

WOOD USED IN NEW RESIDENTIAL CONSTRUCTION INTHEUNITEDSTATES

1988

Robert G. Anderson
David B. McKeever

Anderson, Robert G.; McKeever, David B. 1991. Wood used in new residential construction in the United States 1988. Final report to the Wood Products Promotion Council. Tacoma, WA: American Plywood Association. 73 p.

*American Plywood Association
American Wood Council
National Forest Products Association
Southern Forest Products Association
Western Wood Products Association
Forest Service, U.S. Department of Agriculture*

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(Slightly revised September 1991)

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RESIDENTIAL CONSTRUCTION
IN THE UNITED STATES**

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INTRODUCTION

The new residential construction market has been, and continues to be, of major importance to the wood products industry. Over the years, periodic studies have been conducted to enumerate and evaluate the types and qualities of wood products consumed. The most recent general study was done by the Forest Service in 1970 for 1968 (Statistical Bulletin 452 - Phelps). A study on panels was completed by the American Plywood Association in 1977 for 1976 uses. The need for up-to-date information is critical, both for forest resource planning and for industry marketing efforts.

The current study was conducted as a joint effort by the Wood Products Promotion Council (WPPC)* and the Timber Demand and Technology Assessment Research Work Unit of the Forest Service at the Forest Products Laboratory in Madison, Wisconsin.

Data were gathered through a telephone survey conducted by Market Trends, Inc. of Bellevue, Washington to obtain incidence of materials use in current housing projects.

Data on the actual volumes of each material used in an application were developed from plans and specifications of buildings currently being erected around the country. These plans and materials use details were gathered by field representatives of the WPPC member organizations APA, WWPA and SFPA. Material takeoffs were done by The Bottom Line Construction Services of Tacoma, Washington.

For single family residential construction, there were 1,282 plans representing about 62,750 houses in the incidence of use study and 48 houses in the materials takeoff study. These 48 houses were selected to represent the Census reported range of sizes, story height and foundation type for units in the four geographic regions of the U.S. The Northeast and the Midwest regions were subsequently combined to become the "North" region for this study. For multifamily construction, there were 10 projects representing about 140 living units for the materials take-off segment, and 89 buildings with 3,968 units in the incidence of use segment of the study. Data for multifamily units were not regionalized.

American Plywood Association (APA)
American Wood Council (AWC)
National Forest Products Association (NFPA)
Southern Forest Products Association (SFPA)
Western Wood Products Association (WWPA)

RESIDENTIAL MARKET

SINGLE FAMILY HOUSING

According to the Bureau of the Census, 1,085,000 single family privately owned houses were completed in 1988. These completed units were classified by foundation type, number of stories, square feet of living area and region as a basis for expanding the incidence and volume per use data to arrive at total wood products consumption. The table below shows the numbers of units in each cell of this study.

**NEW PRIVATE SINGLE FAMILY HOUSING UNITS COMPLETED
BY REGION, FOUNDATION TYPE, NUMBER OF STORIES
AND SQUARE FEET OF FLOOR AREA, 1988**
(Thousand units)

Region	One Story and Split Level			Two or More Stories			Total, All Stories		
	Less than 1,600 sq. ft.	1,600 or more sq. ft.	Total	Less than 1,600 sq. ft.	1,600 or more sq. ft.	Total	Less than 1,600 sq. ft.	1,600 or more sq. ft.	Total
BASEMENT/CRAWL SPACE FOUNDATION									
North	75.1	57.4	132.5	40.9	160.2	201.1	116.0	217.6	333.6
South	56.7	40.7	97.4	21.4	96.3	117.7	78.1	137.0	215.1
West	21.6	23.7	45.3	7.2	37.0	44.2	28.8	60.7	89.5
Total	153.4	121.8	275.2	69.5	293.5	363.0	222.9	415.3	638.2
SLAB FOUNDATION									
North	13.3	8.8	22.1	8.8	15.5	24.3	22.1	24.3	46.4
South	76.0	94.2	170.2	19.3	52.4	71.7	95.3	146.6	241.9
West	43.2	42.2	85.4	12.4	60.7	73.1	55.6	102.9	158.5
Total	132.5	145.2	277.7	40.5	128.6	169.1	173.0	273.8	446.8
TOTAL, ALL FOUNDATIONS									
North	88.4	66.2	154.6	49.7	175.7	225.4	138.1	241.9	380.0
South	132.7	134.9	267.6	40.7	148.7	189.4	173.4	283.6	457.0
West	64.8	65.9	130.7	19.6	97.7	117.3	84.4	163.6	248.0
Total	285.9	267.0	552.9	110.0	422.1	532.1	395.9	689.1	1,085.0

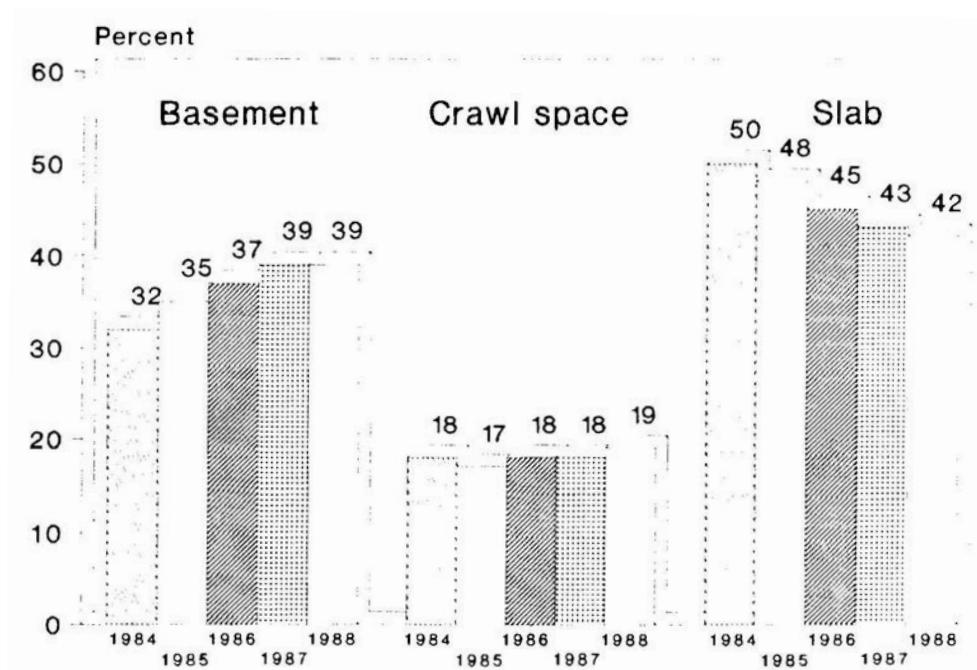
Source: U.S. Department of Commerce, Bureau of the Census, Washington, DC 20233. Derived from unpublished data provided in April, 1989.

Foundation Type

Forty-two percent of all single family houses erected during 1988 were build on slab foundations. The slab percentage has continued its gradual downward share trend from its peak in 1984. From 50% that year to 42% today, slab is giving way to mmore basement and crawl space construction. The following table shows this trend.

Foundation Type	1984	1985	1986	1987	1988
	(Percent)				
Full or partial basement	32	35	37	39	39
Crawl space	18	17	18	18	19
Sub Total	50	52	55	57	58
Slab	50	48	45	43	42
Total	100	100	100	100	100
	(Thousands)				
Number of houses	1,085	1,123	1,120	1,072	1,025

PERCENTAGE OF SINGLE FAMILY HOUSING STARTS, BY FOUNDATION TYPE, 1984-88



The table below compares single family houses built by region and foundation types in 1976 and 1988.

**PERCENT AND NUMBER OF SINGLE FAMILY HOUSES COMPLETED
BY FOUNDATION TYPE AND REGION, 1976 AND 1988**

Foundation Type	North		South		West		Total	
	1976	1988	1976	1988	1976	1988	1976	1988
	(Percent)							
Basement	79	79	21	20	31	13	45	39
Crawl space	10	8	25	27	48	23	19	19
Subtotal	89	87	46	47	79	36	64	58
Slab	11	13	54	53	21	64	36	42
Total	100	100	100	100	100	100	100	100
	(Thousand units)							
Total	392	380	410	457	232	248	1,034	1,085

Note the dramatic increase in the slab share of the market in the West. This has come in large part from the California energy code which has unfairly penalized wood floor construction. Somewhat offsetting this shift to slab floors is a preference in California for two story houses, which typically include a wood floor for the upper levels.

MULTIFAMILY HOUSING

The Bureau of the Census reports that 445,000 multifamily units were completed during 1988. Of these, 19% were in one story buildings, 56% were in two story buildings and 25% were in three or more story buildings.

The table below shows the number of units by region and includes floor area averages.

NEW MULTIFAMILY UNITS COMPLETED, BY REGION, 1988

Region	Total Buildings	Total Units	Floor Area Average/Unit
	(Thousand units)		(Square feet)
North	18	151	1,100
South	15	138	970
West	15	156	930
Total	48	445	

The discussion which follows is based on the foregoing Census statistics combined with the survey data to provide a calculated volume picture by building type and application. Also, regional statistics are presented for single family construction. The discussion covers lumber use, followed by a discussion of structural and nonstructural panel use in single, then multifamily units.

Unless otherwise indicated, lumber data are measured in board feet (bd. ft.): structural and nonstructural data in square feet, 3/8 inch basis (sq. ft., 3/8" basis).

Three appendices follow. Appendix A details lumber and panel products used for millwork and miscellaneous other uses; Appendix B details the derivation of the use factors which are the basis for the study. Appendix C includes statistical tables and authors.

Although this study provides some insights into the use of nonwood products competing with wood products in new residential construction, total nonwood product usage is not reported here. Information on nonwood products use was collected only when used as an alternative to wood. The data for nonwood products usage are therefore incomplete, preventing estimation of total nonwood products consumption.

An effort was made to quantify hardwood and softwood lumber separately. Unfortunately, species information was difficult to obtain. The survey could not separate species volume in framing lumber, although small amounts of hardwood (probably less than 1%) are used as framing lumber products.

Hardwoods were used more extensively in mouldings and some types of millwork. An indication of the major areas of hardwood use will be found on page 57 in Appendix A.

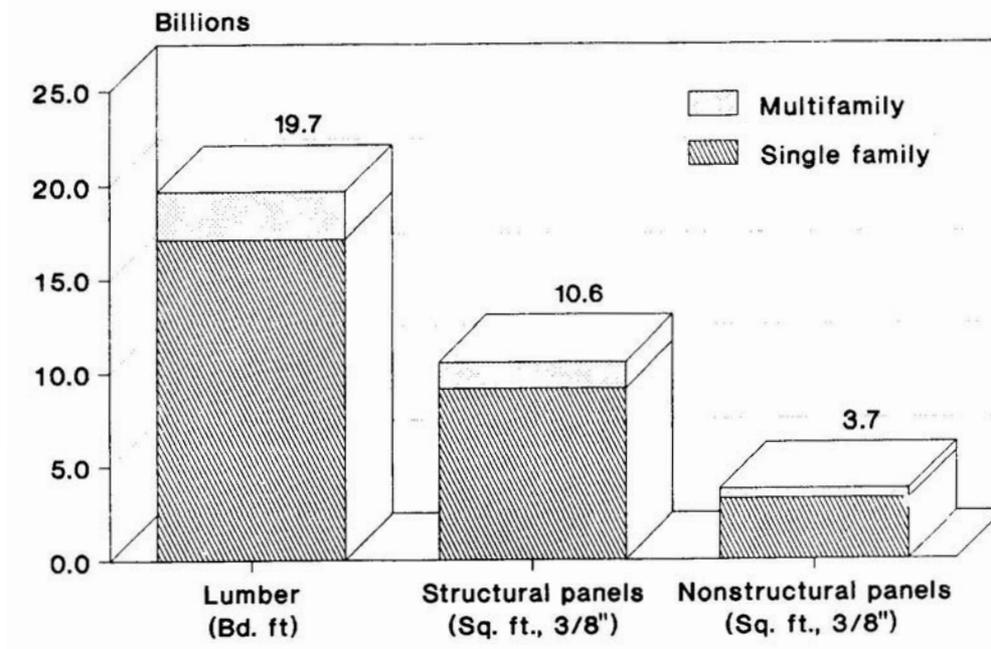
SUMMARY

The new residential construction market is the largest single market for lumber and structural panels in the United States. It is also an important market for nonstructural wood panel products such as particleboard, hardboard, MDF, hardwood plywood, and fiberboard. This study provides a complete picture of lumber and structural panel use in new residential construction by building application. Less detailed information is also provided for nonstructural panels and nonwood competitive materials.

In addition to products which are used directly in the construction of new residences, wood products are also found in manufactured products which form an integral part of the new buildings. Uses in prebuilt cabinets, door and window units, shelving and millwork items are usually covered in reports of use in manufacturing industries, (e.g. McKeever and Martins 1983). Since these products are a part of the new residential market, separate totals and sonic use details are included in this report. Appendix A provides a detailed description of wood products use in individual millwork products.

The report covers lumber and panels by application in the structure. Single and multifamily units are covered separately.

WOOD PRODUCTS USED IN NEW RESIDENTIAL CONSTRUCTION, 1988



Lumber Use

Lumber use in residential construction totaled 19.7 billion board feet during 1988. The table which follows shows this use by application.

