4	840.8	738.5	3,221.3

a/ Taken from "Forest Statistics for Georgia, 1951 - 53" Forest Survey Release No. 44, U.S.D.A. Forest Service, Southeastern Forest Experiment Station.

Table 13

Volume of Sawtimber by County and Species Group
And Commercial Forest Land in Each County for Two Areas in Georgia[a/]

Area 2, 50 mile radius of Albany, Georgia (See Map 6)

County	Softwood	Soft Hardwood (million bd. ft.)	Other Hardwoods	Commercial Forest Land (thousand acres)
Baker	177.3	2.5	21.1	110.2
Calhoun	41.2	47.8	26.4	94.1
Clay	27.7	14.8	20.7	73.3
Colquitt	200.3	21.8	9.9	175.2
Crisp	117.5	24.1	12.6	78.3
Decatur	226.1	77.5	61.3	252.0
Dooly	101.3	63.0	24.7	97.0
Dougherty	95.3	32.5	69.6	86.3
Early	92.8	56.1	53.0	149.7
Grady	237.3	82.9	48.3	176.3
Lee	46.7	25.8	24.3	89.2
Mitchell	192.1	6.5	20.7	132.8
Randolph	49.7	93.3	22.3	146.2
Sumter	43.9	119.4	39.0	138.1
Terrell	40.9	62.2	16.4	72.5
Thomas	391.1	54.5	60.4	197.5
Tift	136.2	25.6	9.1	80.5
Turner	152.6	41.9	1.8	99.5
Webster	35.3	38.8	27.4	92.3
Worth	276.1	50.5	9.9	194.3
Total	2,681.4	941.5	578.9	2,535.3

a/ Taken from "Forest Statistics for Georgia, 1951 - 53" Forest Survey Release No. 44, U.S.D.A. Forest Service, Southeastern Forest Experiment Station.

Table 14

Volume of Residue Produced by Species Group and Wood-Using Industries in Two Areas of Georgia, 1957[a/]

Area 1, 50 mile radius of Thomaston, Georgia (see Map 6)

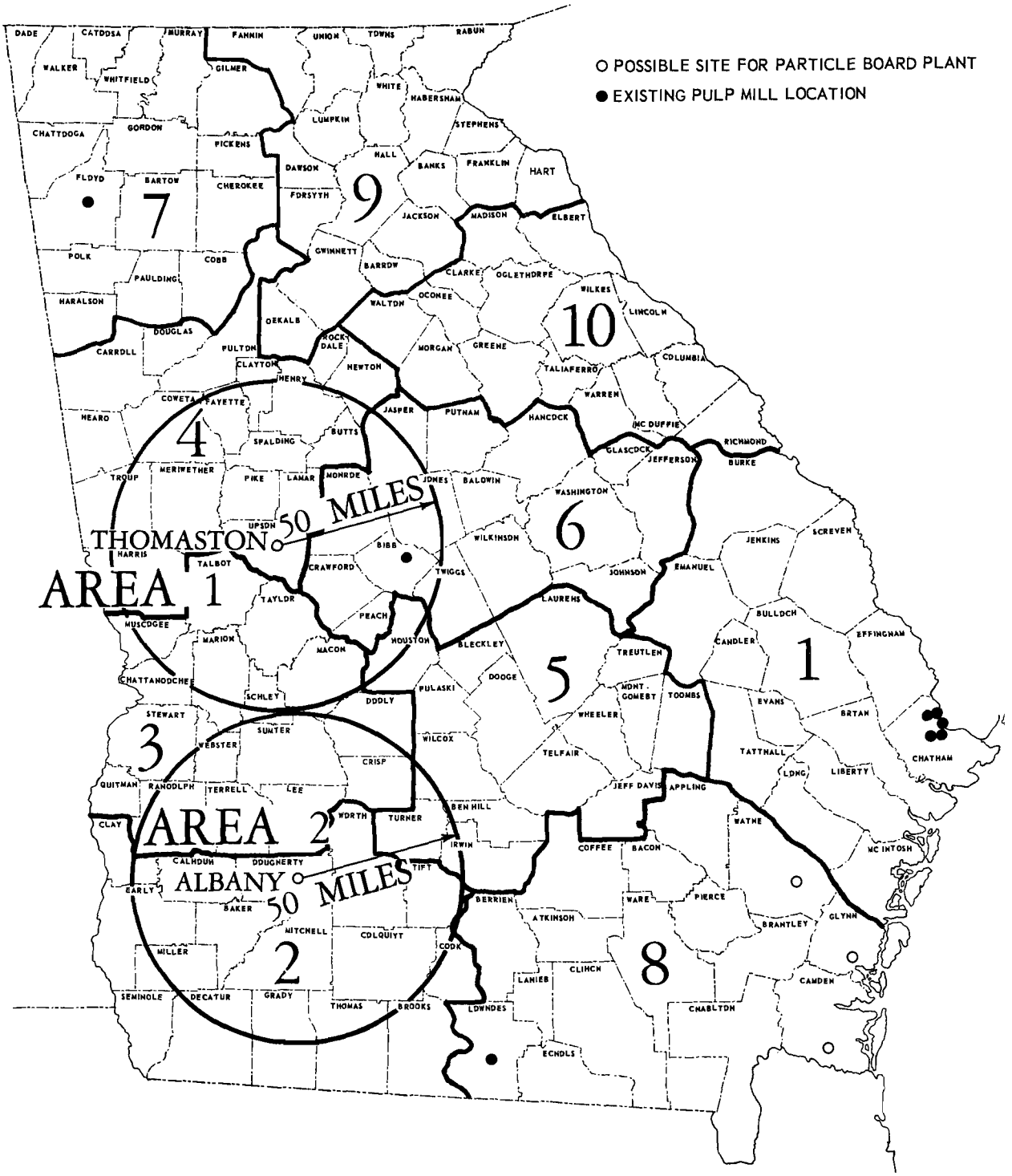
Industry	Chippable Residue (tons, green wgt.) Softwood	Hardwood	Shavings (tons, green wgt.) Softwood	Hardwood
Sawmills	228,710	93,620		
Veneer & Plywood	3,498	72,073		
Furniture	79	3,192	138	2,693
Flooring	17	2,666	305	12,976
Planer	2,943	1,331	52,975	11,180
Misc. Inds.	4,623	3,801	7,401	6,425
Total	239,870	176,683	60,819	33,274

Area 2, 50 mile radius of Albany, Georgia (see Map 6)

Industry	Chippable Residue (tons, green wgt.) Softwood	Hardwood	Shavings (tons, green wgt.) Softwood	Hardwood
Sawmills	233,011	30,490		
Veneer & Plywood		19,898		
Furniture	1	13	2	28
Flooring		2,862		1,696
Planer	2,324	338	41,839	2,843
Misc. Inds.	320	158	562	321
Total	235,656	53,759	42,403	4,888

a/ Estimates are based on data collected in 1958 for publication of Survey of Wood Residue in Georgia. U. S. Forest Service and Georgia Forestry Commission cooperating.

MAP 6
TWO POSSIBLE SITES FOR PARTICLE BOARD PRODUCTION IN GEORGIA



IV. THE MARKET FOR PARTICLE BOARD IN GEORGIA

The Demand for Particle Board

1. Present Demand

The demand for a commodity can generally be derived by totaling purchases over a period of time. Due to the newness of the product, wood particle boards are presently used by a relatively small portion of the potential users in Georgia. Respondents to an Industrial Development Branch survey indicated that most users have only one to three years experience in dealing with this product and many non-users did not even know of its existence. The total demand derived in this study represents one fiscal year, 1957-1958.

The purchases of various particle boards by Georgia users in the past year was first estimated to range from 2,000,000 to 2,500,000 square feet (using 3/4 inch as a base dimension.) However, results of the survey produced a more precise estimate of 2,100,000 square feet.

Table 15

The Market for Wood Particle Board
in Georgia, 1957-1958

Industry	Purchased Volume (000 Sq. Ft.)	Percentage
Cabinets	877.8	41
Furniture	714.0	34
Millwork	224.7	11
Fixtures	222.6	11
Interior Walls	25.2	1
Subfloorings	35.7	2
Total	2,100.0	100

Table 16

The Marketing Distribution by Thickness of Particle Board in Georgia, 1957-1958

Thickness	Purchased Volume (000 Sq. Ft.)	Percentage
3/8"	84	4
1/2"	42	2
5/8"	525	25
7/16"	21	1
3/4"	1,407	67
1 1/8"	21	1
Total	2,100	100

Table 17

The Marketing Distribution by Types of Particle Board in Georgia, 1957-1958

Type of Board	Purchased Volume (000 Sq. Ft.)	Percentage
Flake and Shaving Boards	2,058	98
Splinter Boards	42	2
Total	2,100	100

2. Future Demand

A major interest of this study is the determination of market potentials for wood particle boards in the immediate future. Survey replies from those not currently using particle board were classified into two groups--those who showed an interest and considered the use of wood particle board in their manufacturing, and those who had a knowledge of particle board but had not considered using it. The market potentials for wood particle boards ih Georgia, based on the data of the first group added to the present purchasing volume, is estimated at about 9,343,000 square feet a year on the 3/4-inch thickness basis. This market potential could be easily tapped if a plant located in Georgia does an adequate job of promoting the relatively new product.

Table 18 shows the distribution of this potential among the different outlets. Mobile home makers emerged as a new potential user of wood particle board. This possible outlet calls for further attention because mobile home manufacturing has expanded rapidly in Georgia in the past few years.

Table 18

The Market Potentials for Wood Particle Board by Industries in Georgia, 1958-1959

Market Outlet	Estimated Volume (000 Sq. Ft.)	Percentage
Furniture	6,146.0	65.8
Cabinets	1,675.8	17.9
Fixtures	294.6	3.2
Millwork	441.7	4.7
Mobile Homes	724.0	7.7
Interior Walls	25.2[a/]	0.3
Subflooring	35.7[a/]	0.4
Total	9,343.0	100.0

a/ None of the respondents among the non-users of wood particle board who indicated the possible future use of it in their manufacturing were in the categories of interior wall and subflooring.

A large manufacturer of boxes and crates in Georgia indicated that his business could use up to 20,000,000 square feet of particle board annually instead of veneer if the cost is not prohibitive. The veneer supply, according to him, is becoming shorter each year. His figure was not included in Table 18 because there is some doubt about the satisfactory application of wood particle board in making case goods.

The long-run wood particle board demand depends on the comparative prices of wood particle boards and their alternative materials and the degree of improvement in their physical properties. Particle boards are now accepted in the fields of furniture, cabinets, fixtures, and millwork. Further development in these fields may stress promotional work and cost reduction. The uses in interior walls, subflooring, and doors are limited in scale but are increasing. Greater expansion in these areas may require the development of smoother and firmer surfaces, greater nail holding power, and lower cost. The acceptance of wood particle board in uses for construction and exterior walls

may depend largely on the improvements in strength over weight ratios, water resistance, and screw holding power. The long-run market potential of wood particle board will increase rapidly as these characteristics are improved.

Population growth, disposable personal income, and government spending are certainly highly correlated with the growth of lumber, plywood, furniture, and construction industries. However, no attempt is made in this study to correlate wood particle board with these indicators, due to the difficulty of obtainable production data for wood particle board and the rapidly changing technology.

The market potentials for wood particle board in Georgia may be indicated by an example. The average annual residential building is estimated at around 10,000 houses in the Atlanta metropolitan area and 20,000 houses in Georgia. The average house uses 20,000 board feet of lumber, plywood, hardboard and other types of building board for various purposes. The annual demand for building boards in Georgia will approximate some 400,000,000 board feet for residential building alone. If the particle board industry could capture 1/100 of this market (an extremely conservative estimate), it would result in a 4,000,000-board-feet increase in demand annually, not including uses in other industries.

3. Need for Improvement of Wood Particle Board

The future demand of wood particle board depends largely on the attitudes and opinions of all potential users toward this product. This is one area of interest included in the mail survey. Opinions of the users regarding an ideal type of particle board[1/] that would best suit their needs are classified by industries:

Cabinet makers: Smooth surface, no warpage, good screw holding capability, dimensional stability, good machinability.

Furniture makers: Smooth surface, no warpage, adhesive quality for lamination, low moisture content, no wax content, light weight.

Fixture makers: Smooth surface, constant thickness, screw holding ability, no warpage, minimum water absorption, acceptable paint coverage, comparative in price to plywood but equal to plywood in edge holding and smooth surface for applying glue.

1/ Desirable particle board characteristics for use as a core material and desirable particle board characteristics used as a substitute for lumber are presented in Appendix D.

Mill works: Firmness, density, smoothness, water proofing.

Construction: Water proof requirement for oil-saturated paneling and outside sealing.

Various comments on wood particle boards and their alternative materials follow.

Cabinet makers:

"Freight is high, need a plant in Georgia."

"Particle board is superior to fir plywood for laminating purpose due to adhesive quality and lack of wild grain but it is not equal to plywood in screw holding and tensile strength over a long surface."

"Could use in cabinet tops and 3/8-inch wall panels."

"Does not have the strength of plywood or masonite in proportion to thickness."

"It will be a good product by laminating particle board with a veneer such as pine or gum."

"Not much experience but it is a very good product."

"Improve breaking strength."

"Buyers should know exactly what kind of goods they will get."

Furniture makers:

"Superior to 3/4-inch plywood as core stock."

"Good engineering generally."

"If particle board can be developed where it can be molded, considerable applications could be made in upholstered furniture."

"Particle board is best material to counter warpage but plywood and Masonite finished better and easier."

"Excessive weight per square foot and the wear-and-tear on knives and saws in shaping and sawing."

Fixtures:

"Better for most uses and will help to conserve our timber resources."

"Adopt standard grades for uniformity."

Mill works:

"Could be used extensively in cabinet and door making."

"Could be used for most of the uses of plywood and Masonite."

Construction:

"Equal or preferred to plywood or hardboard as underlayments and cabinet backing."

Construction (continued):

"Particle board would work very well in small dimensions but in large sheets hung vertically the warpage is very bad."

Mobile homes:

"Could be used for sink top only."

Case goods:

"Prefer plywood."

"Surface not as smooth as plywood and Masonite. Coult not use it without veneering. If it is veneered, it would be too expensive for case goods."

"Particle boards in 1/8-inch to 1/4-inch thickness do not have the same strength as plywood or Masonite."

It is apparent that certain outstanding characteristics of particle board make it distinct from alternative materials in some uses. Future development of particle board may lie in the improvement of water-proof ability, weight over strength, and machinability.

The Supply of Particle Board

1. Market mechanism

The supply side of the market system of the wood particle board industry is represented by three elements: manufacturers' sales representatives, wholesale distributors (or jobbers), and f.o.b. mill delivery.

There are only three known permanent manufacturers' sales representatives and three or four wholesale distributors for wood particle boards in Georgia. In general, the particle board sales represent only a fractional part of their whole business operation. Their major products are lumber, plywood, and other building materials. A few lumber wholesalers indicated they would carry particle board as regular stock soon and others showed an interest. This indicates that wood particle boards are in the developing stages in Georgia.

F.o.b. mill sales play an increasing role in supply. Most large users of wood particle board commonly order their goods by carloads direct from the mills. This cuts down the handling and stocking costs and allows a free range of choice of the products without requiring a sales agency in Georgia.

Sales made by the manufacturers' representatives, wholesale distributors and f.o.b. mill delivery are presented below.

Table 19

Particle Board Supply in Georgia by Selling Agencies, 1957-1958

Agency	Estimated Sales Volume Square Feet (3/4 inch Basis)	Percentage
Manufacturers' Representatives	942,000	45
Wholesale distributor	192,000	9
F.o.b. mill delivery	966,000	46
Total	2,100,000	100

2. Available Products on the Georgia Market

There were six major products sold on the Georgia market at the time of the market survey.[1/] Novoply, Timblend, and Graco were the major products on the market. Flake Board, Flake Bond, and Weyerhaeuser's "4-Square" constituted the second group. Besides these six products, a few others were sold in limited amounts. It was reported that a new product from the Formica Corporation (a subsidiary of American Cyanamid) with plastic veneered board will be on the market soon.

Information dealing with type of board, price, freight cost, etc. of the six major products sold in Georgia is listed in Table 20.

Most of the supply of wood particle board in Georgia came from as far as California and Virginia. (See Table 21.) Although quite a number of particle board plants are closer to the Georgia market than those in California and Virginia, their portion of the total supply was negligible compared to the amount supplied by these two states. Certainly product quality, even purchased at a higher freight rate, accounts for the volume supplied at these distances--a cogent argument for an alert Georgia producer.

1/ The market survey was conducted from October to November, 1958.