**LUMBER USES IN NEW RESIDENTIAL CONSTRUCTION
BY TYPE AND APPLICATION, 1988**
(Million Bd. ft.)

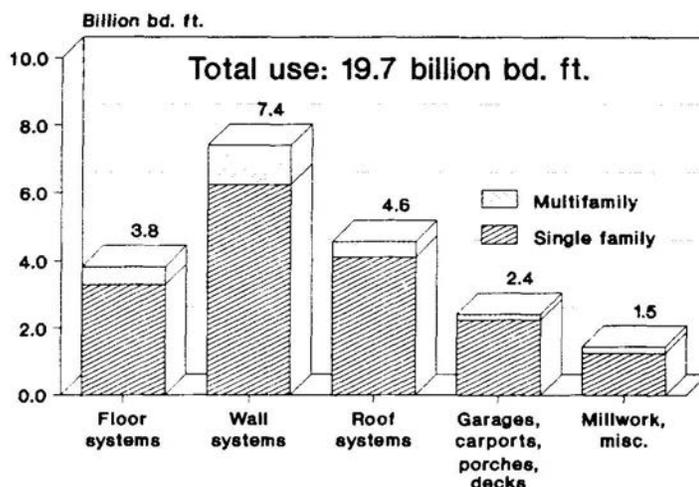
Application	Single Family	Multifamily	Total
Floors and Foundations	3,277	550	3,827
Wall Systems	6,253	1,155	7,408
Roof Systems	4,120	455	4,575
Garages, Porches, Decks	2,256	167	2,423
Subtotal	15,906	2,327	18,233
Millwork	1,265	191	1,456
Total Lumber	17,171	2,518	19,689
Total Units (Thousands)	1,085	445	1,530
Average Usage per living unit (Bd. Ft.)			
Excluding Millwork	14,659	5,229	11,916
Including Millwork	15,824	5,658	12,868

Wall systems account for the major portion of lumber use with 38% of the total. Roof systems account for 23%, and floors account for 19% of the total. The other 20% is made up with use in porches, decks and garages at 13% and millwork at 7%.

Lumber framing dominates the roof and wall markets. Only in floors is there significant competition, with concrete being used in 42% of the single family, and 57% of the multifamily housing units. Where concrete was used, it was usually restricted to the ground floor. Basement floors are almost exclusively concrete.

There was essentially no evidence of metal framing use in single family construction, and only limited mention in multifamily structures. There was, however, substantial evidence of engineered wood products like trusses, laminated veneer lumber, glulams, and structural panel webbed "I" beams.

LUMBER USED IN NEW RESIDENTIAL CONSTRUCTION, 1988



The latest trends in lumber use are difficult to ascertain because the most recent available industry wide study was conducted by the Forest Service in 1970 for 1968 housing activity. However, there is value in this long term comparison. The table below shows the change in lumber use since 1968.

SINGLE FAMILY LUMBER USE PER UNIT BY APPLICATION Size in Sq. ft., Volume in Board feet

	<u>1968</u>	<u>1988</u>
Single Family		
- House size	1,392	1,997
- Lumber use		
- in floors	2,126	3,020
- in walls	3,387	5,762
- in roofs	2,927	3,797
- millwork	1,831	1,166
- garages, porch, deck	NR	2,079
Per Unit	10,271	15,824
Per Square Foot	7.38	7.92

NR- Not Reported.

Note: Garage, porch and deck usage was not reported separately in the 1968 study which could have resulted in minor overstatement of volumes in other applications. The 1968 house size is based on survey sample house size (for FHA inspected houses only). The 1988 size is as reported by Census for all single family houses.

The proportion of lumber use by application has shifted somewhat over the past 30 years. On a percentage of total basis, use in walls increased 14.2%, while use in floors dropped 4.8% and use in roofs declined 13%. The reduced portion going to floors and roofs was primarily caused by reduced use of lumber for floor decking and for roof sheathing. There has been an increase in lumber use for wall framing because of the more frequent applications of 2x6 studs for energy conservation.

The concrete slab portion was 45% in 1968, slightly higher than the 42% 1988 level. Framing systems for walls and roofs also remained quite similar in the incidence of lumber use.

Structural Panel Use

The following table summarizes structural panel use in residential construction.

**STRUCTURAL PANEL USE IN NEW RESIDENTIAL CONSTRUCTION
BY TYPE AND APPLICATION, 1988
(Million Sq. ft., 3/8" basis)**

Application	Single Family	Multifamily	Total
Floors and Foundations	3,153	580	3,733
Wall Systems	1,917	256	2,173
Roof Systems	3,307	439	3,746
Garages, Porches, Decks	704	104	808
Subtotal	9,081	1,379	10,460
Millwork	69	25	94
Total	9,150	1,404	10,554
Total Units (Thousands)	1,085	445	1,530
Average Usage per unit (Sq. ft., 3/8" basis)			
Excluding Millwork	8,370	3,099	6,837
Including Millwork	8,433	3,155	6,898

Floors and roofs are about equal as the dominant consuming areas for structural panels. Each represents 35% of the consumption. Walls consume 21%. and the balance goes into porches, decks, and millwork.

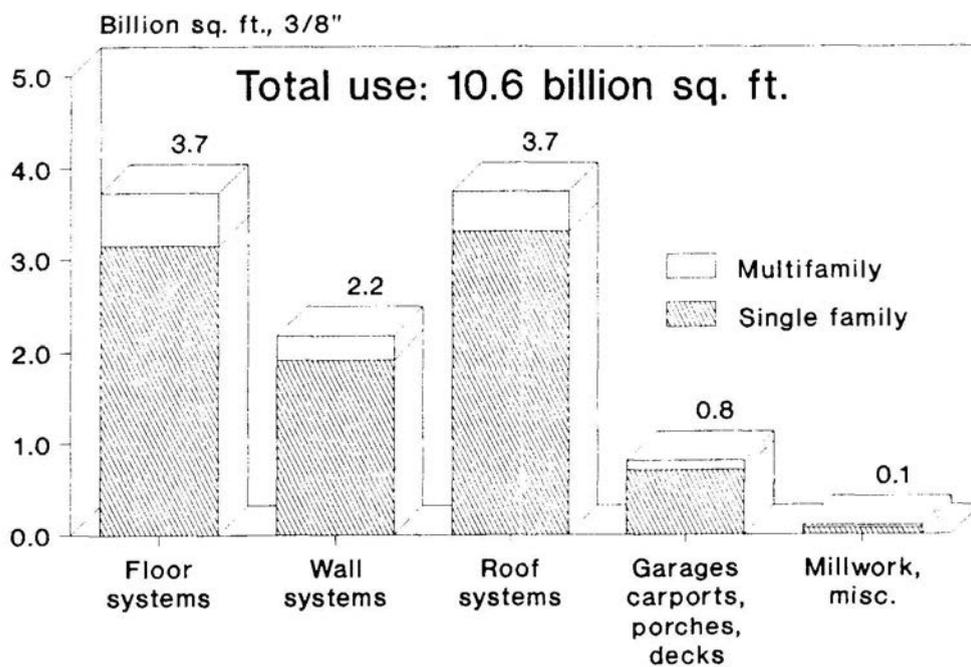
As with lumber, concrete is the primary competitive material for floor and foundation use. Despite the large share held by concrete slab, panel consumption in floors nearly equals that used in roofs. This is because typical floor panels are 3/4" thick while roof panels are usually 15/32". This explains why a 60% floor share equals a 90% roof share in terms of 3/8" basis volume.

Wall usage is also impacted by competitive factors. Although both wall sheathing and exterior siding could be structural panels, there are many competitive sheathing materials and many siding options.

Structural panel wall sheathing totaled 1,203 million, and held 26% of the single family, and 40% of the multifamily walls. Structural panel siding totaled 967 million sq. ft., and held 23% and 19% respectively of the single and multifamily siding markets.

Panel usage in garages, porches, decks and millwork accounts for about 8% of panel consumption in new residential construction. Part of this is caused by the overwhelming preferences for nonstructural particleboard and MDF in manufacturing millwork, and the general practice of using lumber as the primary material for porches and for decks.

STRUCTURAL PANEL USE IN NEW RESIDENTIAL CONSTRUCTION, 1988



The trends in structural panel use are upward, both in terms of volume per unit and volume per sq. ft. as shown in the following table. The 1968 and 1976 data are based on studies by the American Plywood Association.

STRUCTURAL PANEL USE PER UNIT
(Sq. ft., 3/8" basis)

	1968	1976	1988
Single Family			
- House size	1,580	1,679	1,997
- Panel use			
- per unit	5,436	5,542	8,433
- per sq. ft. floor	3.4	3.3	4.2
- Per unit use			
- in floors	1,918	1,865	2,906
- in walls	702	1,034	1,766
- in roofs	2,649	2,495	3,049
- in millwork	128	52	64
- in other	39	94	648

Note: The 1988 study gathered separate data for garages, porches and decks. This volume is included in "Other", hence the large change in volume for 1988 in that category. Garages, porches and decks were much less prevalent in new construction during 1968 and 1976, and usage was included in the floor, wall, roof, and miscellaneous categories. This is not considered to be significant enough to invalidate the comparisons, however, except that the "Other" category would be on a substantially different base.

House size based on APA survey sample for 1968 and 1976; based on Census data 1988.

Nonstructural Panel Use

Nonstructural wood panels include particleboard and medium density fiberboard (MDF), fiberboard, hardboard, and hardwood plywood. These products are used in varying degrees in new residential construction, with particleboard being used most extensively. Although the data base did not provide as much detail or the same statistical reliability as for lumber and structural panels, they are shown for information.

To determine reasonableness, a check was made by comparing particleboard shipments reported by the National Particleboard Association for 1988. The NPA report shows underlayment shipments for 1988 totaled 514 million sq. ft. 3/4" basis. The new residential consumption according to the study, totaled 330 million sq. ft., or 64% of shipments. This seems reasonable considering the fact significant particleboard underlayment volume is used in remodeling, and for mobile homes. Some is also used in nonresidential construction.

A similar comparison was made with industrial particleboard, where new residential millwork consumption was 940 million sq. ft. or 35% of the 2.7 billion sq. ft. total reported industrial particleboard shipments. This was considered reasonable in light of the large volumes of the product used in furniture and fixtures manufacturing.

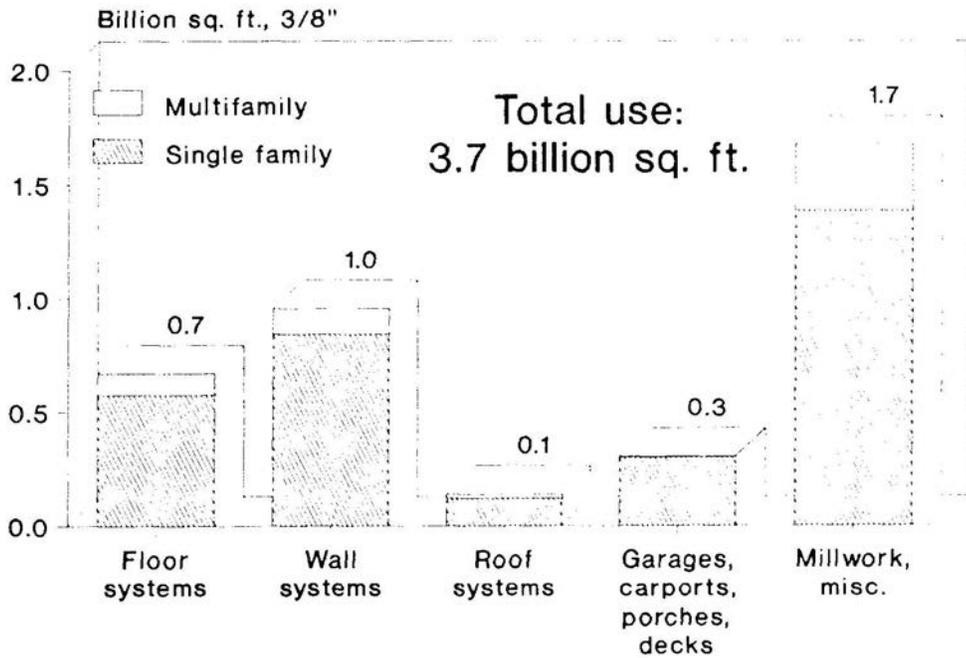
**NONSTRUCTURAL PANEL USE IN NEW RESIDENTIAL
CONSTRUCTION BY APPLICATION, 1988**
(Million sq. ft.)

Application	Total (3/8")	Particleboard		Fiberboard		Hardboard		Hardwood plywood	
		(3/8")	(3/4")	(3/8")	(1/2")	(3/8")	(1/8")	(3/8")	(1/8")
Floor Systems	670	660	330	--	--	5	15	5	15
Wall Systems	954	--	--	464	348	490	1,470	--	--
Roof Systems	137	--	--	77	58	60	180	--	--
Garages, Decks	303	--	--	150	113	153	458	--	--
Millwork	1,675	1,364	682	--	--	88	264	224	672
Total	3,739	2,024	1,012	691	518	796	2,387	229	687

The hardboard usage in new residential construction was primarily for wall and gable siding and soffit materials in the roof systems. Other uses included underlayment, garage door panels, wall paneling and parts in cabinets.

Fiberboard use includes MDF used in millwork as well as standard fiberboard used for wall sheathing.

**NONSTRUCTURAL PANEL USE IN NEW
RESIDENTIAL CONSTRUCTION, 1988**



A comparison of the 1988 findings and information from the 1968 Forest Service study provides an indication of the shifts which are occurring.

NONSTRUCTURAL PANEL USE COMPARISON

Nonstructural Products	1968	1988
Particleboard (sq. ft., 3/4" basis)		
Use per unit	180	1,170
Fiberboard (sq. ft., 1/2" basis)		
Use per unit	741	576
Hardboard (sq.ft., 1/8" basis)		
Use per unit	469	714

Particleboard use has taken a dramatic jump as a result of greater use in millwork. This dramatic increase might be partially explained by the counting of installed premanufactured cabinets in the 1988 study. Discounting the 627 sq. ft. 3/4" basis used for millwork; however, there still is a sizeable jump in particleboard use since 1968.

The fiberboard decline is explainable, as there was a dramatic drop in the use of fiberboard wall sheathing since 1968. Only the increasing use of MDF has held the fiberboard total as high as it is.

Hardboard use has increased somewhat, part from the inclusion of that used in manufactured cabinets, but also due to new uses for soffits, garage door panels and siding.

The discussion which follows provides further detail on individual uses for lumber and panel products, particularly details of use in wood foundations, in stairways, and expanded details of wall, roof and floor system use. Appendix A details millwork usage.

DISCUSSION

LUMBER USES - SINGLE FAMILY HOUSING

Single family housing is the largest part of the new residential construction market. This study provides a look at the major using areas and gives an indication of the major competition and the untapped market potential.

WOOD FOUNDATIONS

The incidence of use for wood foundations was too small to permit regional estimates with an acceptable degree of accuracy. The overall incidence of use was close to 2%, so wood foundations were assumed to have been used in 2% of the new single family homes built during 1988. On this basis, lumber used for wood foundations in 1988 was 76 million bd. ft., as indicated in the table below.

LUMBER USED FOR SINGLE FAMILY WOOD FOUNDATIONS, 1988

Total units (thousands)	1,085
Wood foundations (percent)	2%
Total wood foundations (thousands)	21.7
Floor area completed with wood foundations (million sq. ft.)	43.3
Lumber use per sq. ft. of floor area (bd. ft.)	1.75
Total treated lumber use (million bd. ft.)	76

FLOOR SYSTEMS

Nonconcrete floor systems almost universally use lumber for framing, and occasionally use lumber for subfloor or single layer floor decks. The table below shows lumber usage by region and floor application.

LUMBER USED FOR SINGLE FAMILY FLOOR SYSTEMS, 1988 (Million Bd. ft.)

Region	Floor Framing	Floor Decking	Interior Stairways	Total, All Floor Applications
North	1,343	91	152	1,586
South	917	18	120	1,055
West	479	16	65	560
				76*
Total	2,739	125	337	3,277*

* Total includes 76 million bd. ft. for wood foundations.

The North region is the largest lumber using region in floor systems. This is primarily related to the fact that most houses in the region have wood floors, while concrete slab reduces the lumber share in other regions, as shown in the table which follows.

LUMBER SHARE OF SINGLE FAMILY FLOOR MARKET, 1988

Region	Percentage of Units Using Lumber For:			Use Per Unit, all Flr. Applications (Board feet)
	Floor Framing	Floor Decking	Interior Stairways	
	(Percent)			
North	89.5	11.0	81.8	4,173
South	59.8	2.6	58.2	2,308
West	61.3	4.3	61.9	2,258
U.S. Average	70.5	5.9	67.3	3,020

The primary lumber use in floor decks is for single layer floor applications, with 61 million bd. ft. Subfloor use follows closely at 57 million bd. ft. Only 7 million bd. ft. were used for underlayment, most of which was in the North.

Unfortunately, the survey data did not clearly define the spacing of floor joists and trusses. However, it did show that trusses are becoming more common in floor systems. Trusses were used in 7% of the single family houses in the North, 9% in the South, and 11% in the West. As shown in the panel section of this report, 3% of the units used plywood webbed trusses (I-Beans), while the other 6% used parallel chord lumber trusses.

WALL SYSTEMS

Wall systems are the largest lumber consuming application in new single family construction, accounting for 36% of total consumption. The table which follows shows use by application and region.

LUMBER USED FOR SINGLE FAMILY WALL SYSTEMS, 1988
(Million Bd. ft.)

Region	Exterior Walls			Interior Walls	Total, All Wall Applications
	Framing	Sheathing	Siding		
North	1,194	7	209	888	2,298
South	1,244	16	213	1,030	2,503
West	799	18	89	545	1,451
Total	3,237	41	511	2,463	6,252

Exterior walls consumed the largest lumber volume in the wall category. One of the reasons that exterior walls use more than interior walls is the increasing use of 2"x6" studs instead of the more traditional 2"x4" studs. Interestingly, although thicker walls for energy conservation purposes are increasing, there is little change in stud spacing. Most wall studs, whether for interior or exterior walls, are spaced 16" on center (o.c.), as shown in the following table.

PERCENTAGE OF SINGLE FAMILY WALLS
BY SIZE AND SPACING OF STUDS, 1988
(Percent)

Region	2" x 4"		2" x 6"	
	16" o.c.	24" o.c.	16" o.c.	24" o.c.
EXTERIOR WALLS				
North	62	2	28	8
South	82	3	12	3
West	69	2	22	7
U.S.	71	2	21	6
INTERIOR WALLS				
North	96	2	2	T
South	88	10	2	T
West	85	11	2	2
U.S.	90	7	2	1

T= Trace

Wall Sheathing

The use of lumber wall sheathing is rather limited, being used on only 2% of houses nationwide. Use in the North was 1%, in the South 2%, and in the West 3%.

Lumber sheathing was most frequently used on small houses with a basement. The survey did not provide any further details on this use. Total volume used for exterior wall sheathing in single family houses was 40 million bd. ft. in 1988.

Siding

Wood siding is a more significant volume lumber user than wall sheathing. An estimated 511 million bd. ft. was used in 1988. This is 8% of all lumber used in wall systems, and 13% of that used on exterior walls. Lumber siding accounted for 12% of the exterior wall area sided.

In terms of market share, 17% of all houses used lumber siding as the primary wall covering; 9% used it as trim or secondary siding in combination with other materials. The following table shows these shares by region.

PERCENTAGE OF SINGLE FAMILY HOUSES
WITH LUMBER SIDING, 1988
(Percent)

Region	Percent of Houses Sided With:	
	All Lumber	Lumber and Other Materials
North	24	10
South	13	11
West	13	5
U.S.	17	9

Other Lumber Uses in Walls

Most of the lumber used in walls is for framing, sheathing or siding. Another 53 million bd. ft. was accounted for, however, by use for furring strips. These strips are used primarily to accommodate nailing the interior surface to masonry exterior walls. This use accounted for 47 million bd. ft., or 89% of the furring use. The balance was used for interior wall furring where nailing strips were needed for cabinet installation, attaching odd sized wall materials, or as special reinforcing.

Solid wood paneling was also used in a variety of wall and ceiling applications. Information on this solid wood wall paneling use is included in the Millwork and Miscellaneous Uses section of this report, in Appendix A.

ROOF SYSTEMS

Lumber used in roof systems includes that used for rafters, joists, trusses, roof sheathing, and trim. Total volume for this use during 1988 was 4,120 million bd. ft., the second largest consuming area in new residential construction. The table which follows shows use by application and region.

LUMBER USED FOR SINGLE FAMILY ROOF SYSTEMS, 1988
(Million Bd. ft.)

Region	Roof Framing	Roof Sheathing	Fascia and Soffits	Total, All Roof Applications
North	1,235	9	90	1,334
South	1,734	71	133	1,938
West	712	35	101	848
Total	3,681	115	324	4,120

Roof framing is either in rafters and joists, or in trusses and associated framing. This study showed that trusses were used in nearly 62% of the houses, accounting for 1,811 million bd. ft. of lumber. Rafters were used in nearly 38% of the houses, accounting for another 1,870 million bd. ft. Less than one percent of new houses had steel or other roof framing systems.

The primary reason for the nearly equal volumes of lumber used for rafters and joists, and truss roof systems is that trusses are almost universally placed 24" o.c., while the rafters and joists are on 16" centers more than half the time. Another factor is that materials other than lumber are used in trusses, including structural panel webbing. Also, the primary justification for trusses is to permit efficient lumber usage by taking advantage of the engineered values of joining smaller dimension lumber pieces to carry the required loads.

The average board foot volume per house used for truss framing was 2,709, while the average volume for joist/rafters was 4,566. In other words, the joist/rafter system used 69% more material.

The tables which follow show the details of this analysis.

NUMBER OF SINGLE FAMILY HOUSES BY TYPE OF ROOF FRAMING, 1988

Region	Houses with:							
	Lumber Rafters and Joists		Lumber Trusses		Total		Non-wood Roof Systems	
	(thousand houses)	(percent)	(thousand houses)	(percent)	(thousand houses)	(percent)	(thousand houses)	(percent)
North	133.0	35.0	244.0	64.2	377.0	99.2	3.0	.8
South	203.7	44.4	252.5	55.3	456.2	99.8	.8	.2
West	72.8	29.4	172.2	69.4	245.0	98.8	3.0	1.2
U.S.	409.5	37.7	668.7	61.6	1,078.2	99.4	6.8	.6

PERCENTAGE OF SINGLE FAMILY HOUSES WITH LUMBER ROOF FRAMING, BY TYPE AND SPACING, 1988 (Percent)

Region	Rafters and Joists		Trusses	
	16" o.c.	24" o.c.	16" o.c.	24" o.c.
North	69	31	8	92
South	46	54	11	89
West	34	66	4	96
U.S.	51	49	8	92

Another interesting finding is that there is substantial difference in roof framing methods by region. All regions use trusses more frequently than the traditional rafter and joist system. However, Southern builders use rafters in 45% of the houses, compared to 35% in the North, and only 29% in the West.

In spacing, the North seems most conservative with 69% of the rafters and 8% of the trusses on 16" centers; this probably reflects snow load requirements. In the South, 16" o.c. spacing was used 46% of the time with rafters, and 11% of the time with trusses. The West uses 16" spacing for rafters 34%, and for trusses 4% of the time. Overall, roof framing was spaced 16" o.c. only 24% of the time. with 51% of all rafters being 16" o.c., and just 8% of all trusses being 16" o.c.

Trends to multiple roof lines which create new architectural values may make the rafter construction method a bit more economical in those cases. There may also be variations required to meet different snow load and wind load conditions that could influence the selections. Whatever the reason, it is interesting that the headlong drive of the 1970's toward roof trusses has slowed dramatically, and spacing is gradually moving back toward 16" o.c. During 1976, 64% of the houses used roof trusses. and 81% had trusses or rafters spaced 24" o.c. This study showed 62% of 1988's single family houses using trusses, and 76% of all roof framing being spaced 24" o.c.

Roof sheathing use totaled 115 million bd. ft. of lumber during 1988. This represented use on 5% of the houses. Solid board decking was used in 81% of the cases; spaced boards on the balance.

Regionally, the North seldom used lumber for roof sheathing. Just 1% of the houses built in 1988 in the North had lumber decked roofs. The South and the West used lumber roof decks in nearly 8% of the units. However, 28% of the Western applications were spaced boards while only 10% were spaced boards in the South.

Substantial amounts of lumber are used for fascia and soffits, despite inroads being made by metal and plastic trim products. Lumber has 61% of the fascia market and 20% of the soffit market.

By region, the West is a somewhat more frequent user of lumber for fascia and soffits than the other two regions. The table which follows shows the usage rates.

LUMBER USED FOR SINGLE FAMILY FASCIA AND SOFFITS. 1988

Region	Fascia		Soffits	
	Percent	Volume (million bd. ft.)	Percent	Volume (million bd. ft.)
North	52	44	18	46
South	63	81	19	52
West	73	60	25	41
U.S.	61	185	20	139

GARAGES, CARPORTS, PORCHES AND DECKS

Garages, carports, porches and decks are increasingly important markets for lumber. Nearly 2.3 billion bd. ft. were used in these applications during 1988. Details of the number of garages are shown in the panel section of this report on page 37. The table which follows shows total lumber volume by application and region.

LUMBER USED FOR SINGLE FAMILY GARAGES, CARPORTS,
PORCHES AND DECKS, 1988
(Million Bd. ft.)

Region	Garages and Carports	Porches and Decks	Total
North	483	365	848
South	535	352	887
West	376	145	521
Total	1,394		2,256

MILLWORK AND MISCELLANEOUS USES

In 1988, an estimated 1,264 million bd. ft. of lumber were used for millwork and miscellaneous uses in new single family houses. These uses include windows and doors, kitchen and bathroom cabinets, moldings and trim, and a variety of other uses. Appendix A details lumber use in these applications.

More millwork, in total, was used in the South than in other regions, while the largest average volume per house was used in the West. The following table summarizes lumber for millwork and miscellaneous uses in 1988.

LUMBER USED FOR SINGLE FAMILY MILLWORK
AND MISCELLANEOUS USES, 1988

Region	Total Use	Use Per Unit
	(million bd. ft.)	(bd. ft.)
North	428	1.126
South	491	1,075
West	345	1,392
Total	1,264	1,165

TOTAL LUMBER USE, ALL SINGLE FAMILY APPLICATIONS

The following table summarizes lumber use by region and foundation type. This provides some insight into the impact of the slab foundation on wood use. The North used 4,173 bd. ft. per unit for the floors compared with 2,308 for the South and 2,258 for the West.

LUMBER USED IN NEW SINGLE FAMILY HOUSES
BY FOUNDATION TYPE AND APPLICATION, 1988
(Million Bd. ft.)

Region/ foundation Type	Floor Systems	Wall Systems	Roof Systems	Garages, Carports, Porches, Decks	Total	Millwork and Misc. Uses	Total
North							
B/C ⁽¹⁾	1,556	1,887	1,177	764	5,384	381	5,765
Slab	30	203	158	84	475	47	522
Total	1,586	2,090	1,335	848	5,859	428	6,287
(2)		2,299					
South							
B/C ⁽¹⁾	859	1,086	929	464	3,338	245	3,583
Slab	196	1,204	1,008	423	2,831	247	3,078
Total	1,055	2,290	1,937	887	6,169	492	6,661
(2)		2,503					
West							
B/C ⁽¹⁾	351	480	317	205	1,353	133	1,486
Slab	209	882	531	316	1,938	212	2,150
Total	560	1,362	848	521	3,291	345	3,636
(2)		1,451					
U.S.							
B/C ⁽¹⁾	2,766	3,453	2,423	1,433	10,075	759	10,834
Slab	435	2,289	1,697	823	5,244	506	5,750
Total ⁽²⁾	3,201	5,742	4,120	2,256	15,319	1,265	16,584
Grand Total	3,277	6,253	4,120	2,256	15,906	1,265	17,171

(1) Basement and crawl space foundations.

(2) Supplemental totals include siding use (511 million bd ft) which was not collected by foundation type, and wood foundation use (76 million bd ft) which was not collected by region.