Table 20

MAJOR WOOD PARTICLE BOARDS SOLD IN GEORGIA, 1958

Trade name	Manufacturer	Plant Location	Type of Board	Panel size (inches)	Thickness (inches)	Wholesale price in Atlanta 3/4"/M	Freight cost 3/4"/M	Recommended uses
Flake Board	Pope and Talbot Co.	Oakridge, Ore.	Splinter and flake	48 x 96	3/8,1/2, 5/8,11/16, 3/4,1	$223	$42.00	Doors, furniture
Flake Bond	Carolina Forest Products, Inc.	Wilmington, N. C.	Shaving	24 x 96, 30 x 96, 48 x 96, 30 x 120	1/2, 5/8, 3/4	$191	$15.95	Underlay for counter top and floor
Graco	Gray Products Co., Inc.	Waverly, Va.	Flake	48 x 96, 60 x 96, 48 x 120	7/16,9/16, 11/16,12/16, 13/16,15/16, 1 1/8	$175[a/]	$20.00	Plastic underlay core for wood veneer
Novoply	U. S. Plywood Corp.	Anderson, Calif.	Shaving	48 x 96, 48 x 60, 60 x 70	3/8, 1/2, 5/8, 3/4	$270	$42.82	Various
Timblend	Roddis Plywood Corp.	Arcata, Calif.	Shaving	48 x 96	3/8, 1/2, 5/8, 3/4, 1 1/8	$216	$35.27	Various
Weyerhaeuser 4-square Particle Board	Weyerhaeuser Timber Co.	North Bend, Ore.	Shaving	48 x 96	5/8, 3/4	$202	$35.00	Doors, furniture

a/ F.O.B. mill price

Table 21

Sources of Particle Board Sold
in Georgia, 1958

State	Estimates-Volume 3/4-inch Basis (000 Sq. Ft.)	Percentage
North Carolina	132	6
South Carolina	21	1
California	1,057	50
Oregon	42	2
Virginia	848	40
Total	2,100	99 a/

a/ Short one per cent, due to rounding off.

3. Problems of Market Development

To gain consumer acceptance, any new product entering the market will face a testing period. The wood particle board industry must cope with three major marketing problems: gaining consumer acquaintance, overcoming consumer misunderstanding, and establishing standard grades.

According to the mail survey, about one out of eight potential users of wood particle board were not acquainted with this product and about one out of three had a limited knowledge of it. The lack of consumer acquaintance will naturally delay the growth of market demand for this product. The need for promotional and advertising work for wood particle board in this area is quite obvious.

Consumer misunderstanding also creates a problem. Various products are available without a prescribed standard for application. Any improper use of wood particle board due to misunderstanding of a specific product will lead to a general distrust of all products. Poor products in the early years gave a bad impression, which has some effect on today's market. Technical assistance in the best application of a specific product will help to eliminate misunderstandings.

Like all industries in their developing stage, the wood particle board industry is currently in the process of working out a uniform grading standard. Without standard grades, customers may hesitate to purchase a product which they do not know thoroughly. The action of the industry in establishing standards should aid the firm acceptance of particle board in ever widening markets.

V. ECONOMICS OF PRODUCTION

There are five or six processing methods used for manufacturing wood particle board in the United States. No attempt is made in this study to describe and to compare these methods. Two of them were selected for application and are subject to certain qualifications. They should be regarded only as guides for setting up a wood particle board plant under certain conditions and serving different purposes.

Consideration of investment involves many variables such as raw materials, products, processing method, plant scale, marketing area, etc. Most of these variables cannot be considered separately. They are related to each other in a number of ways that affect the investment involved.

All cost figures used in this study represent approximations and should be applied only under the conditions given. For the most part the data were obtained from equipment manufacturers but without a specific commitment or guarantee that a plant could be built and operated for the specific costs given. Nevertheless, these figures seem reasonable and are believed to be reliable.

Income taxes and financial charges are omitted. The amount of tax depends upon the organization. Individual proprietorships and corporations are taxed at different rates and under different regulations. Partnerships are not taxed as such but distribute income to partners for individual taxation. With these complications the financial analysis is for income "before tax."

Financial charges, such as interest and dividends, also depend upon the organization. Since major concern is with total income from operations and not with the distribution of income among the various capital holders, these charges are also omitted in the analysis.

For each model a summary statement is presented, followed by a break-even chart. This chart illustrates the relationship among sales, costs, and the resulting profits. Variable costs are those that change directly in proportion to changes in production volume. These costs are the raw materials (resin and wood), labor costs associated with production, and certain overhead costs, such as production supplies, power, oil, and steam. In addition to variable costs there are fixed costs which do not change in proportion to changes in production volume. These are the costs of administration, insurance, taxes, and depreciation. The production output where total costs and sales are equal is the break-even point. It is illustrated by the intersection of the total costs and sales

lines on the break-even chart. For Model A it is 2,525,000 square feet of particle board; for Model B it is 7,703,000 square feet. A production and sales volume less than this amount results in a loss; larger volume results in profits. This is a long-run break-even point where sales are sufficient not only to cover all costs which must be paid currently but also to eventually cover the cost of replacing fixed assets through a depreciation charge.

In the short-run it is only necessary to cover the costs to be paid currently. These are the variable costs and the out of pocket fixed costs, such as salaries, insurance, and property taxes. The sales necessary to cover these costs are the short-run break-even point. This is the volume at which the firm can meet current costs but cannot replace fixed assets. The firm can continue to operate in the short run but will be forced to close when equipment must be replaced. For Model A this volume is 1,787,000 square feet; for Model B it is 5,251,000 square feet.

The break-even chart can be used to estimate income at various volumes. For example, with a two-shift operation Model A has a long-run income of $54,289 or a 11.80% return on investment. Model B has a long-run income of $180,186 or 10.07% return on investment.

After the summary statement and break-even chart there are detailed statements of income, expenses, and investment. These schedules are indexed so that the reader may go from the summary statement to any degree of detail desired.

Model A

This plant model is designed to produce a low-cost product, primarily to serve the Georgia market potential. The plant capacity is recommended at around 5,000,000 square feet a year--well within the annual market potential of 9 to 10 million square feet in Georgia. A plant scale of 5,000,000 square feet annual capacity, according to several sources, is regarded as the minimum scale for efficient operation of a non-captive plant.

The product is splinter-type board which is suitable for uses as core materials and sub-flooring. Cross-banding is needed when it is applied with top veneers.

Wood residues would be used for raw materials. Cost of wood residues of various types is estimated around $5.00 per cord in green weight.

The horizontal extrusion process is suggested for plant equipment, due to its low cost compared with the multi-platen process. Products from this

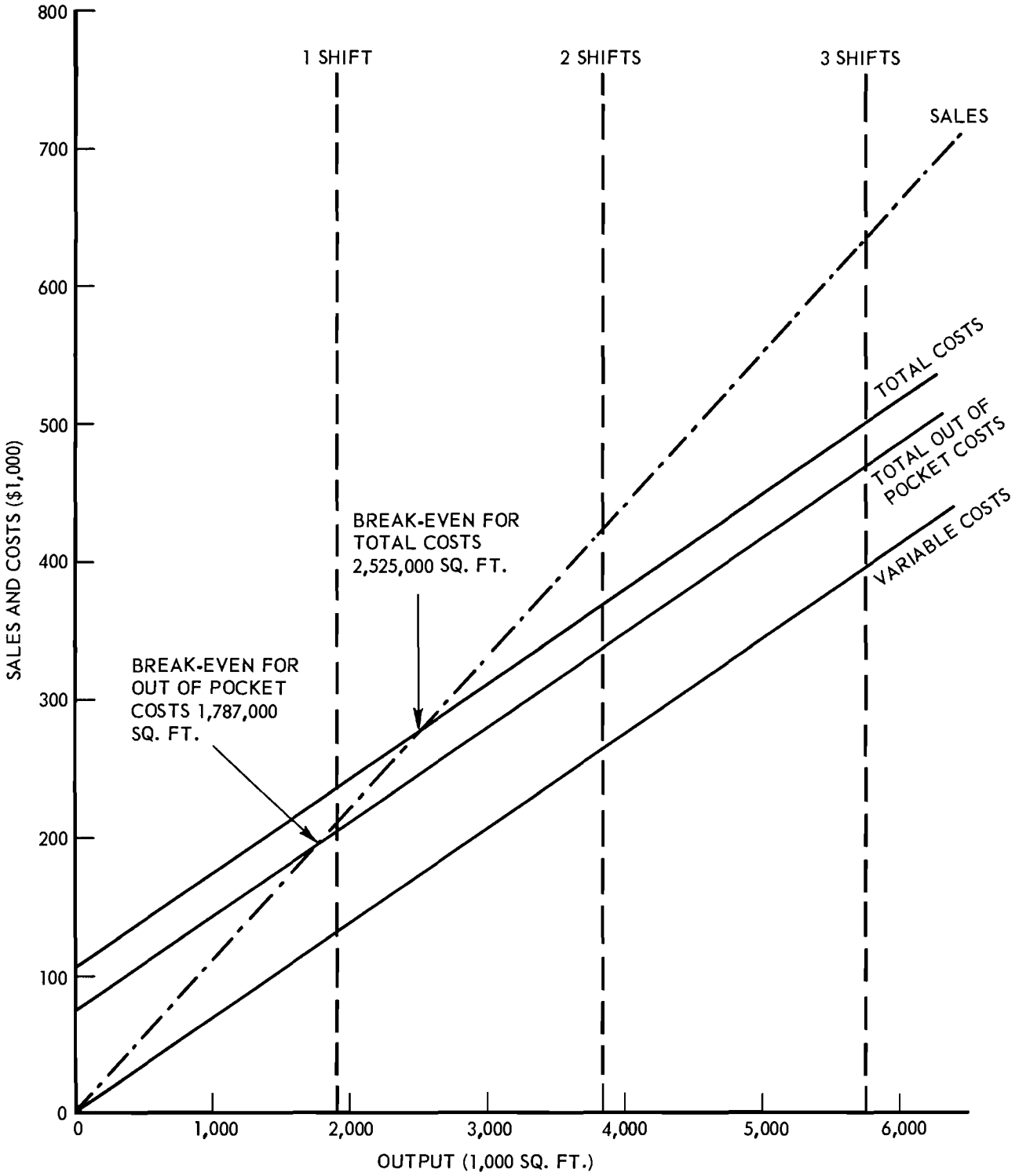
process according to observation, are good enough to serve as a core stock.

The f.o.b. mill price of the board made by this model plant is $110.00 per thousand square feet, which is comparable to other splinter-type boards produced in neighboring states. If the plant is operated under an integrated or diversified basis, production costs will be cut considerably, resulting in a wider margin for competition. However, the estimates on cost and return of Plant Model A are based on an independent operation.

SUMMARY: MODEL A

	Per 1,000 Sq. Ft.	1 Shift	2 Shifts	3 Shifts
Income (Schedule A)				
Unit Sales at Capacity		1,920,000 Sq. Ft.	3,840,000 Sq. Ft.	5,760,000 Sq. Ft.
Sales	$ 110.00	$ 211,200	$ 422,400	$ 633,600
Variable Costs	68.70	131,905	263,808	395,712
Variable Profit	$ 41.30	$ 79,295	$ 158,592	$ 237,888
Out of Pocket Fixed Costs		73,806	73,806	73,806
Cash Income		$ 5,489	$ 84,786	$ 164,082
Non-Cash Fixed Costs (Depr.)		30,497	30,497	30,497
Net Income		$ -25,008	$ 54,289	$ 133,585
Break-even (Sq. Ft.)				
To cover out of pocket costs		1,787,000	1,787,000	1,787,000
To cover all costs, including fixed		2,525,000	2,525,000	2,525,000
Investment				
Fixed Investment (Schedule B)		$ 364,195	$ 364,195	$ 364,195
Working Capital (Schedule C)		47,954	95,908	143,862
Total Investment		$ 412,149	$ 460,103	$ 508,057
Per Cent Return				
On Fixed Investment		-6.87 %	14.91 %	36.68 %
On Total Investment		-6.07 %	11.80 %	26.29 %
Payout Period				
Period for Cash Income to Cover Fixed Investment		67 years	5 years	3 years

BREAK-EVEN CHART – MODEL A



STATEMENT ON MODEL A's INCOME AND EXPENSE

Schedule A

	Per 1,000 Sq. Ft.	1 Shift	2 Shifts	3 Shifts
Unit Sales at Capacity		1,920,000 Sq. Ft.	3,840,000 Sq. Ft.	5,760,000 Sq. Ft.
Sales	$ 110.00	$ 211,200	$ 422,400	$ 633,600
Variable Costs				
Resin (Sch. A-1)	$ 31.90	$ 61,248	$ 122,496	$ 183,744
Wood (Sch. A-2)	7.64	14,669	29,338	44,006
Labor (Sch. A-3)	13.23	25,402	50,803	76,205
Overhead (Sch. A-4)	15.93	30,586	61,171	91,757
Total Variable Costs	$ 68.70	$ 131,905	$ 263,808	$ 395,712
Variable Profit	$ 41.30	$ 79,295	$ 158,592	$ 237,888
Fixed Costs				
Out of Pocket Fixed Costs				
Salaries (Sch. A-5)		$ 23,000	$ 23,000	$ 23,000
Insurance (Sch. A-6)		10,161	10,161	10,161
Property Tax (Sch. A-6)		10,161	10,161	10,161
Maintenance (Sch. A-6)		15,242	15,242	15,242
Development and Selling (Sch. A-6)		15,242	15,242	15,242
Total Out of Pocket Fixed Costs		$ 73,806	$ 73,806	$ 73,806
Cash Income		$ 5,489	$ 84,786	$ 164,082
Non-Funds Fixed Costs				
Depreciation (Sch. A-6)		30,497	30,497	30,497
Net Income		$ -25,008	$ 54,289	$ 133,585

Model A

RESIN COST

Schedule A-1

65% solid at $0.095/lb. delivered in truck load.

Process shrinkage at 22.5%

$0.095 ÷ 77.5% = $0.123/lb.

Amount of resin used - 17 lbs. of 65% solid urea resin to 150 lbs. of chip

17 lbs. x $0.123 ÷ 150 = $0.0139 of resin per lb. of wood chip

Cost/sq. ft. = $0.0139 x 2.3 = $0.0319

Cost/1000 sq. ft. = $31.90

WOOD COST

Schedule A-2

1 cord of wood residue costs $5.00 at green weight of 4,510 lbs. with 40% moisture and 25% bark.

1 cord yield:

4510 x .75 = 3,382 lbs. debarked

3480 x .66 = 2,232 lbs. dried to 6% moisture

Process shrinkage - 32.5%

2,232 lbs. x 67.5% = 1,507 lbs.

$5.00 ÷ 1,507 lbs. = $0.00332/lb.

Cost/sq. ft. = $0.00332 x 2.3 lbs. = $0.00764

Cost/1000 sq. ft. - $7.64

LABOR COST

Schedule A-3

Common $1.65/hr.
Foreman $2.25/hr.

Operation	No. Men	No. Shift	Hours	Daily Cost
Yard	2	2	32	$ 52.80
Hogs and chipper	2	2	32	52.80
Drying and screening	1	2	16	26.40
Press	1	3	24	39.60
Resin mixing	1	3	24	39.60
Warehousing	3	1	24	39.60
Foreman	1	3	24	54.00
Total			176	$ 304.80

Cost/1000 sq. ft. = $304.80 ÷ 23,040 x 1,000 = $13.23

Model A

VARIABLE OVERHEAD COSTS — Schedule A-4

Supplies (Pallets, straps, labels, gasoline, oil, nails, ink, stationery, forms, etc.)	$ 50/day
Power	115/day
Oil	157/day
Steam	45/day
Total	$ 367/day

Cost per 1000 sq. ft.

$367 ÷ 23,040 x 1,000 = $15.93/1000 sq. ft.

SALARIES — Schedule A-5

Plant Manager	$ 12,000
Wood Technologist	8,000
Stenographer	3,000
Total	$ 23,000

ANNUAL DEPRECIATION AND OTHER CHARGES FOR FIXED INVESTMENT — Schedule A-6

	Original Cost	Annual Charge
Building Depreciation at 20 years (Building, Building Equipment, and 10 per cent contingency)	$ 118,448	$ 5,922
Equipment Depreciation at 10 years (Equipment and 10 per cent contingency)	245,747	24,575
Taxes at 2% of Total Investment (Three Shifts)	508,057	10,161
Insurance at 2% of Total Investment	508,057	10,161
Maintenance at 3% of Total Investment	508,057	15,242
Development and Sale at 3% of Total Investment	508,057	15,242
Total		$ 81,303

Model A

FIXED INVESTMENT

Schedule B

Building		
Construction	$ 71,400	
Foundations and Shedding	10,000	
Land	7,780	
Total Building		$ 89,180
Building Equipment		
Sprinkler System	$ 3,000	
Glue Storage Tank	2,500	
Fuel Oil Storage Tank	1,000	
Silos for Chip Storage	5,000	
Miscellaneous Incoming Freight	2,000	
Boiler	5,000	
Total Building Equipment		18,500
Equipment		
Lanewood Horizontal Extrusion Press Process	$ 169,406	
Dryer	25,000	
Debarker	11,000	
Fork Lift Trucks (2)	15,000	
Panel Saw	3,000	
Total Equipment		223,406
Total Fixed Investment, Estimated		331,086
Contingency (10%)		33,109
Total Fixed Investment		$364,195

WORKING CAPITAL INVESTMENT

Schedule C

	1 Shift	2 Shifts	3 Shifts
1 Month Resin Supply	$ 5,140	$ 10,280	$ 15,420
6 Months Wood Supply	7,334	14,668	22,002
1 Month Finished Goods	17,740	35,480	53,220
1 Month Invoice Payable	17,740	35,480	53,220
Total	$ 47,954	$ 95,908	$ 143,862

Model B

This plant model is designed to produce a high quality product comparable to the best wood particle board put out in the nation. The primary marketing area is aimed at the three states--Georgia, Florida, and Alabama. Although this study did not cover the Florida and Alabama markets, it is assumed that this three-state area will have a market potential neighboring 30,000,000 square feet annually. A plant scale of 15 to 16 million square feet annually is adopted.

The product will be flake-type board with smooth surface and good machinability. The board will be suitable as a core stock for any kind of surface laminate without cross-banding. It could also be used as a structural board with good paintability and natural beauty.