A series of final calculations were made to facilitate future estimates of lumber consumption. These calculations provide averages for use per unit and use per sq. ft. of living area by region and in total.

LUMBER USED PER UNIT AND PER SQUARE FOOT OF FLOOR AREA FOR
NEW SINGLE FAMILY HOUSING, BY REGION, 1988
(Bd. ft.)

Region	Excluding Millwork		Including Millwork	
	Use Per Unit	Use Per Sq. Ft. of Floor Area	Use Per Unit	Use Per Sq. Ft. of Floor Area
North	15,965	7.94	17,091	8.50
South	13,964	7.03	15,040	7.57
West	13,627	6.83	15,019	7.52
U.S.	14,658	7.34	15,824	7.92

LUMBER USES - MULTIFAMILY HOUSING

There were 445,000 multifamily units started during 1988. The incidence of materials use data were developed from information on 89 buildings with 3,968 units, and the volume per use from 10 projects and 140 units.

As stated earlier, usage rates were found to be fairly uniform from one region to another. Thus, totals were developed on a national basis. Regional totals can be derived by multiplying the use factors (wood products use per multifamily unit) by the total number of multifamily units built in the region.

FLOOR SYSTEMS

Forty-one percent of the multifamily buildings had conventional wood floor systems and 2% had wood/concrete systems for the main (first) floor. Wood/concrete floor systems are those floors with wood framing and subfloor covered with a lightweight concrete underlayment. In upper stories, 85% were all wood and 7% were wood/concrete floor systems. The balance were poured or precast concrete.

Framing was the dominant lumber usage area in floor systems. When lumber framing was used, dimension lumber was found in 75% of the first story floors, and wood trusses in 25%. For upper floors, 62% used dimension lumber and 38% trusses. These percentages translate to 1,724 bd. ft. per unit for dimension framing, and 1,580 bd. ft. for truss framing. Based on these usage rates, total lumber use for all floor framing was estimated to be 484 million bd. ft., 332 million for dimension framed floors and 152 million for truss framed floors.

Lumber floor decks were found in 9% of the single layer floor systems, and 13% of subfloors in double layer floor systems on the main floor. Upper floors had 9% and 7% respectively. This translates to about 6% of all multifamily floors having lumber decks. The use per unit was 990 bd. ft. Total lumber use for floor decking in multifamily units built in 1988 was 26 million bd. ft.

Stairways also used a fair amount of lumber. Eighty-two percent of the multifamily units had stairways. The average stairway used 164 bd. ft. of lumber. Total use for stairways was 40 million bd. ft.

The table below shows total lumber usage in multifamily floor systems in 1988.

LUMBER USED FOR MULTIFAMILY FLOOR SYSTEMS, 1988

Application	Million Bd. ft.
Floor framing	484
Floor decking	
Single layer floor	15
Double layer subfloor	11
Sub Total	26
Stairways	40
Total	550

WALL SYSTEMS

Wall systems consume the largest share of lumber in multifamily construction, as is the case for single family construction. Interior and exterior walls consumed 1,155 million bd. ft. of lumber, or half of all lumber used in multifamily structures, excluding millwork.

The following table details lumber usage in multifamily walls in 1988.

LUMBER USED FOR MULTIFAMILY WALL SYSTEMS, 1988

Application	Million Bd. ft.
Wall framing	
Exterior walls	425
Interior walls	
Framing	616
Furring	33
Sub Total	649
Total	1,074
Exterior sheathing	6
Exterior siding	75
Total	1,155

As in single family housing, framing in multifamily housing has also responded to energy considerations. Twenty six percent of all wood framed walls, and 21% of all exterior walls were built with 2" x 6" studs. Stud spacing, however, has remained relatively unchanged, with 90% spaced 16" on center.

Lumber siding was used on 15% of the multifamily units. This compares to 26% of single family units using lumber siding.

ROOF SYSTEMS

Lumber use in roof systems is primarily for the framing. Ninety seven percent of all multifamily units built in 1988 had wood framed roof systems. Nearly three fourths of these used roof trusses. The remaining were framed with rafters and joists. There is also a small amount of lumber used for roof decks. The following table shows lumber use for multifamily roofs by application.

LUMBER USED FOR MULTIFAMILY ROOF SYSTEMS, 1988

Application	Million Bd. ft.
Roof framing*	
Trusses	286
Rafters and joists	157
Sub Total	443
Roof decking	12
Total	455

*Includes fascia and soffits.

GARAGES, CARPORTS, PORCHES AND DECKS

Other applications for lumber in multifamily housing are for garages, carports, porches and decks. The table below summarizes these uses.

LUMBER USED FOR MULTIFAMILY GARAGES,
CARPORTS, PORCHES AND DECKS, 1988

Application	Million Bd. ft.
Garages and carports	125
Porches and decks	42
Total	167

Lumber use per car for garages averaged 850 bd. ft. This is the same usage rate as was developed for single family garages, and may slightly overstate lumber use. However, only a third of the multifamily units reported had covered parking.

MILLWORK AND MISCELLANEOUS USES

In 1988, an estimated 191 million bd. ft. of lumber were used for millwork and miscellaneous interior uses in new multifamily houses. This includes lumber used for windows and doors, kitchen and bathroom cabinets, moldings and trim, and a variety of other uses. Appendix A details lumber use for these applications.

TOTAL LUMBER USE, ALL MULTIFAMILY APPLICATIONS

The following table summarizes lumber use, by application, in multifamily housing. It also shows the use per unit, and the use per square foot of floor area.

LUMBER USED IN NEW MULTIFAMILY HOUSING, 1988

Application	Total Use (million bd. ft.)	Average Use Per Unit (bd. ft.)	Average Use Per Sq. Ft. of Floor Area (bd. ft.)
Floor systems	550	1,236	1.25
Wall systems	1,155	2,596	2.62
Roof systems	455	1,022	1.03
Garages, carports, porches and decks	167	375	0.38
Sub Total	2,327	5,229	5.28
Millwork and misc.	191	429	.43
Total	2,518	5,658	5.71

PANEL PRODUCTS USES - SINGLE FAMILY HOUSING

A variety of wood-based panels are used in new residential construction. In this study, panels were categorized as being either structural or nonstructural. Structural panels include softwood plywood and waferboard/OSB (OSB). Nonstructural panels include particleboard, medium density fiberboard, hardboard, insulation board, and hardwood plywood.

WOOD FOUNDATIONS

As stated in the lumber section of this report, the survey showed too small an incidence of use to permit development of regional estimates of wood foundation use. The survey did indicate an overall incidence of use of 2% for all new single family houses built in 1988. For these houses, structural panel use per square foot of floor area averaged 1.86 sq. ft., 3/8" basis. The following tabulation summarizes structural panel use in wood foundations.

TREATED STRUCTURAL PANELS USED FOR SINGLE FAMILY WOOD FOUNDATIONS, 1988

Total units (Thousands)	1,085
Wood foundations (Percent)	2%
Total wood foundations (Thousands)	21.7
Floor area completed with wood foundations (Million sq. ft.)	43.3
Treated panel use per sq. ft. of floor area (Sq. ft., 3/8" basis)	1.86
Total treated structural panel use (Million Sq. ft., 3/8" basis)	80

FLOOR SYSTEMS

Floor systems which use wood rather than concrete, almost universally use lumber for framing, and wood-based panel products for floor decking. Additionally, small amounts of panels are used for interior stairways and floor framing applications. The table below shows panel usage by region and floor application.

PANEL PRODUCTS USED FOR SINGLE FAMILY FLOOR SYSTEMS, 1988 (Million Sq. ft., 3/8" basis)

Region	Floor Decking		Floor Framing	Interior Stairways		Total, All Floor Applications	
	Structural	Nonstructural	Structural	Structural	Nonstructural	Structural	Nonstructural
North	1,499	218	27	.3	.4	1,526	219
South	1,061	215	22	.2	.3	1,083	215
West	444	140	19	.1	.2	463	140
						3,072	
Foundations						80	
Total	3,004	573	68	.7	.9	3,152*	574

* Includes 80 million sq. ft. treated plywood for wood foundations

Floor Decking

Floors are built in a number of combinations with a variety of materials. Typical construction uses a single floor decking material such as Sturd-I-Floor in areas to be carpeted. Other areas, such as kitchens, baths, and entry halls, often have materials other than carpeting, so will include an underlayment as a base for resilient floor coverings. Ceramic tile, strip flooring or other finished floor materials may be used either over a single layer floor or a subfloor/underlayment (multilayer floor) combination.

The table below shows the total volume of structural and nonstructural panels used in single family floor decking during 1988.

PANEL PRODUCTS USED FOR SINGLE FAMILY FLOOR DECKING, 1988

Region	Structural Panels			Nonstructural Panels	Total
	Plywood	OSB	Total		
(million Sq. ft., 3/8" basis)					
North	1,257	242	1,499	218	1,717
South	908	153	1,061	215	1,276
West	369	75	444	140	584
Total	2,534	470	3,004	573	3,577
Percent	70.9	13.1	84.0	16.0	100.0

The following table shows the volumes of structural and nonstructural panel products used by type of floor system in 1988.

PANEL PRODUCTS USED FOR SINGLE FAMILY FLOOR DECKING,
BY TYPE OF FLOOR SYSTEM. 1988

Region	Single Layer Floors			Multilayer Floors					
				Subfloor			Underlayment		
	Structural		Non-structural	Structural		Non-structural	Structural		Non-structural
	Plywood	OSB		Plywood	OSB		Plywood	OSB	
(million square feet, 3/8" basis)									
North	485	102	21	420	95	25	352	45	172
South	364	38	11	309	71	51	235	44	153
West	216	32	28	105	22	30	48	21	81
Total	1,065	172	60	834	188	106	635	110	406
Percent	29.8	4.8	1.7	23.3	5.3	3.0	17.7	3.1	11.3

The floor decking market is a very important market for both structural and nonstructural panels. As stated at the outset, the major competition for wood products is the concrete slab. Trends in floor decking materials within the wood products sector are also important. The table below shows the incidence of use of wood panels by type of floor system and panel in 1988.

INCIDENCE OF USE OF PANEL DECKING MATERIALS
IN SINGLE FAMILY FLOORS, 1988

Type of Floor Systems	Percent Houses	Wood Panels Percent			
		Structural Panels		Nonstructural Panels	Total
		Plywood	OSB		
Single layer floors	38.3	81.7	13.4	4.9	100.0
Multilayer floors	36.1	70.3	14.6	15.1	100.0
Concrete slab floors*	25.6	--	--	--	--

* The Bureau of the Census reports 41.8% of all houses were built on slab foundations in 1988. Thirty eight percent of these slab houses had a wood floor for the second or split level floor. Overall, 25.6% of all houses had no wood floors.

Single layer floor systems continue to be the most commonly used systems for floor construction where wood occurs. Interestingly, however, use has not changed appreciably since 1976. One possible explanation is that resilient floor coverings have become less rigid and much more likely to mirror underlayment imperfections. Therefore, when resilient floor coverings are used, an underlayment is also used to avoid potential grain show-through problems that could occur from a construction damaged single floor surface.

The table below compares floor types in 1976 and 1988.

PERCENTAGE OF SINGLE FAMILY HOUSES
BY TYPE OF FLOOR SYSTEM, 1976 AND 1988
(Percent)

Floor Type	1976	1988
Units with:		
Single layer floor	38	38
Multilayer floor	26	36
Concrete slab floor*	36	26

* Includes 1 story houses with concrete slab foundations only. Two story and split level houses with concrete slab foundations are classified according to the floor type of the second story. Forty-two percent of all houses have concrete slab for part of the floor area, with 61% of these (26% of total) having no wood floor.

This study indicates that the typical basement or crawl space house uses 2.13 sq. ft., 3/8" basis of structural panels and 0.42 sq. ft., 3/8" basis of nonstructural panels per sq. ft. of floor area. The two story slab house which has a wood floor on the second story uses .73 sq. ft. and .09 sq. ft., 3/8" basis of structural and nonstructural panels respectively, per sq. ft. of floor area. The vast majority of single layer floor materials are 3/4" or 23/32" thick.

Stairways

The number of interior stairways per unit varied from none to four, based primarily on the type of foundation and number of stories. In general, two story houses with a basement had two, and two story house with a slab had one. Larger two story houses with basements sometimes had three or four stairways. The table below shows the percentage of houses according to the number of stairways present.

PERCENTAGE OF SINGLE FAMILY HOUSES WITH STAIRWAYS, BY NUMBER OF STAIRWAYS, FOUNDATION TYPE AND NUMBER OF STORIES, 1988
(Percent)

Foundation Type, and Number of Stories	Zero	One	Two	Three	Four or More
Basement/ crawl space, One story	37	54	8	1	0
Basement/ crawl space, Two story	0	38	54	6	2
Slab, One story	91	8	1	0	0
Slab, Two story	0	86	12	1	1
All Houses	34	39	23	3	1

Stairways are generally 36" or 48" wide. Three stringers are common. Treads and risers can be plywood, OSB, particleboard, or lumber, as well as concrete and steel. The percentages of each are reported in the following table.

PERCENTAGE OF MATERIALS USED FOR STAIRWAY TREADS AND RISERS
IN SINGLE FAMILY HOUSES, 1988
(Percent)

Material	Percent of Stairways
Lumber	59
Plywood/OSB	6
Particleboard	7
Concrete	24
Steel	3
Other	1
Total	100

During 1988 an estimated 1,047,519 stairways were built in new single family houses. A typical stairway has 11 treads and 12 risers. The treads are nominal 12" and the risers nominal 8". Usually, the same material is used for treads and risers. However, particleboard treads are also found with lumber risers. The following table presents estimates of wood products used for stairway treads and risers, based on average wood products use per stairway. Average particleboard use per stairway may be somewhat overstated and lumber understated due to the particleboard/lumber combination of treads and risers. The following table shows the approximate wood product volumes used to build stairways.