Round pulpwood pine is recommended as the wood raw material. Cost of pulpwood pine is around $15 to $16 per cord in green weight. If adequate supply of slabs and edgings is available, wood residue may also be a source of wood raw materials.

The multi-platen process is recommended for plant equipment. This process is widely used among the existing wood particle board plants and has established itself as the flake-type board producer.

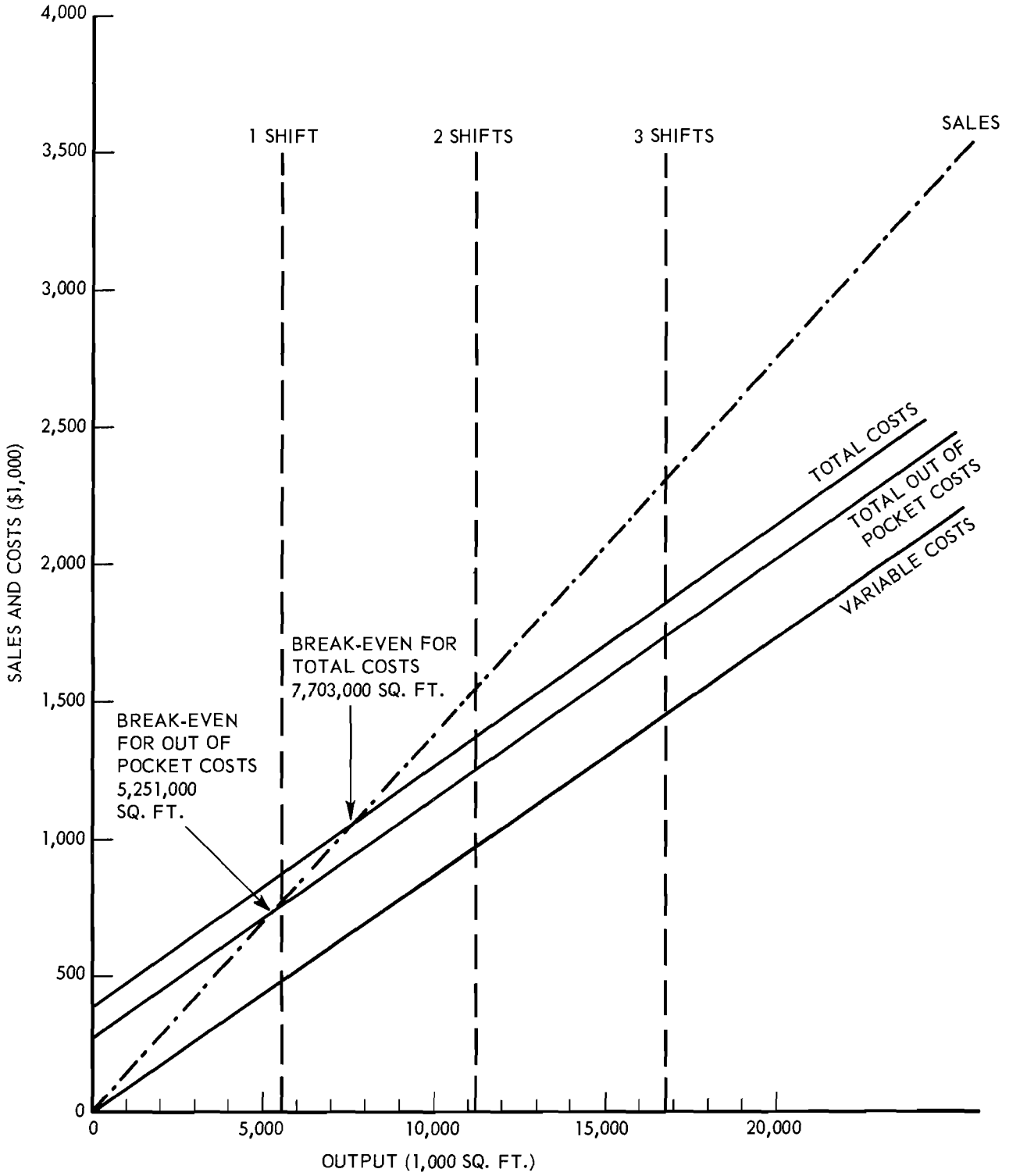
The f.o.b. mill price of the board made by this model plant is $138 per thousand square feet, which is 5 to 20 per cent lower than the f.o.b. mill prices of the existing flakeboards in the market. With this price margin plus the advantage of transportation cost, the product of this model plant should not be difficult to sell in the three-state marketing area.

The estimate of cost and return for this plant model is presented in the following.

SUMMARY: MODEL B

	Per 1,000 Sq. Ft.	1 Shift	2 Shifts	3 Shifts
Income (Schedule A)				
Unit Sales at Capacity		5,600,000 Sq. Ft.	11,200,000 Sq. Ft.	16,800,000 Sq. Ft.
Sales	$ 138.00	$ 772,800	$ 1,545,600	$ 2,318,400
Variable Costs	86.48	484,288	968,576	1,452,864
Variable Profit	$ 51.52	$ 288,512	$ 577,024	$ 865,536
Out of Pocket Fixed Costs		270,526	270,526	270,526
Cash Income		$ 17,986	$ 306,498	$ 595,010
Non-Cash Fixed Costs (Depr.)		126,312	126,312	126,312
Net Income		$ -108,326	$ 180,186	$ 468,698
Break-even (Sq. Ft.)				
To cover out of pocket costs		5,251,000	5,251,000	5,251,000
To cover all costs, including fixed		7,703,000	7,703,000	7,703,000
Investment				
Fixed Investment (Schedule B)		$ 1,357,488	$ 1,357,488	$ 1,357,488
Working Capital (Schedule C)		215,922	431,848	647,770
Total Investment		$ 1,573,410	$ 1,789,336	$ 2,005,258
Per Cent Return				
On Fixed Investment		-7.98 %	13.27 %	34.53 %
On Total Investment		-6.88 %	10.07 %	23.37 %
Payout Period				
Period for Cash Income to Cover Fixed Investment		76 years	5 years	3 years

BREAK-EVEN CHART – MODEL B



STATEMENT ON MODEL B's INCOME AND EXPENSE

Schedule A

	Per 1,000 Sq. Ft.	1 Shift	2 Shifts	3 Shifts
Unit Sales at Capacity		5,600,000 Sq. Ft.	11,200,000 Sq. Ft.	16,800,000 Sq. Ft.
Sales	$ 138.00	$ 772,800	$1,545,600	$2,318,400
Variable Costs				
Resin (Sch. A-1)	$ 37.70	$ 211,120	$ 422,240	$ 633,360
Wood (Sch. A-2)	24.75	138,600	277,200	415,800
Labor (Sch. A-3)	9.07	50,792	101,584	152,376
Overhead (Sch. A-4)	14.96	83,776	167,552	251,328
Total Variable Costs	$ 86.48	$ 484,288	$ 968,576	$1,452,864
Variable Profit	$ 51.52	$ 288,512	$ 577,024	$ 865,536
Fixed Costs				
Out of Pocket Fixed Costs				
Salaries (Sch. A-5)		$ 70,000	$ 70,000	$ 70,000
Insurance (Sch. A-6)		40,105	40,105	40,105
Property Tax (Sch. A-6)		40,105	40,105	40,105
Maintenance (Sch. A-6)		60,158	60,158	60,158
Development and Selling (Sch. A-6)		60,158	60,158	60,158
Total Out of Pocket Fixed Costs		$ 270,526	$ 270,526	$ 270,526
Cash Income		$ 17,986	$ 306,498	$ 595,010
Non-Funds Fixed Costs				
Depreciation (Sch. A-6)		126,312	126,312	126,312
Net Income		$-108,326	$ 180,186	$ 468,698

Model B

RESIN COST

Schedule A-1

65% solid at $0.095/lb. delivered in truck load or 1 lb. resin solid costs $0.1462 delivered.

Process shrinkage at 22.5%

1 lb. resin yields .775 lbs. (1 at .775)

.775 lbs. x $.1462 = $.1887 per lb. in product

Cost/sq. ft. = $.1887 x .2 lbs. in product = $.0377

Cost/1000 sq. ft. - $37.70

WOOD COST

Schedule A-2

1 cord of round pine pulpwood costs $16.00 at green weight of 6,000 lbs. with 60% moisture and 15% bark.

1 cord yield:

6,000 lbs. x .85 = 5,100 lbs. debarked

5,100 lbs. x .46 = 2,346 dried to 6% moisture

Process shrinkage - 30%

2,346 lbs. x .70 = 1,642 lbs.

$16.00 ÷ 1,642 lbs. = $0.009744/lb.

Cost/sq. ft. = $0.009744 x 2.54 lbs. = $0.02475

Cost/1,000 sq. ft. = $24.75

LABOR COST

Schedule A-3

Common $1.65/hr.
Foreman $2.25/hr.