WOOD PRODUCTS USED FOR SINGLE FAMILY
STAIRWAY TREADS AND RISERS, 1988

Wood Products	Number of Stairways	Use Per Stairway	Total Use for Treads and Risers
	(thousand)	(units)	(million)
Lumber (bd. ft.)	618	5.5	3.4
Plywood/OSB (sq. ft., 3/8" basis)	63	11.0	.7
Particleboard (sq. ft., 3/4" basis)	73	6.0	.4
Nonwood	293	--	--

Floor Framing

One additional use for structural panels in floor systems is for floor framing. The survey indicated 3% of the units used structural panel webbed beams for floor support. They were usually placed 24" o.c. and consumed an estimated 69 million sq. ft. of structural panels.

WALL SYSTEMS

Wood panels use in wall systems is concentrated in the exterior walls for sheathing and exterior siding. A small amount of structural panel volume was also reported for interior shear walls. In 1988, a total of 2,760 million sq. ft., 3/8" basis, of wood panels were used for all wall applications. Of this, 1,916 million sq. ft. were structural panels; 844 million sq. ft. were nonstructural panels. Interior shear walls accounted for just under 1 million sq. ft. of the structural panels consumed. The table below summarizes panel products use for wall systems.

PANEL PRODUCTS USED FOR SINGLE FAMILY WALL SYSTEMS, 1988
(Million Sq. ft., 3/8" basis)

Region	Exterior Sheathing		Exterior Siding		Interior Shear Walls	Total, All Wall Applications	
	Structural	Nonstructural	Structural (1)	Nonstructural (1)	Structural	Structural	Nonstructural
North	391	103	NA	NA		391	103
South	400	220	NA	NA		400	220
West	255	98	NA	NA		255	98
Total	1,046	421	870	424	.9	1,917	845

(1) Regional data not available but included in totals.

Sheathing

Exterior sheathing was the single largest wall application for wood panels in new single family houses in 1988. A total of 1,466 million sq. ft., 3/8" basis was used, 53% of all wood panels used in wall systems. Of this, 1,046 million sq. ft. (71%) were structural panels, and 421 million sq. ft. (29%) were nonstructural panels. The following table details this use by region and panel type.

PANEL PRODUCTS USED FOR SINGLE FAMILY HOUSE
EXTERIOR WALL SHEATHING, BY REGION AND TYPE, 1988
(Million Sq. ft., 3/8" basis)

Panel Type	North	South	West	Total
Structural panels				
Plywood	268	331	219	818
OSB	123	69	36	228
Sub Total	391	400	255	1,046
Nonstructural panels	103	220	98	421
Total	494	620	353	1,467

INCIDENCE OF USE OF SINGLE FAMILY HOUSE
EXTERIOR WALL SHEATHING MATERIALS, BY REGION, 1988 AND 1976
(Percent)

Region	Lumber	Plywood	OSB	Fiber-board	Foam Board	Foil-faced Board	Other	None	Total
	1988								
North	1	25	11	11	28	20	3	T	100
South	1	23	5	15	21	20	11	4	100
West	3	34	5	14	14	9	8	13	100
U.S.	2	26	7	13	22	17	8	5	100
	1976								
U.S.	T	16	--	34	7	T	18	25	100

T = Trace

Wall sheathing usage has undergone a rather dramatic change since 1976. Foil-faced board and OSB have expanded in the market from very small beginnings. Fiberboard is less than half its share of 12 years ago, and walls with no sheathing have had an even more precipitous decline. At the same time, plywood and foam board have expanded their penetration.

Reasons for these shifts include changing insulation requirements and increasing use of siding types which require a nail base sheathing.

Siding

Exterior sidings include a wide variety of wood, metal, plastic, cement and masonry products. Because more than one exterior facing is often used on the same house, it is difficult to develop precise incidence of use factors. Even the names of the products can cause confusion. In this study, two separate incidence of use surveys were conducted. The second survey provided information not obtained in the initial survey, and was used to verify the initial findings. The results reported here are a combination of these two surveys.

The following table shows the incidence of siding use by type, based on the estimated surface area covered.

INCIDENCE OF USE OF EXTERIOR SIDINGS FOR SINGLE FAMILY HOUSES
AND SURFACE AREA COVERED, 1988

Siding Type	Incidence of Use	Surface Area* Covered
	(Percent)	(Million sq. ft.)
Plywood/OSB	23	521
Hardboard	16	363
Lumber	12	272
Vinyl	8	181
Metal	7	159
Brick/masonry	15	340
All other	19	431
Total	100	2,267

* Based on 1,085,000 units and 2,089 sq. ft. wall area per unit.

Sidings used for garages, privacy screening, fascia, soffits, and other miscellaneous applications increase the panel siding volume. The following table shows the estimated volumes of structural and nonstructural panel sidings used in 1988 for new residential construction.

STRUCTURAL AND NONSTRUCTURAL PANEL SIDING USED FOR
SINGLE FAMILY HOUSES, BY APPLICATION, 1988
(Million Sq. ft.)

Application	Structural Panel Siding		Nonstructural Panel Siding	
	Area Sided	Volume	Area Sided	Volume
		(3/8" basis)		(3/8" basis)
House siding	521	870	363	424
Trim, fascia, soffits	110	184	--	(1)
Garages, carports, porches and decks	150	250	104	122
Total	781	1,304	467	546

(1) Nonstructural panel siding use included with other nonstructural panel use for trim, fascia and soffits. See ROOF SYSTEMS below for details.

Total structural panel siding used for single family housing (1,304 million sq. ft. 3/8" basis) represents 63% of the reported shipments of structural panel siding for 1988, a logical result considering siding uses for multifamily, nonresidential and miscellaneous uses.

Note: Structural panel siding includes plywood and OSB whether in panel or lap siding form. Nonstructural panel siding includes hardboard and particleboard in panel or lap form.

ROOF SYSTEMS

Panel products used for roof systems are primarily used for roof decking. Additional uses include gables, soffits, fascia and other trim, and a small amount for manufactured beams (primarily structural panel webbed "I" beams) and truss gussets. The following tables summarize panel use for roof systems, and detail structural panel use by application in 1988.

PANEL PRODUCTS USED FOR SINGLE FAMILY ROOF SYSTEMS, 1988
(Million Sq. ft., 3/8" basis)

Region	Roof Decking		Trim, Fascia and Soffits		Mfgd. Beams and Gussets	Total, All Roof Applications	
	Structural	Nonstructural	Structural	Nonstructural	Structural	Structural	Nonstructural
North	927	36	65	10	57	1,049	46
South	1,099	22	133	28	111	1,343	50
West	618	11	50	14	63	731	25
Sub total	2,644	69	248	52	231	3,123	121
Siding	--	--	184*	--	--	184*	--
Total	2,644	69	432*	52	231	3,307	121

* Includes 184 million sq. ft. of structural panel siding use.

STRUCTURAL PANELS USED FOR SINGLE FAMILY ROOF SYSTEMS,
 BY REGION, APPLICATION AND PANEL TYPE, 1988
 (Million Sq. ft., 3/8" basis)

Region	Roof Decking			Trim, Fascia and Soffits		
	Plywood	OSB	Total	Plywood	OSB	Total
North	656	271	927	65	0	65
South	863	236	1,099	132	1	133
West	478	140	618	49	1	50
Sub Total				246	2	248
Siding*						184
Total	1,997	647	2,644	246	2	432
	Manufactured Beams, Gussets			Total		
	Plywood	OSB	Total	Plywood	OSB	Total
North	57	0	57	778	271	1,049
South	100	11	111	1,095	248	1,343
West	59	4	63	586	145	732
Sub Total				2,459	664	3,123
Siding*				184*	--	184*
Total	216	15	231	2,643*	664	3,307*

* 184 million sq. ft. of structural panel siding use included without regional breakdown.

Shares of the roof systems market have changed appreciably over the past 20 years with structural panels increasing share at the expense of lumber. The structural panel share went from 74% in 1968 to 85% in 1976, and to 91% during 1988. OSB accounted for roughly 21% of single family residential roofs, compared with 1% (waferboard) in 1976. The table below shows overall incidence of use comparisons between 1976 and 1988.

INCIDENCE OF USE OF SINGLE FAMILY HOUSE
 ROOF DECKING MATERIALS, 1968, 1976 AND 1988
 (Percent)

	1968	1976	1988
Plywood	74	84	70
Waferboard/OSB	0	1	21
Lumber/Boards	26	15	6
Other	0	T	3
Total	100	100	100

T = Trace

GARAGES, CARPORTS, PORCHES AND DECKS

In addition to the house itself, substantial quantities of structural panel products are used for the construction of garages, carports, porches and decks. In 1988 an estimated 703 million sq. ft., 3/8" basis of structural panels, and 299 million sq. ft., 3/8" basis of nonstructural panels were used for garages, carports, porches and decks. The following table summarizes panel use by application by region. It shows total siding use separately because inadequate regional usage rate observations were obtained for siding in these applications.

PANEL PRODUCTS USED FOR GARAGES, CARPORTS, PORCHES AND DECKS, 1988
(Million Sq. ft., 3/8" basis)

Region	Garages and Carports		Porches and Decks		Siding*		Total All Applications	
	Structural	Non-structural	Structural	Non-structural	Structural	Non-structural	Structural	Non-structural
North	160	43	15	4	N/A	N/A	175	47
South	131	73	16	10	N/A	N/A	147	83
West	120	44	12	4	N/A	N/A	132	48
Total	411	160	43	18	250	122	704	300

* Regional data not available.

Garages and Carports

Estimates of panel use for garages and carports were derived from estimates of the number of parking spaces present per house. To estimate the number of parking spaces, it was first necessary to estimate the actual number of garages or carports built. Based on this study, the following total garages and carports were built in conjunction with single family houses in 1988.

NUMBER OF GARAGES AND CARPORTS BUILT WITH
SINGLE FAMILY HOUSES, BY REGION AND TYPE, 1988
(Thousands)

Region	Garages		Carports	None	Total
	Attached	Detached			
North	292	18	3	67	380
South	332	16	24	85	457
West	215	10	10	13	248
Total	839	44	37	165	1,085

The garage size was established according to the number of cars it was designed to hold. On that basis, garages in the West were larger, with more two car garages than in the other two regions. The sizes are indicated in the table below.

PERCENTAGE OF PARKING FACILITIES, BY NUMBER OF CARS, 1988
(Percent)

Region	Garages		Carports
	One Car	Two or More Cars	
North	23	76	1
South	19	76	5
West	6	90	4

Numbers of garages and carports were converted to numbers of parking spaces by assuming 2.1 spaces for each two or more car garage, one parking space for each one car garage, and one-half parking space for each carport. Thus, an estimated 1,641 thousand covered parking spaces were built in 1988.

The average covered parking space required an estimated 738 sq. ft. of wall and roof sheathing. Assuming the same mix of panel types was used to sheath the garage as was used to sheath the house, an estimated 411 million sq. ft. of structural panels were used in 1988 to build garages and carports. Average structural panel use per parking space was 250 sq. ft. The following table reports structural panel use for garages and carports by panel type.

PANEL PRODUCTS USED FOR SHEATHING SINGLE FAMILY
GARAGES AND CARPORTS, BY REGION AND TYPE, 1988

Region	Number of Parking Spaces (thousands)	Structural Panels (million square feet, 3/8" basis)			Nonstructural Panels
		Plywood	OSB	Total	
North	568	110	50	160	43
South	630	109	22	131	73
West	443	104	16	120	44
Total	1,641	323	88	411	160

Porches and Decks

Porches and decks are another area where additional volumes of wood products are used. The renewed popularity of porches and decks in the past few years has made them an important application for wood use. While lumber is the major product used, there are substantial amounts of panels used as well.

PANEL PRODUCTS USED FOR SINGLE FAMILY PORCHES AND DECKS, BY REGION AND TYPE, 1988 (Million Sq. ft., 3/8" basis)

Region	Structural Panels			Nonstructural Panels
	Plywood	OSB	Total	
North	10	5	15	4
South	14	2	16	10
West	10	2	12	4
Total	34	9	43	18

MILLWORK AND MISCELLANEOUS USES

In 1988, an estimated 69 million sq. ft., 3/8" basis of structural panels, and 1,389 million sq. ft., 3/8" basis of nonstructural panels were used for millwork and miscellaneous uses in new single family houses. As previously stated, these uses include windows and doors, kitchen and bathroom cabinets, moldings and trim, and a variety of other uses. Appendix A details panel use in these applications.

More millwork, in total, was used in the South than in other regions, while the largest average volume per house was used in the West. These results closely parallel those for regional lumber use for millwork. The following table summarizes panel consumption for millwork and miscellaneous uses in 1988.

PANEL PRODUCTS USED FOR SINGLE FAMILY MILLWORK AND MISCELLANEOUS USES, 1988 (Sq. ft., 3/8" basis)

Region	Structural Panels		Nonstructural Panels	
	Total Use	Use Per Unit	Total Use	Use Per Unit
	(million)	(sq. ft.)	(million)	(sq. ft.)
North	24	62	474	1,247
South	29	64	586	1,282
West	16	65	329	1,326

TOTAL PANEL USE, ALL SINGLE FAMILY APPLICATIONS

The following table summarizes panel use by region and foundation type.

PANEL PRODUCTS USED IN NEW SINGLE FAMILY HOUSES
BY FOUNDATION TYPE AND APPLICATION, 1988
(Million Sq. ft., 3/8" basis)

Region/ Foundation Type	Floor Systems		Wall Systems		Roof Systems		Garages, Carports, Porches and Decks	
	Structural	Non- structural	Structural	Non- structural	Structural	Non- structural	Structural	Non- structural
North								
B/C ⁽¹⁾	1,496	219	314	103	928	30	146	46
Slab	30	0	77	0	121	16	28	0
Total	1,526	219	391	103	1,049	46	174	46
South								
B/C ⁽¹⁾	962	205	181	94	547	22	61	32
Slab	122	10	219	126	796	28	86	51
Total	1,084	215	400	220	1,343	50	147	83
West								
B/C ⁽¹⁾	345	118	125	52	281	8	52	20
Slab	118	22	130	46	450	17	81	29
Total	463	140	255	98	731	25	133	49
U.S.								
B/C ⁽¹⁾	2,806	541	620	249	1,756	60	259	98
Slab	267	33	426	172	1,367	61	195	80
Total ⁽²⁾	3,073	574	1,046	421	3,123	121	454	178
Siding ⁽³⁾	--	--	870	424	184	--	250	122
Founda- tion	80	--	1	--	--	--	--	--
Total ⁽²⁾	3,153	574	1,917	845	3,307	121	704	300

(1) Basement and crawl space foundations.