Operation	No. Men	No. Shift	Hours	Daily Cost
Yard	4	2	64	$ 105.60
Shaving and hammer mills	1	2	16	26.40
Drying and screening	1	2	16	26.40
Resin preparation and forming	1	3	24	39.60
Press	2	3	48	79.20
Saws and sanders	3	3	72	118.80
Warehouse and sizing	8	1	64	105.60
Foremen	2	3	48	108.00
Total			352	$ 609.60

Cost/1000 sq. ft. = $609.60 ÷ 67,200 x 1,000 = $9.07

Model B

VARIABLE OVERHEAD COSTS

Schedule A-4

Supplies (Pallets, straps, labels, gasoline, oil, nails, ink, stationery, forms, etc.)	$ 100/day
Power	325/day
Oil	450/day
Steam	130/day
Total	$1,005/day

Cost per 1000 sq. ft.

$1,005 ÷ 67,200 x 1,000 = $14.96/1000 sq. ft.

SALARIES

Schedule A-5

Plant Manager	$ 20,000
Office Manager	8,000
Wood Technologist	8,000
Plant Engineer	8,000
Plant Superintendent	8,000
Stenographers (3) at $3,000	9,000
Clerks (3) at $3,000	9,000
Total	$ 70,000

ANNUAL DEPRECIATION AND OTHER CHARGES FOR FIXED INVESTMENT

Schedule A-6

	Original Cost	Annual Charge
Building Depreciation at 20 years (Building, Building Equipment, and 10 per cent contingency)	$ 188,738	$ 9,437
Equipment Depreciation at 10 years (Equipment and 10 per cent contingency)	1,168,750	116,875
Taxes at 2% of Total Investment (Three Shifts)	2,005,258	40,105
Insurance at 2% of Total Investment	2,005,258	40,105
Maintenance at 3% of Total Investment	2,005,258	60,158
Development and Sale at 3% of Total Investment	2,005,258	60,158
Total		$326,838

Model B

FIXED INVESTMENT

Schedule B

Building		
Construction	$ 94,800	
Foundations and Shedding	13,300	
Land	9,480	
Total Building		$ 117,580
Building Equipment		
Sprinkler System	$ 8,000	
Glue Storage Tank	5,000	
Fuel Oil Storage Tank	3,000	
Silos for Chip Storage	10,000	
Miscellaneous Incoming Freight	3,000	
Boiler	25,000	
Total Building Equipment		54,000
Equipment		
Miller Hofft Multi-Platen Process (All Equipment)	$ 850,000	
Incoming Freight on Multi-Platen Process Equipment	9,000	
Erection on Prepared Sites	50,000	
Two Tandem Double Trim Saws, Installed	32,000	
Eight Drum Double Sander, Installed	38,000	
Four Debarkers and Conveyor	45,000	
Fork Lift Truck (3)	22,500	
One Edge Gluer, Electronic	10,000	
Two Large Panel Saws for Cutting to Size	6,000	
Total Equipment		1,062,500
Total Fixed Investment		1,234,080
Contingency (10%)		123,408
Total Fixed Investment		$ 1,357,488

WORKING CAPITAL INVESTMENT

Schedule C

	1 Shift	2 Shifts	3 Shifts
1 Month Resin Supply	$ 17,734	$ 35,468	$ 53,202
6 Months Wood Supply	69,300	138,600	207,900
1 Month Finished Goods	64,444	128,890	193,334
1 Month Invoice Payable	64,444	128,890	193,334
Total	$ 215,922	$ 431,848	$ 647,770

Appendix A

WOOD PARTICLE BOARD PLANTS IN THE UNITED STATES

Name	Distribution	Particle Type	Annual Capacity (Million Sq. Ft.)	Type of Process	Board Size
American Furniture Co. Martinsville, Va.	Captive	Splinter	5.0	Ext.	49" wide
American Furniture Co. N. Wilkesboro, N. C.	Captive	Splinter	5.0	Ext.	49" wide
American Parboard Corp. Black Mountain, N. C.	Non-captive	Shaving	6.4	M-P	5' x 8'
Bemis Hardwood Lumber Co. Robbinsville, N. C.	Non-captive	Shaving	12.0	M-P	NA
Berkline Corp. Morristown, Tenn.	Captive	Splinter	3.0	Ext.	49" wide
Broyhill Furniture Factories Lenoir, N. C.	Captive	Splinter	5.0	Ext.	49" wide
Broyhill Furniture Factories Newton, N. C.	Captive	Splinter	5.0	Ext.	49" wide
Brownsville Wood Prod. Corp Brownsville, Ore.	Non-captive	Shaving	7.5	M-P	4' x 8'
Carolina Forest Products, Inc. Wilmington, N. C.	Non-captive	Shaving	12.0	M-P	5' x 8'
Cascades Plywood Corp. Lebanon, Ore.	Non-captive	Splinter	20.0	M-P	4' x 8'
Cavalier Corp. Chattanooga, Tenn.	Non-captive Captive	Splinter	5.0	M-P	4' x 8'
Caldwell Furniture Co. Lenoir, N. C.	Captive	Splinter	5.0	Ext.	49" wide
Chapman-Woods, Inc. Corvallis, Ore.	Non-captive	Flake	6.25	M-P	4' x 8'
Chipboard Products Grants Pass, Ore.	Non-captive	Splinter	5.0	Ext.	49" wide

Appendix A

WOOD PARTICLE BOARD PLANTS IN THE UNITED STATES

Name	Distribution	Particle Type	Annual Capacity (Million Sq. Ft.)	Type of Process	Board Size
Clear Fir Products Springfield, Ore.	Non-captive	Flake	8.75	M-P	4' x 8'
Columbia Hardboard Co., Inc. Everette, Washington	Non-captive	Splinter	20.0	M-P	4' x 8'
Coreboard Products, Inc. Belhaven, N. C.	Non-captive	Shaving	5.0	M-P	4' x 24' 4' x 40'
Curtis Co., Inc. Clinton, Iowa	Captive	Sawdust	2.5	M-P	4' x 4'
Dixie Chipboard Co. Rural Hall, N. C.	Non-captive	Splinter	5.0	Ext.	49" wide
Formica Corp. (American Cyanamid) Farmville, N. C.	Non-captive	Flake	40.0	M-P	6' x 12'
Granite Board, Inc. Goffstown, N. H.	Non-captive	Splinter	3.75	M-P	4' x 8'
Gray Products Co., Inc. Waverly, Va.	Non-captive	Flake/Splinter	25.0	M-P	5' x 10'
Gulf Naval Stores Gulfport, Miss.	Non-captive	Splinter	3.0	Ext.	49" wide
Hardwood Products Inc. Hart, Mich.	Non-captive	Splinter	3.0	Ext.	49" wide
Hickory Mfg. Co. Hickory, N. C.	Captive	Splinter	2.0	M-P	5 1/2' x 9'
Hudson Lumber Co. N. Sacramento, Calif.	Non-captive	Flake	1.25	M-P	NA
Jasper-American Henderson, Ky.	Non-captive	Splinter	2.25	Ext.	49" wide
Kroehler Mfg. Co. Meridian, Miss.	Captive	Flake/Splinter	12.0	M-P	NA

Appendix A

WOOD PARTICLE BOARD PLANTS IN THE UNITED STATES

Name	Distribution	Particle Type	Annual Capacity (Million Sq. Ft.)	Type of Process	Board Size
The Lane Co., Inc. Altavista, Va.	Captive	Splinter	5.0	Ext.	49" wide
The Long-Bell Lumber Co. Longview, Wash.	Non-captive	Flake	20.0	M-P	4' x 8'
Mississippi Wood Products Jackson, Miss.	Captive	Splinter	6.25	M-P	4' x 8'
Mount Shasta Plywood Corp. Mt. Shasta, Calif.	Non-captive	-	-	M-P	-
National Starch Products Inc.	-	Splinter	12.0	M-P	4' x 8'
New England Industries High Point, N. C.	Non-captive	Splinter	10.0	Ext.	49" wide
Owosso Mfg. Co. Benton, Ark.	Captive	Splinter	1.5	Ext.	24" wide
Pack River Lumber Co. Sand Point, Ida.	Non-captive	Flake	40.0	M-P	4' x 16'
Pacific Plywood Co. Dillard, Ore.	Non-captive	Splinter	37.5	M-P	4' x 16'
Poinsett Lumber & Mfg. Co. Pickens, S. C.	Non-captive Captive	Splinter	5.0	M-P	4' x 8'
Pope & Talbot, Inc. Oakridge, Ore.	Non-captive	Flake/Splinter	12.0	M-P	4' x 8'
Ritter, W. M. Lumber Co. Halloboro, N. C.	Non-captive	Splinter	3.0	Ext.	49" wide
Rock Island Millwork Co. Rock Island, Ill.	Non-captive Captive	Sawdust	18.0	M-P	-
Roddis Plywood Corp. Arcata, Calif.	Non-captive	Shaving	12.0	M-P	4' x 8'