(2) Totals include applications without regional or foundation type breakdown.

(3) Regional siding data not available.

PANEL PRODUCTS USED IN NEW SINGLE FAMILY HOUSES
BY FOUNDATION TYPE AND APPLICATION, 1988 (continued)
(Million Sq. ft., 3/8" basis)

Region/ Foundation Type	Total, Excluding Millwork		Millwork		Total, Including Millwork	
	Structural	Non- structural	Structural	Non- structural	Structural	Non- structural
North						
B/C ⁽¹⁾	2,884	398	21	420	2,905	818
Slab	256	16	3	54	259	70
Total	3,140	414	24	474	3,164	888
South						
B/C ⁽¹⁾	1,751	353	13	274	1,764	627
Slab	1,223	215	16	312	1,239	527
Total	2,974	568	29	586	3,003	1,154
West						
B/C ⁽¹⁾	803	198	6	120	809	318
Slab	779	114	10	209	789	323
Total	1,582	312	16	329	1,598	641
U.S.						
B/C ⁽¹⁾	5,441	948	40	814	5,481	1,762
Slab	2,255	346	29	575	2,284	921
Total ⁽²⁾	7,696	1,294	69	1,389	7,765	2,683
Siding ⁽³⁾	1,304	546	--	--	1,304	546
Founda- tion	81	--	--	--	81	--
Total ⁽²⁾	9,081	1,840	69	1,389	9,150	3,229

(1) Basement and crawl space foundations.

(2) Totals include applications without regional or foundation type breakdown.

(3) Regional siding data not available.

A series of final calculations were made to facilitate future estimates of panel consumption. These calculations provide a use per unit average and a use per sq. ft. of living area average, and are presented by region in the following table.

**PANELS USED PER UNIT AND PER SQUARE FOOT OF FLOOR AREA
FOR NEW SINGLE FAMILY HOUSING, BY REGION, 1988**
(Sq. ft., 3/8" basis)

Region/ Foundation Type	Excluding Millwork				Including Millwork			
	Use Per Unit		Use Per Sq. Ft. of Floor Area		Use Per Unit		Use Per Sq. Ft. of Floor Area	
	Structural	Non- structural	Structural	Non- structural	Structural	Non- structural	Structural	Non- structural
North	8,263	1,089	4.11	.54	8,326	2,337	4.14	1.16
South	6,507	1,243	3.27	.63	6,571	2,525	3.31	1.27
West	6,379	1,258	3.20	.63	6,444	2,585	3.23	1.29
U.S.*	8,370	1,696	4.19	.85	8,433	2,976	4.22	1.49

* Totals include 1,304 million sq. ft. structural panel siding, 80 million sq. ft. treated structural panels, and 546 million sq. ft. nonstructural panel siding for which no regional data were available. Total units and floor area by region are shown in Appendix C.

PANEL PRODUCTS USES - MULTIFAMILY HOUSING

There were 445,000 multifamily units started during 1988. The materials use data were developed from survey data on 89 buildings with 3,968 units.

The usage rates were found to be quite similar for units in all regions, varying mostly due to size of building. As a consequence, the usage totals were developed on a national basis, with numbers of units by region and building height controlling regional volumes.

FLOOR SYSTEMS

Floor systems in multifamily buildings were stratified into first floor and upper floors due to differences in the types of floor systems used. First story floor systems are frequently concrete slabs, while upper story floor systems are usually wood framed with panel decking. In terms of all units built in 1988, 57% had concrete slabs as the first story floor system, while wood systems were used in 43% (including 2% with concrete over wood) of the first floor systems. Upper floors used wood systems in 92%, and concrete in 8% of the buildings.

Where wood floors were used, 58% were single layer floors, and 42% were multilayer systems on the first floor; 66% and 34% on upper floors. The typical single layer floor used 2,176 sq. ft. 3/8" basis. The multilayer floor systems used 1,447 sq. ft. for subfloor, and 1,814 for underlayment, or 3,261 sq. ft. 3/8" basis. Underlayment is usually thicker than subfloor, accounting for the apparent inconsistency.

Panel usage by type included plywood and OSB in the structural category, and hardboard and particleboard in the nonstructural category. Single layer floor panels were plywood 83% of the time, OSB 13% and other nonstructural panels 4%. For multilayer subfloors, plywood accounted for 88%, OSB 5% and other panels 7%. Plywood accounted for 51%, OSB for 11% and other panels for 38% of the panel underlayment.

Stairways were present in 82% of the buildings, and averaged 47 sq. ft. 3/8" basis of structural and nonstructural panels per stairway.

Total panel usage for multifamily floor systems is shown in the table below.

PANEL PRODUCTS USED FOR MULTIFAMILY FLOOR SYSTEMS, 1988
(Million Sq. ft., 3/8" basis)

Application	Structural Panels			Non-structural	Total
	Plywood	OSB	Total		
Single layer floor	278	44	322	15	337
Multilayer floors					
Subfloor	137	7	144	11	155
Underlayment	93	20	113	69	182
Sub Total	230	27	257	80	338
Total	508	71	579	95	675
Stairways	1	0	1	1	2
Total	509	71	580	96	676

WALL SYSTEMS

Results of this study indicate that 40% of multifamily units built in 1988 used structural panel wall sheathing, and 19% used structural panel siding. Nonstructural panel sheathing was used in 11% of the units, and 13% used nonstructural siding. The average sheathing usage rate was 893 sq. ft., 3/8" basis per using unit, while the average siding rate was 1,145 sq. ft. on a 3/8" basis. Sheathing averaged 7/16" while siding averaged 9/16" in thickness.

The table below shows panel usage in wall systems.

PANEL PRODUCTS USED IN MULTIFAMILY WALL SYSTEMS, 1988
(Million Sq. ft., 3/8" basis)

Application	Structural Panels			Non-structural	Total
	Plywood	OSB	Total		
Wall sheathing	123	36	159	44	203
Exterior siding	*	*	97*	66	163
Total	123	36	256	110	366

* Breakdown between plywood and OSB not available.

ROOF SYSTEMS

Panel usage in roof systems includes that used for the basic roof deck plus materials used for soffits and fascia. The average use per unit is a reflection of whether the unit is in a one, two or three plus story building, with the average usage rate in total and per sq. ft. decreasing with increasing numbers of stories.

Ninety-two percent of all units had structural panels in the roof system for decking, and 3% had nonstructural panels. Ninety-three percent of all units had fascia and/or soffits, with 43% of these using structural and nonstructural panels for those applications. The average usage rate per unit was 1,027 sq. ft. 3/8" basis for decking, and 120 sq. ft. 3/8" basis for fascia and soffit use. The table below shows the volume of panel use during 1988.

PANEL PRODUCTS USED IN MULTIFAMILY ROOF SYSTEMS, 1988
(Million Sq. ft., 3/8" basis)

Application	Structural Panels			Non-structural	Total
	Plywood	OSB	Total		
Roof decking	347	73	420	14	434
Fascia and soffits	19	*	19	2	21
Total	366	73	439	16	455

* Less than 500,000 sq. ft.

GARAGES, CARPORTS, PORCHES AND DECKS

Garages and carports, and porches and decks are another important application for structural and nonstructural panels. One third of the units built in 1988 had a garage or carport and nearly one-third had a porch or deck. Panels were used in 97% of the garage or carport construction, and in 31% of the porches or decks.

The weighted average panel use for a garage or carport was 738 sq. ft. per car. When panels were used for porches or decks, the usage rate was 48 sq. ft. per use. Total panel use for garages, carports, porches and decks is shown in the table below.

PANEL PRODUCTS USED FOR GARAGES, CARPORTS, PORCHES AND DECKS, 1988
(Million Sq. ft., 3/8" basis)

Application	Structural Panels			Non-structural	Total
	Plywood	OSB	Total		
Garages and carports	84	18	102	3	105
Porches and decks	2	T	2	T	2
Total	86	18	104	3	107

T=Trace

MILLWORK AND MISCELLANEOUS USES

In 1988, an estimated 310 million sq. ft., 3/8" basis of panel products were used for millwork and miscellaneous interior uses in new multifamily houses, with 92% (285 million sq. ft.) of these panels being nonstructural. Appendix A details panel use for these applications.

TOTAL PANEL USE, ALL MULTIFAMILY APPLICATIONS

Excluding millwork and miscellaneous applications, panel use in new multifamily construction totaled 1,605 million sq. ft., 3/8" basis in 1988, averaging 3,607 sq. ft. per unit. Nearly 86% of the total volume, 1,380 million sq. ft., was structural panels, with the remaining 14% being nonstructural panels. Average structural panel use per unit was 3,100 sq. ft., 3/8" basis, and nonstructural panels averaged 507 sq. ft. With millwork included, total use increases to 1,915 million sq. ft., 3/8" basis, with structural panel use accounting for 73% of total use. The following table summarizes panel use by type and application, in multifamily housing.

PANEL PRODUCTS USED IN MULTIFAMILY HOUSING. 1988
(Million Sq. ft., 3/8" basis)

Application	Structural Panels	Nonstructural Panels	Total Volume	Percent
Floor systems	580	96	676	35.3
Wall systems	256	110	366	19.1
Roof systems	439	16	455	23.8
Garages, carports, porches and decks	104	3	107	5.6
Total	1,379	225	1,604	83.8
Millwork and misc.	25	285	310	16.2
Total	1,404	510	1,914	100.0

PANELS USED PER UNIT AND PER SQUARE FOOT OF FLOOR AREA
FOR NEW MULTIFAMILY HOUSING, 1988
(Sq. ft., 3/8" basis)

Application	Use Per Unit		Use Per Sq. Ft. of Floor Area	
	Structural Panels	Nonstructural Panels	Structural Panels	Nonstructural Panels
Floor systems	1,304	217	1.32	.22
Wall systems	575	247	.58	.25
Roof systems	988	35	1.00	.04
Garages, carports, porches and decks	233	8	.24	.01
Total	3,100	507	3.14	.52
Millwork and misc.	55	640	.06	.65
Total	3,155	1,147	3.20	1.17

TOTAL PANEL USE NEW RESIDENTIAL CONSTRUCTION

Excluding millwork, more than 12.5 billion sq. ft., 3/8 basis of panels were used in 1988 for new residential construction. Of this, nearly 10.5 billion sq. ft. (84%) were structural panels. The remaining 2.0 billion sq. ft. were nonstructural panels.

Panel use per unit was 8,186 sq. ft., 3/8" basis, of which 6,838 sq. ft. were structural panels. When millwork and miscellaneous uses are added, total usage increases to nearly 14.3 billion sq. ft., 3/8" basis. The percentage of total accounted for by structural panels, however, decreases to 74% as millwork is primarily manufactured with nonstructural panels.

The following table reports total structural and nonstructural panel use, and use per unit for single and multifamily residential construction in 1988. It also reports structural panel use and use per unit in 1976.

PANEL USE IN NEW RESIDENTIAL CONSTRUCTION, 1976 AND 1988
Panel Use in Million Sq. ft. 3/8" Basis

Panel Type	Single Family		Multifamily		Total	
	1976	1988	1976	1988	1976	1988
Excluding millwork						
Structural	6,462	9,081	1,250	1,379	7,711	10,460
Nonstructural	n.a.	1,840	n.a.	225	--	2,065
Sub Total	--	10,921	--	1,604	--	12,525
Including millwork						
Structural	n.a.	9,150	n.a.	1,404	--	10,554
Nonstructural	n.a.	3,227	n.a.	510	--	3,739
Total	--	12,379	--	1,914	--	14,293
PANEL USE PER UNIT (Sq. ft., 3/8" basis)						
Excluding millwork						
Structural	5,540	8,370	3,278	3,099	4,983	6,837
Nonstructural	n.a.	1,696	n.a.	506	--	1,350
Sub Total	--	10,066	--	3,605	--	8,187
Including millwork						
Structural	n.a.	8,433	n.a.	3,155	--	6,898
Nonstructural	n.a.	2,976	n.a.	1,146	--	2,444
Total	--	11,409	--	4,301	--	9,342

n.a. = Not available.

The structural panel use trend in single family houses is strongly upward, resulting from a combination of increasing unit size and greater use per unit. Between 1976 and 1988, single family usage increased 51% per unit. There was a 17% increase in floor area, a major factor in increased wood use. Floor systems provided another major gain. This was partly from a higher share of two-story houses with wood upper floors, and partly from the use of thicker panels. The use of slab foundations actually increased from 36% of the single family units in 1976 to 42% in 1988, a factor which reduces the panel use potential.

Multifamily usage declined 5% but the size of the average unit declined 12%. Here again, the greatest increase by application was in the floor systems. Thicker panels and multistory construction with wood upper floors helped achieve the gain in multifamily use per sq. ft. of floor area.

APPENDIX A

MILLWORK AND MISCELLANEOUS USES

New residential construction includes substantial volumes of lumber and panels in products which are installed in the structure, but have been manufactured elsewhere. Products like kitchen cabinets, doors, windows and trim are made in industrial plants and shipped to the job site in finished or semifinished form. As such, these wood products are usually accounted for in studies of wood use in manufacturing industries (For example, see McKeever and Martins 1983). Since these wood products are ultimately used in new residential construction, volume estimates are included here for completeness. Separate totals excluding and including millwork and miscellaneous uses were reported to help avoid double counting.