Appendix A

WOOD PARTICLE BOARD PLANTS IN THE UNITED STATES

Name	Distribution	Particle Type	Annual Capacity (Million Sq. Ft.)	Type of Process	Board Size
Scottdale Wood Prod. Scottdale, Pa.	Non-captive	Splinter	3.0	Ext.	49" wide
Sencore Industries Fernwood, Miss.	Non-captive	Splinter	3.0	M-P	4' x 8'
Souhegan Wood Products, Inc. Wilton, N. H.	-	Splinter	6.0	M-P	-
Southern Plaswood Corp. Hope, Ark.	Non-captive	Splinter	7.5	M-P	4' x 8'
Swain Industries Seymour, Ind.	Non-captive	Splinter	5.0	M-P	4' x 8'
Sylvanal, Inc. Longview, Wash.	Non-captive	Shaving	1.88	M-P	3' x 3'
Thomason Plywood Corp. Fayetteville, N. C.	Captive	Splinter	3.0	Ext.	49" wide
United Wood Corp.	-	Flake	8.0	M-P	4' x 16'
U. S. Korboard	-	Splinter	18.0	Ext.	Cut to size
U. S. Plywood Corp. Anderson, Calif.	Non-captive	Shaving	50.0	M-P	NA
Soothdale Wood Products Eldred, Pa.	Captive	Splinter	3.0	Ext.	49" wide
Versatile Products, Inc. Anacortes, Wash.	Non-captive	-	-	M-P	-
Wabash Screen Door Co. Minneapolis, Minn.	Non-captive	Shaving	3.75	M-P	5 1/2' x 6'
Western Panel, Inc.	-	Shaving	5.0	M-P	4' x 8'

Appendix A

WOOD PARTICLE BOARD PLANTS IN THE UNITED STATES

Name	Distribution	Particle Type	Annual Capacity (Million Sq. Ft.)	Type of Process	Board Size
Tyrone Building Board Div. (West Va. Pulp & Paper Co.) Tyrone, Pa.	Non-captive	Shaving	25.0	M-P	4' x 8'
Weyerhaeuser Timber Co. North Bend, Ore.	Non-captive	Shaving	13.5	M-P	4' x 8'
Williamette Fiber & Chipboard Co. Sweet Home, Ore.	Non-captive	Splinter	10.0	M-P	4' x 8'
Woodcore Inc. Scottdale, Pa.	Non-captive	Splinter	3.0	M-P	4' x 1'
Wynnewood Products Co. Jacksonville, Tex.	Non-captive	Splinter	10.0	M-P	4' x 8'

Sources: Wood Particle Board Handbook, North Carolina State College, The School of Engineering, Raleigh, N. C.

Industrial Woodworking, Vol. 10, No. 2.

Miller Hofft, Inc.'s circulated papers.

Correspondence.

APPENDIX B

Species Used for Particle Board Manufacture in North America

Species	Particle Form	Associated Species in Mixtures
	SOFTWOODS	
Cedar:		
Eastern red	Splinter	Alone Mahogany Yellow Poplar Gum Oak Walnut
Western red	Flakes	Alone Douglas fir Western hemlock Western firs Oregon maple
Douglas fir	Flakes Splinters Shavings	Alone Western hemlock Western firs Western red cedar Oregon maple
Fir, balsam	Splinters Flakes	Red pine Jack pine Eastern white pine Aspen Eastern spruce
Hemlock, western	Flakes	Douglas fir Western firs Western red cedar Oregon maple
Pine:		
Eastern white	Splinters Flakes	Alone Jack pine Red pine Balsam fir Eastern spruce Aspen
Jack	Splinters Flakes	Red pine Eastern white pine Balsam fir Aspen Eastern spruce
Ponderosa	Flakes Fine splinters	Alone Western softwoods

Species	Particle Form	Associated Species in Mixtures
Pine:		
Red	Splinters Flakes	Jack pine Eastern white pine Balsam fir Aspen Eastern spruce
Southern yellow	Flakes Shavings Splinters Chips (from turpentine extraction)	
Spruce, eastern	Splinters Flakes	Red pine Jack pine Eastern white pine Aspen Balsam fir
	HARDWOODS	
Aspen	Splinters Flakes	Red pine Jack pine Eastern white pine Balsam fir Eastern spruce
Birch	Splinters	Gum Yellow poplar Mahogany Walnut
Gum	Splinters Flakes	Alone Birch Yellow poplar Mahogany Walnut
Mahogany	Splinters	Birch Gum Yellow poplar Walnut
Maple:		
Oregon	Flakes	Douglas fir Western hemlock Western firs Western red cedar
Soft	Flakes	Yellow poplar
Oak	Splinters	Alone
Walnut	Splinters	Birch Gum Yellow poplar Mahogany

Species	Particle Form	Associated Species in Mixtures
Yellow poplar	Splinters Fakes	Soft maple Birch Gum Mahogany Walnut

Source: Timber Engineering Company, What Wood Can You Use in Particle Board? Wood Research No. 34, April, 1958.

Several species tested by the Timber Engineering Company with favorable results in experimental manufacture of particle boards are corkwood (Musanga Smithii), cherry, ekki (Lophira procera), elm, eucalyptus, mountain ash, redwood, sycamore, and willow. These species were tested alone without any combination with other species.

Several commercial woods which may be useful for particle board manufacture but not included in the above table are listed below:[1/]

Softwoods

Alaska Cedar	Cypress	Lodgepole pine
Port Orford Cedar	Eastern hemlock	Sugar pine
Incense cedar	Larch	Western white pine

Hardwoods

Red Alder	Basswood	Holly	Hickory
Ash	Hackberry	Locust	Magnolia

1/ Timber Engineering Company, What Wood Can You Use in Particle Board? Wood Research No. 34, April, 1958.

Appendix C–1

Estimated volume of softwood residue available from Georgia wood-using industries, by districts, 1957

(in tons green weight)

Kind of residue	District 1	District 2	District 3	District 4	District 5	District 6	District 7	District 8	District 9	District 10	State
Slabs	147,521	110,059	108,905	102,729	150,605	104,645	87,395	172,599	60,434	74,390	1,119,282
Edgings	58,178	46,999	44,097	40,652	62,827	44,296	35,633	68,885	25,690	31,375	458,632
End trim	20,868	16,317	14,252	20,935	21,370	16,104	10,470	25,534	8,692	8,995	163,537
Panel trim	11	4	0	411	105	107	376	11	34	23	1,082
Cull pieces	66	32	0	933	204	91	24	52	29	41	1,472
Shavings	72,170	45,232	50,606	60,312	77,372	79,373	75,005	32,523	49,394	52,922	594,912
Sawdust	90,568	57,589	63,127	75,453	115,149	86,360	72,837	128,984	48,882	60,163	799,112
Sanderdust	6	3	0	94	20	9	4	5	8	4	153
Bark	41,244	28,847	40,897	43,980	57,550	40,165	33,028	73,987	22,500	28,539	410,737
Total	430,632	305,082	321,884	345,499	485,202	371,150	314,772	502,583	215,663	256,452	3,548,919

Source for Tables 9, 10, 11, and 12: **"Survey of Wood Residue in Georgia,"**
Resource – Industry Series Number 1
Georgia Forest Research Council

Appendix C–2
Estimated volume of hardwood residue available from Georgia wood-using industries, by districts, 1957

(in tons green weight)

Kind of residue	District 1	District 2	District 3	District 4	District 5	District 6	District 7	District 8	District 9	District 10	State
Slabs	15,289	13,355	4,135	39,532	18,810	35,050	29,052	4,272	19,619	31,641	210,755
Edgings	8,291	7,465	2,143	20,910	10,333	19,701	5,230	1,364	10,483	16,103	102,023
End trim	3,398	3,409	2,380	12,474	5,521	7,484	7,154	1,355	3,641	10,413	57,229
Bolt trim-off	2,780	0	0	400	810	2,675	0	1,658	307	346	8,976
Veneer cores	37,808	10,296	6,712	7,170	11,023	36,379	0	22,551	4,171	4,704	140,814
Ven. roundup	18,626	0	0	3,532	5,430	17,922	0	11,110	2,055	2,317	60,992
Veneer clip	30,024	0	0	5,694	8,753	28,889	0	17,908	3,312	3,736	98,316
Panel trim	1,326	0	0	88	2,475	2,471	921	4,484	0	5	11,770
Cull pieces	121	8	190	901	303	274	617	150	149	343	3,056
Shavings	2,546	2,318	10,861	27,290	9,293	16,987	19,811	1,184	5,891	15,786	111,967
Sawdust	8,918	13,782	16,535	49,257	25,538	42,627	39,525	6,018	22,115	33,747	258,062
Sanderdust	321	1	0	27	597	579	1,089	16	2	24	2,656
Bark	24,087	8,298	2,417	27,324	18,026	40,910	18,072	14,527	13,765	20,476	187,902
Total	153,535	58,932	45,373	194,599	116,912	251,948	121,471	86,597	85,510	139,641	1,254,518