The survey for this study gathered a fair amount of detail on the incidence of use of premanufactured products in single family housing. There was also some information, but in less detail, for multifamily usage. The volume of wood used for these premanufactured products was gathered partially from the study, and partially from a relatively limited number of observations taken outside of the study proper.

It is hoped that a detailed study of industrial uses of wood will be conducted in the near future to permit validating and updating of these results. In the meantime, the data are being presented as a guide to the amount of wood used in premanufactured products that are incorporated into new residential construction. These data should be expected to undergo revision as better data become available.

The data are presented first for single family houses, and then for multifamily units. Detailed explanations of the procedures used to develop wood consumption estimates are presented for millwork by primary areas of use identified in this study -- doors, windows, mouldings, shelving, cabinets, counter tops, interior wall coverings, roof coverings, and garage doors. Similar procedures were used for single family and multifamily millwork, so the description is shown only once, with the single family analysis.

SINGLEFAMILY MILLWORK AND MISCELLANEOUS USES

DOORS

Nearly 20 million doors were used in new single family houses built in 1988. Eighteen percent of these were exterior doors; 82% were interior doors. Exterior doors differ from interior doors in that they tend to be larger thicker and usually have a solid rather than a hollow core. For these reasons, estimates of wood products use in exterior doors were made separately from estimates for interior doors. Descriptions of the procedures used for each follow.

Exterior Doors

There were nearly 3.6 million exterior doors used in new single family construction during 1988. The typical house had 3.3 exterior doors, excluding garage doors. Of these, 41% were wood. Sliding glass doors and steel doors accounted for the balance.

Two types of wood doors were used; flush doors which accounted for 86% of all wood exterior doors, and wood panel doors which accounted for the remaining 14%. The calculations for wood use assumed the typical exterior door to be 3' x 6'8" x 1-3/4". Flush doors can be either hollow core or solid core. Hollow core exterior doors were used an estimated 25% of the time, solid core doors 75%. The average hollow core exterior door used 14.2 bd. ft. of lumber, 1.3 sq. ft., 3/8" basis of softwood plywood and 36.0 sq. ft., 1/8" basis of hardwood plywood.

The solid core door averaged 1 1.7 bd. ft. of lumber, 1.3 sq. ft., 3/8" basis of softwood plywood, 36.0 sq. ft., 1/8" basis of hardwood plywood and 27.4 sq. ft. 3/4" basis of particleboard. The wood panel door used 33.0 bd. ft. of lumber.

Materials for the door jambs and trim accounted for 14.4 bd. ft. of lumber. It was assumed that 33% of the nonwood doors had wood jambs and trim.

Interior Doors

There were 15,982,000 interior doors used in new single family construction during 1988. Nearly all of these (99%) were made from wood or wood products. 73% were classified as wood interior doors because they were made from either all lumber, or lumber and softwood or hardwood plywood; 26% were classified as hardboard interior doors because they were made with hardboard skins or panels and a lumber frame. Just 1% were nonwood doors.

Of the 11,711,100 wood interior doors, 67% were flush doors and 33% panel doors. Hardboard doors were flush type in 77%, and panel type in 23% of the cases.

To estimate interior wood door use, an average size of 2'4" x 6'8" x 1-3/8" was assumed. For the wood panel door, lumber use was estimated to be 20.7 bd. ft. For hardboard panel doors, lumber use was set at 15.2 bd. ft. with hardboard use at 32.8 sq. ft., 1/8" basis, for the panel inserts.

Hollow core flush doors used an estimated 9.1 bd. ft. of lumber for the frame, and 10.4 sq. ft., 3/8" basis of panels, either softwood or hardwood plywood, or hardboard for the door skin. Solid core flush wood doors used 7.8 bd. ft. of lumber, 10.4 sq. ft., 3/8" basis of panels for the door skin, and 15.7 sq. ft., 3/4" basis of particleboard for the core.

Wood door jambs and stops for interior doors was estimated at 7.8 bd. ft. per opening for all openings. This calculation does not include trim mouldings that frame the door opening. These mouldings are estimated separately later in this appendix.

The following table shows the number of doors used in new single family housing in 1988, by type, and the amounts of wood products used in each.

NUMBER AND WOOD PRODUCTS USED FOR SINGLE FAMILY DOORS, 1988

Total Application	Number of Doors (thousand)	Lumber (million bd. ft.)	Structural Panels (3/8")	Nonstructural Panels			Total (3/8")
				Hardwood plywood (1/8")	Hard-board (1/8")	Particle-board (3/4")	
				(million sq. ft.)			
Exterior doors							
Wood doors							
Flush doors	1,256.6	34	2	45	--	26	67
Panel doors	204.1	10	--	--	--	--	--
Total	1,460.6	44	2	45	--	26	67
Nonwood doors	2,138.0	10	--	--	--	--	--
Total	3,598.6	54	2	45	--	26	67
Interior doors							
Wood doors*							
Flush doors	9,100.8	209	10	256	--	20	125
Panel doors	2,634.7	75	--	--	--	--	--
Total	11,735.5	284	10	256	--	20	125
Hardboard doors							
Flush doors	3,201.6	54	--	--	100	6	45
Panel doors	978.2	23	--	--	32	--	11
Total	4,179.8	77	--	--	132	6	56
Nonwood doors	108.2	T	--	--	--	--	--
Total	16,023.5	361	10	256	132	26	181
Total, All Doors	19,622.1	415	12	301	132	52	248

* Includes lumber and softwood or hardwood plywood doors.

Garage doors

An estimated 1,641 thousand parking spaces were built for new single family houses in 1988. Of these, 1,506 thousand (92%) had wooden garage doors. Because most garages are two-car garages, a typical 7' x 16' two-car garage door was used to estimate wood products consumption.

The volume used per two-car door was divided in half to arrive at a use per parking space. Garage door panels were lumber about 15%, hardboard 40%, and plywood 45% of the time. The plywood panels were about two-thirds hardwood plywood and one-third softwood plywood.

The table below shows the number of doors by type and the usage rate applied to each.

LUMBER AND PANEL USE FOR WOOD GARAGE DOORS - 1988

Materials	Thousand Doors	Use Per Parking Space		Total Use (1,000)	
		Lumber	Other	Lumber	Other
Total doors	1,641				
Wood doors	1,506				
All lumber	226	60 B.F.	--	13,560	
Hardboard	602	22 B.F.	138 sf 1/8"	13,244	83,076
Hardwood plywood	452	22 B.F.	97.5 sf 1/8"	9,944	44,070
Softwood plywood	226	22 B.F.	32.5 sf 3/8"	4,972	7,345

Total Usage for new residential garages during 1988 was estimated as follows:

Lumber	41,720,000 bd. ft.
Hardboard	83,076,000 sq. ft. 1/8" basis
Hardwood plywood	44,070,000 sq. ft. 1/8" basis
Softwood plywood	4,972,000 sq. ft. 3/8" basis

WINDOWS

New residential construction used 16,800,700 windows during 1988 for single family housing. Almost half of these were wood, with metal accounting for 44% and vinyl for 7%. Although vinyl windows often use wood as a substrate, no data were available to estimate the wood volumes used. Therefore, the estimates here are for wood windows only, and should be considered somewhat conservative in terms of total wood used in windows.

The average wood window size was assumed to be 24"x48" with half in the double hung type and half in casements. Average wood use, including interior edging materials, was calculated to be 10.9 bd. ft. per window.

Regional differences in window materials are evident from the incidence of use data collected in this study. Houses in the North region (Northeast and Midwest Bureau of the Census regions) are dominated by wood windows, with 69% of all windows being wood. In the South wood is 44%, and in the West wood has just a 32% share. Metal windows dominate the South (53%) and West (66%).

The table below shows wood use in windows.

LUMBER USED FOR SINGLE FAMILY WINDOWS, BY REGION, 1988

Region	Number of Windows (Thousands)	Principal Material			Lumber Use (mil. bd. ft.)
		Wood	Metal	Vinyl	
		(Percent)			
North	5,591.4	69	16	15	43
South	7,117.0	44	53	3	34
West	4,092.3	32	66	2	14
U.S.	16,800.7	49	44	7	91

WOOD MOULDINGS

Wood mouldings and trim are commonly used in new residential construction. The biggest competition to wood moulding is no moulding at all. If moulding is used, it is almost always wood.

The survey provided information on the linear feel of moulding per sq. ft. of floor area. Conversion of linear feet of moulding to board feet of lumber was based on reported average widths for commonly used mouldings. Estimates of the board feet of moulding per square foot of floor area are shown below.

<u>Application</u>	<u>Bd. ft. per sq. ft. of floor area</u>
Base mouldings	0.046
Window/door mouldings	0.031
Other mouldings	0.021

The lumber equivalent of wood moulding used in new single family houses in 1988 totaled 210 million bd. ft. This includes mouldings for door and window trim, for base along the floor, and for miscellaneous other applications.

INTERIOR WOOD SHELVING

Shelving is a common use for wood products. The study showed lumber to be the dominant shelving material, followed by particleboard and then by structural panels. Nonwood shelving is becoming more popular, and already accounts for more linear feet of than does structural panel shelving. It will be a major competitor to wood in the future. Metal wire storage systems are being shown broadly in model homes, and seem to be catching the fancy of new home buyers.

The survey showed that the average house had 81 lineal feet of shelving. It was assumed that all shelving was 12" wide, and that lumber was 1", and particleboard and plywood were 3/4" thick.

The use of wood products for shelving is summarized in the following table.

WOOD PRODUCTS USED FOR SINGLE FAMILY SHELVING, 1988

Wood Product	Unit of Measure	Shelving Surface Area		Wood Products Use
		(millions)	(percent)	(millions)
Lumber	(Bd. ft.)	34	22.8	34
Structural panels	(Sq. ft., 3/8")	12	8.4	24
Particleboard	(Sq. ft., 3/4")	29	19.8	29
Nonwood	(Sq. ft., surface)	13	49.0	--
Total		88	100.0	

CABINETS AND COUNTER TOPS

Cabinets and counter tops are commonly prebuilt before installation in new single family construction. The kitchens and bathrooms are the primary areas of installation. The typical new housing unit has 32 lineal feet of base cabinets, and 25 lineal feet of wall cabinets.

Estimates of material use for these cabinets and countertops are based on the measurement of several store model cabinets which may or may not be representative of all manufactured cabinets. The survey provided share of market information for the cabinet fronts but data for the box itself were not gathered. Therefore, it was assumed that cabinet boxes were made with particleboard machined to fit together with minimum wood bracing. Also, one decorative hardwood plywood side panel was allocated for each 6 feet of cabinets, and a hardwood plywood toe kick for base cabinets was used. Front framing was assumed to be all lumber. Cabinet door estimates were based on the shares shown in the survey results.

Based on these assumptions, particleboard use may be somewhat overstated, while plywood and lumber use could be understated in the cabinet boxes. Unfortunately, without data to indicate the share of cabinet boxes made from materials other than particleboard, or the share with just a lumber frame instead of a box, it is not possible to improve on these estimates. Particleboard was used as the primary box material because it is currently the dominant material seen in model kitchens and other places where cabinets were being installed.

Readers may estimate the volumes of other materials by using the following size data related to the cabinet box. For every lineal foot of base cabinet, there are 3 sq. ft. of box wall area. For every lineal foot of wall cabinet there are 2 sq. ft. of box wall area. This area does not include the cabinet front or door.

Counter tops are related to the base cabinets. Base cabinets are generally 24" deep, but the countertop overhangs by 1", and on a sizeable portion of countertops, there is a 3-1/2" back splash. Based on these dimensions, there was a total counter top surface area of 76 million sq. ft. in 1988, or 2.25 sq. ft. per linear foot of cabinet.

The following table shows wood materials used in cabinets and countertops based on the foregoing assumptions.

**LINEAR FEET AND WOOD PRODUCTS USED
FOR SINGLE FAMILY CABINETS AND COUNTERTOPS, 1988**

Application	Linear Feet Installed (thousand)	Lumber (million bd. ft.)	Structural Panels (3/8") (million sq. ft.)	Non-structural Panels		Total (3/8")
				Hardwood Plywood (1/8")	Particle-board (3/4")	
Cabinets						
Base	34,873	69	--	174	292	642
Wall	26,765	49	--	58	117	254
Total	61,638	118	--	232	409	896
Countertops	33,633	--	18	--	69	139
Total, Cabinets and Countertops	--	118	18	232	478	1,034

FINISHED WOOD FLOORING

Wood flooring was used in 24% of new single family houses built in 1988. Nearly 60 million bd. ft. were used, with 67% being strip flooring, and 33% parquet.

The average volume used per house when finished wood flooring was present was 231 bd. ft., indicating that use was probably limited to one room and a hallway.

INTERIOR WALL AND CEILING COVERINGS

Less than 5% of the single family houses built in 1988 used wood products for the walls or ceilings. Total volume was estimated at about 45 million sq. ft. Hardwood and softwood lumber accounted for 65% of the square footage (29 million bd. ft.). softwood plywood 18% (8 million sq. ft.). hardwood plywood 1.3% (6 million sq. ft.), and hardboard 4% (2 million sq. ft.).

SHAKE AND SHINGLE ROOFS

Another small wood use in single family houses is for roofing shingles. This study showed that about 10% of the new units built in 1988 had wooden shake or shingle roofs.

A total volume of 307 million sq. ft. were purchased by builders to cover 254 million sq. ft. of roof area. This converts to nearly 267 million bd. ft. of lumber.

TOTAL, MILLWORK AND MISCELLANEOUS MANUFACTURED WOOD PRODUCTS

The table below summarizes the previously described wood product uses in single family housing.