Appendix C–3
Reported estimated value of softwood residue in Georgia by districts, 1957 1/

(in dollars per ton, green weight)

residue	District 1	District 2	District 3	District 4	District 5	District 6	District 7	District 8	District 9	District 10	State
Slabs	5.83	4.22	3.63	1.58	191.	4.39	1.42	6.40	2.94	1.58	3.80
Edgings	5.82	4.26	3.53	1.62	2.06	3.61	1.64	6.42	3.05	1.30	3.63
End trim	4.65	3.94	3.09	2.98	1.86	2.20	1.87	6.03	2.63	1.56	3.30
Panel trim	.11	1.00	—	6.14	1.04	2.50	2.87	1.75	1.50	1.00	3.33
Cull pieces	.17	.55	0	6.50	1.04	1.00	2.82	1.11	1.50	1.00	4.31
Shavings	3.46	1.40	1.40	2.55	1.76	.43	1.18	2.68	1.40	1.51	1.78
Sawdust	2.68	1.00	2.36	2.34	1.37	.84	.56	3.35	.73	1.13	1.80
Sanderdust	1.00	.89	0	2.00	1.00	0	1.00	2.00	0	1.00	1.51
Bark	2.62	1.00	1.30	1.09	1.00	.69	0	3.38	1.77	.52	1.52
Average all kinds	4.27	2.57	2.65	1.99	1.67	2.13	1.06	4.78	1.96	1.31	2.66

1/Values based on weighted averages

Appendix C–4

Reported estimated value of hardwood residue in Georgia by districts, 1957 1/

(in dollars per ton, green weight)

Kind of residue	District 1	District 2	District 3	District 4	District 5	District 6	District 7	District 8	District 9	District 10	State
Slabs	5.26	.50	2.29	1.56	4.67	3.98	1.33	4.50	1.99	1.04	2.43
Edgings	5.28	.75	2.28	1.65	5.15	4.01	1.77	4.50	1.99	.97	2.56
End trim	5.04	.50	1.48	2.67	4.16	2.36	1.77	4.42	1.64	1.02	2.21
Bolt trim-off	2.50	5.00	—	—	7.00	—	—	—	—	—	3.64
Veneer cores	5.40	1.50	1.50	6.00	4.20	3.85	—	4.30	5.00	5.60	4.33
Veneer roundup	2.50	5.00	—	—	7.00	—	—	—	—	—	3.68
Veneer clip	2.50	5.00	—	—	7.00	—	—	—	—	—	3.68
Panel trim	2.50	—	—	5.57	7.00	—	2.50	—	—	—	3.81
Cull pieces	4.67	.89	.63	2.76	2.93	2.50	2.40	1.18	1.03	1.25	2.06
Shavings	3.16	1.50	0	2.25	4.26	.49	1.33	1.59	1.27	1.40	1.22
Sawdust	2.03	0	1.86	2.57	5.07	.67	.50	3.00	.96	1.07	1.68
Sanderdust	2.50	.89	—	5.00	6.80	2.00	3.00	1.59	1.27	.91	3.17
Bark	2.12	2.18	2.91	—	2.86	.59	—	3.00	1.13	.50	1.33
Average all kinds	3.45	1.77	1.66	1.91	4.75	1.73	1.03	2.22	1.46	1.11	2.09

1/ Values based on weighted averages

APPENDIX D

Desirable Wood Particle Board Characteristics For Uses as a Core Material

1. Density: 40-45 lbs. per cubic foot (Sp. gr. 0.64-0.72).
2. Tranverse strength (modulus of rupture)--over 1,500 p.s.i.
3. Tensile strength--over 700 p.s.i.
4. Water absorption: 4" x 4" X 3/4" specimens, 2 hrs. 3%; 12 hrs. 15%. By ASTM-D-1037-49T-less the 3% by volume.
5. Hardness (ASTM-D143-49): Approximately 800 lbs.
6. Thermal conductivity (K factor)--approximately 0.75.
7. Screw-holding power--No. 8 wood screw driven 3/4" 1/8" pilot hole requires over 300 lbs. for withdrawal.
8. Dimensional stability (effect of humidity, ASTM-D1037-49T): Unveneered panels will show an increase in linear dimension of approximately 0.25% when subjected to a R.H. of 95% at 70° F., as compared with its equilibrium dimension at 50% R.H. and 70° F. However, when veneered with plastic laminates, the dimensional change produced by a change in humidity is negligible.
9. Machinability: Machines readily with ordinary woodworking equipment and with approximately the same power requirements as fir plywood of similar thickness. However, saws and cutters should be fitted with carbide cutting edges.
10. Gluability: Can be glued in the same manner as fir, poplar, or gum core, using approximately the same adhesives, pressure, temperature, and glue spreads. It may be edge glued to give a glue joint which is stronger than the parent material.
11. Warpage: Generally more resistant to warping than wood. It can be made to warp somewhat by subjecting opposite sides to widely different humidity conditions, but any such induced warpage is reversible by reversing conditions. However, in making laminated panels, highly stable and flat panels can be produced by giving reasonable attention to balancing the construction, particularly with regard to control of stresses developed in the surface laminates, and also the control of moisture transmission through surface.

12. Finish: Sanded both sides for gluing finish.

Source: Robert A. Caughey, "Development and Market Potential of Particle Board," Forest Products Journal, Vol. V, No. 4, August 1955, p. 19-A

Desirable Board Characteristics

Wood particle board to be used as a substitute for lumber should have the following characteristics.

1. Dimensional stability equal to the wood to be replaced.
2. Even density throughout its whole volume.
3. Good screwholding power.
4. Freedom from inherent warpage tendencies.
5. Machineability to produce a flat and stable surface for veneering or laminating.
6. Good compressive strength.
7. Reasonable flexure and modululus of rupture in bending.
8. Good shear strength.
9. Economic cost as compared with the lumber or plywood for which it is to substitute.
10. Good gluing properties.
11. Density not more than about 12% higher than the lumber replaced.

Source: R. D. Bibby, "Manufacture and Use of Wood Particle Board," Forest Product Journal, Vol. VI, No. 5, May 1956, p. 169.

APPENDIX E

Industrial Development Branch
Engineering Experiment Station
Georgia Institute of Technology
Atlanta 13, Georgia

Date_____

SURVEY OF THE WOOD PARTICLE BOARD MARKET

1. Name of establishment: _____

2. Address: _____

3. Name of manager: _____ 4. Number of employees: _____

5. What are the major products of your firm? _____

_____

_____

_____

6. Do you use wood particle board in your manufacturing? Yes___ No___. If YES, please answer questions 7-17. If NO, please skip to question 18.

* *

7. For how many years have you been using wood particle board? _____

8. Approximately how many square feet of wood particle board did you use during the past year? _____

9. Where do you purchase wood particle board? _____

_____

10. Please give the types, prices, and uses of wood particle board used in your manufacturing during the last year.

Trade Name	Thickness	Price	Purchased Volume (sq. ft.)	Uses

11. How does particle board compare with alternate materials such as fir plywood, Masonite, or others in terms of physical characteristics, cost and uses? Please put a check mark (✓) under particle board or alternate material to indicate which one possesses the better physical characteristics. Mark both if they are of equal quality.

		Alternate Materials		
Physical Characteristics	Particle Board	#1 Plywood	#2 Masonite	#3
Hardness	( )	( )	( )	( )
Smoothness	( )	( )	( )	( )
Dimensional stability	( )	( )	( )	( )
Relative water absorption	( )	( )	( )	( )
Screw holding ability	( )	( )	( )	( )
Warping tendency	( )	( )	( )	( )
Bending strength	( )	( )	( )	( )
Breaking strength	( )	( )	( )	( )
Density	( )	( )	( )	( )
Comparative costs	$ sq/ft	$ sq/ft	$ sq/ft	$ sq/ft
Best uses				

12. About how many square feet of fir plywood did you use in your manufacturing last year?_____

13. Could you estimate in square feet the amount of other alternate materials (such as Masonite) used in your manufacturing last year? _____ square feet of _____ (specific material).

14. Have you had any difficulty in getting wood particle board? Yes ___ No ___. If so, please explain:

_____

_____

_____

15. Do you expect to increase the volume of wood particle board used in your manufacturing? Yes___ No__
If YES, to what extent? _____per cent.

16. What qualities are needed for an ideal type of particle board that would best suit your needs?_____

_____

_____

_____

17. Do you have any suggestions for improving the wood particle board industry?_____

_____

_____

_____

_____

_____

18. Are you acquainted with wood particle board? Yes ___ No ___

19. Could you compare wood particle board with other materials (such as plywood or Masonite) which could be used for similar purposes? _____

_____

_____

_____

_____

_____

_____

20. Do you think that you might use wood particle board in your manufacturing? Yes ___ No ___

21. If YES, in what quantity per year? _____ square feet.