WOOD PRODUCTS USED FOR SINGLE FAMILY MILLWORK
AND MISCELLANEOUS USES, 1988

Application	Lumber (million bd. ft.)	Struct. Panels (3/8")	Nonstructural Panels			Total (3/8")
			Hardwood Plywood (1/8")	Hardboard (1/8")	Particle- board (3/4")	
		(million sq. ft.)				
Doors						
Exterior	54	2	45	--	26	67
Interior	361	10	256	132	26	181
Total	415	12	301	132	52	248
Garage doors	42	7	44	83	--	42
Windows	91	--	--	--	--	--
Mouldings	210	--	--	--	--	--
Shelving	34	24	--	--	29	57
Cabinets	118	--	232	--	409	896
Counter tops	--	18	--	--	69	139
Flooring	60	--	--	--	--	--
Wall/ceiling covering	29	8	17	5	--	8
Roofs	267	--	--	--	--	--
Total	1,266	69	594	220	559	1,390

MULTIFAMILY MILLWORK AND MISCELLANEOUS USES

A total of nearly 191 million bd. ft. of lumber, 25 million sq. ft., 3/8" basis of structural panels, and 285 million sq. ft., 3/8" basis of nonstructural panels were used for millwork and miscellaneous uses in new multifamily residential construction in 1988. The following table summarizes wood products use for multifamily millwork and miscellaneous uses by application and type of wood product.

WOOD PRODUCTS USED FOR MULTIFAMILY MILLWORK
AND MISCELLANEOUS USES, 1988

Application	Lumber (million bd. ft.)	Nonstructural Panels				Total (3/8")
		Structural Panels (3/8")	Hard- wood Plywood (1/8")	Hard- board (1/8")	Particie- board (3/4")	
		(million sq. ft.)				
Doors						
Exterior	6	1	3	--	4	8
Interior	45	5	16	35	2	20
Total	51	6	19	35	6	28
Garage doors	4	1	4	7	--	4
Windows	4	--	--	--	--	--
Mouldings	48	--	--	--	--	--
Shelving	3	11	--	--	13	25
Cabinets	23	--	48	--	92	200
Counter tops	--	6	--	--	12	25
Flooring	19	--	--	--	--	--
Wall/ceiling covering	3	1	7	2	--	3
Roofs	36	--	--	--	--	--
Total	191	25	78	44	123	285

TOTAL RESIDENTIAL MILLWORK AND MISCELLANEOUS USES

In 1988, an estimated 1,155 million bd. ft. of lumber, 94 million sq. ft., 3/8" basis of structural panels, and 1,674 million sq. ft., 3/8" basis of nonstructural panels were used in new residential construction for millwork and miscellaneous uses. Nonstructural panels included 672 million sq. ft., 1/8" basis of hardwood plywood, 264 million sq. ft., 1/8" basis of hardboard, and 681 million sq. ft., 3/4" basis of particleboard. The table which follows summarizes wood products use by type of building, and wood product.

WOOD PRODUCTS USED FOR NEW RESIDENTIAL MILLWORK
AND MISCELLANEOUS USES, 1588

Building Type	Lumber (million bd. ft.)	Softwood Plywood (3/8")	Nonstructural Panels			Total (3/8")
			Hardwood Plywood (1/8")	Hardboard (1/8")	Particle- board (3/4")	
		(million sq. ft.)				
Single family	1,266	69	594	220	559	1,390
Multifamily	191	25	78	44	123	285
Total	1,457	94	672	264	682	1,675

Hardwood vs Softwood Lumber

A limited amount of data were gathered on the use of hardwood vs softwood lumber in the millwork sector of the study. Unfortunately, the data do not lend themselves to quantification, but may provide a useful indication of the major areas for hardwood applications.

Doors and Windows

Data on doors indicated 62% were softwood and 38% were hardwood, based on the door skin materials used. Added detail is shown in the table on page 50. Note that the door frames and material used in the core are most often softwood, regardless of the face materials.

The survey did not collect data on species used for windows. However, it was observed that most premanufactured windows are made with pine cut stock.

Mouldings

The survey indicated 72% of the wood mouldings were softwood, and 28% hardwood. Total mouldings were estimated at 210 million bd. ft.

Interior Walls and Ceilings

Lumber used for wall and ceiling paneling was reported to be softwood in 55%, and hardwood in 45% of the applications.

Kitchen Cabinets

Cabinets were classed on the basis of the cabinet doors. It indicated that hardwood doors were used in 89% and softwood in 11% of the cases. The cabinet box was usually particleboard or softwood plywood, but the front framing materials likely were in proportion to the door materials.

Other

The survey did not confirm, but suggested that most finished wood flooring was hardwood, most garage doors were softwood, and most shelving was softwood lumber.

APPENDIX B

PROCEDURES

The total volume of wood products used in new residential construction is dependent on the numbers, types, size and geographical distribution of the units built. The most significant factors are foundation type, number of stories, floor area, and whether attached or detached.

The study was designed to use the U.S. Department of Commerce, Bureau of Census, data on numbers of units by type, size and geographic location. Separate surveys were used to determine the incidence of use for various wood products and to determine the volume of materials used per unit when a particular wood product was applied.

The number of wood using units was derived by multiplying the incidence of use by the total units built, based on the Census data. Then the use factor per house was multiplied by the derived number of using houses to get the total volume consumed.

In the cases of inadequate data to fill certain information cells, combinations of available related data were used to avoid gross unexplainable errors. Details of the procedures follow.

HOUSING CHARACTERISTICS

The first set of data collected for this study was detailed information on the numbers of housing units built during 1988. This information was provided by the U.S. Department of Commerce, Bureau of Census, from a special tabulation of data contained in "Characteristics of New Housing: 1988" Report C25-88-13.

DATA STRATIFICATION

Data stratification was an integral part of this study. In order to hold the sample size to cost effective levels, building sectors were stratified according to the probable level of wood product use. Single family units use more wood per living unit than do multifamily units. This is a function of not only size, but also the use of common walls and roofs in multifamily structures. Larger units will use more wood than small ones. Units built with a basement or crawl space will use more wood than those built on concrete slabs.

Multifamily units were not stratified beyond being classed as multifamily units. It was found that wood consumption rates per unit did not vary appreciably from region to region nor was there a great deal of variation in living unit size in buildings with comparable numbers of units. Therefore, national averages were used in the multifamily sector.

The single family data were stratified by region because there is substantial variation in regional construction characteristics. Particularly, there is a large difference between units with a concrete slab foundation, and those with a basement or crawl space foundation. Slab usage is a regional characteristic.

There is also substantial size variation in single family housing, so stratification by size was accomplished, to reflect the differences in wood use between large houses and small houses.

Story height is another area for potential variations in wood use per unit in the single family sector. This was the final area of data stratification used in the study. It was recognized that a two story house has less roof area than a one story house with the same floor area, thus would likely use less wood per sq. ft.

It was felt that the study results would be less likely to be skewed by an atypical observation in the sample when the sample was stratified than if all the observations were bulked together. This system also has the advantage of providing a better estimating base in future analyses, since the Census data base typically is gathered to provide size, foundation type, story height, and regionality.

Regarding regional data, the Census Northeast and Midwest regions were combined into the North region to permit more efficient data collection. The housing characteristics were found to be adequately similar (most had basements, and the one story-two story relationships were similar) to allow combination without distortion.

INCIDENCE OF USE

The second study segment was designed to determine how frequently wood products were used in each of the stratified sample cells. The incidence of use is defined as that share of the total units which utilize a selected wood product like lumber, plywood, or particleboard in a particular application.

The primary areas of application were for floors, for walls, for roofs, and for garages, carports, porches or decks. Millwork use was also covered.

To collect this information, a random sample of building contractors was selected by Dun & Bradstreet¹ from its building contractor list. Names were called systematically from this list by interviewers from Market Trends, A Research Company² to complete a target number of interviews in each region, and for each building type and size needed to fill the sample cells.

Approximately 1,200 single family units and 350 multifamily buildings with 12,500 units were covered in the final incidence of use sample.

An example of the results of this procedure is shown in the following table for the North region usage of wood single and double floor systems.

¹ Dun & Bradstreet, Inc., 99 Church St., New York, N.Y.

² Market Trends, A Research Company, 14711 N.E. 29th Place, Suite 101, Bellevue, WA. 98007

INCIDENCE OF USE OF THE NUMBER OF FLOOR LAYERS
IN NEW SINGLE FAMILY HOUSES IN THE NORTH - 1988

Foundation Type	Number of Stories	Size Class	Single Layer Floors	Multilayer Floors
		(sq. ft.)	(percent)	
Bsm/Crawl	1	<1,600	63	37
Bsm/Crawl	1	1,600+	46	54
Bsm/Crawl	2	<1,600	64	36
Bsm/Crawl	2	1,600+	43	57
Slab	1	<1,600	0	0
Slab	1	1,600+	0	0
Slab	2	<1,600	56	44
Slab	2	1,600+	69	31

WOOD USE FACTORS

The third survey element was the development of wood consumption factors for the various wood products used in the various applications. The quantity was developed as use per sq. ft. of floor area initially. In the case of garages and carports, the factor was developed as use per parking space.

The data for calculating wood use was gathered primarily from a personal interview survey conducted by field men of the Wood Products Promotion Council member Associations. The calls were made at random on builders to determine the volumes of wood products being used on current construction projects. Targets were established to balance the data collection for units in each of the survey cells.

Actual building plans and specifications were also collected for material take-offs by Bottom Line Construction Services³, a professional building cost estimator. This procedure augmented the materials use data gathered in the other surveys.

³ Bottom Line Construction Services, 6835 Topaz Dr. S.W., Tacoma, WA 98498

The following table shows an example of the wood use factors for lumber and panels in single family housing for floor decking in the North region. Note that lumber use factors for floor decks in two story slab houses are about half those for two story crawl space or basement houses. This is because the slab houses do not have a first story wood floor system. Panel use factors are less than half because the second level floor decks are generally thinner than the first floor decks in the North region.

WOOD USE FACTORS FOR SINGLE LAYER FLOOR DECKING IN NEW SINGLE FAMILY HOUSES IN THE NORTH - 1988

Foundation Type	Number of Stories	Size Class	Lumber	Panels
		(sq. ft.)	(bd. ft.)	(sq. ft., 3/8")
Bsmt/Crawl	1	<1,600	1.01	2.08
Bsmt/Crawl	1	1,600+	.98	2.02
Bsmt/Crawl	2	<1,600	1.03	2.09
Bsmt/Crawl	2	1,600+	1.04	2.16
Slab	1	<1,600	0	0
Slab	1	1,600	0	0
Slab	2	<1,600	.51	.35
Slab	2	1,600+	.52	.35

WOOD USE CALCULATION

The wood use calculation consisted of taking the incidence of use to arrive at a share of the total units in a stratum which used a particular wood product. This number of units was multiplied by the use per unit to arrive at a total product use in the application. The totals for each application were summed to arrive at total wood use.

Where the incidence of use data were judged inadequate, either by limited use reported, or by insufficient observations, available data were combined to arrive at a judgmental result.

The following table provides an example of the basic procedure.

LUMBER USED FOR SINGLE FAMILY FLOOR DECKING IN THE NORTH - 1988

Founda- tion Type	No. of Stories	Size Class (sq. ft.)	House comple- tions (thou- sands)	Average House Size (sq. ft.)	Floor Area Com- pleted (million sq. ft.)	Percent Single Layer Floors	Percent With Lumber Decking	Floor Area With Lumber Decking (million sq. ft.)	Lumber Use per sq. ft. Floor Area (bd. ft.)	Total Lumber Use (million bd.ft.)
B/C	1	<1,600	75	1,358	102.0	63	10	6.4	1.01	6.5
B/C	1	1,600+	57	2,382	136.8	46	8	5.0	0.98	4.9
B/C	2	<1,600	41	1,358	55.5	64	11	3.9	1.03	4.0
B/C	2	1,600+	160	2,382	381.5	43	17	27.9	1.04	29.0
Slab	1	<1,600	13	1,358	18.0	0	0	0.0	0.00	0.0
Slab	1	1,600+	9	2,382	21.0	0	0	0.0	0.00	0.0
Slab	2	<1,600	9	1,358	12.0	56	0	0.0	0.51	0.0
Slab	2	1,600+	15	2,382	36.8	69	25	6.3	0.52	3.3
Total North			380	--	763.7	--	--	49.5	--	47.7

Similar calculations were made for each major application by region and by housing type for lumber and for panels. Data for single family and multifamily houses by region are summarized in the tables included in Appendix C.

INSUFFICIENT DATA

The extensive level of stratification led to insufficient data in some data cells. To minimize the effect of this missing data on overall wood use estimates, data cells were combined, or overall averages were used. For example, missing roof system data were estimated by combining observations for the various foundation types since the type of foundation probably has little impact on the structure of the roof. Similarly, floor data were developed by combining information on one and two story houses of the same foundation type.

In addition, outside data were used in several instances to confirm the reliability of the report data.

The report discussion section provides additional information on these procedures

RELIABILITY OF RESULTS

Although the study was designed using accepted sampling procedures, no formal tests of statistical reliability were made on the incidence of use, or the wood use factor data. Statistical reliability of the housing completions data was assured by the U.S. Department of Commerce, Bureau of Census.

Results of the study were checked for reasonableness against production information from government and trade association sources. Past industry studies were also referenced, and special reviews were conducted by industry experts.

As a result of these checks, it is concluded that the study accurately reflects the use of wood products in new residential construction for the year 1988.

APPENDIX C

ACKNOWLEDGEMENTS, AUTHORS, REFERENCES AND
STATISTICAL TABLES

ACKNOWLEDGEMENTS

The authors wish to thank the builders and contractors who provided the data essential to the successful completion of this study, the field representatives of the member associations of the Wood Products Promotion Council for their efforts in data collecting and verification, and the Bottom Line Construction Company for its assistance in extracting materials use information from residential blueprints. Their contributions to this study are gratefully acknowledged. A special thanks is extended to Steve Bissen, formerly statistical clerk at the Forest Products Laboratory, for his assistance throughout the course of this study in data tabulation and analysis, and computer programming.

AUTHORS

The study principals were Robert G. Anderson, Forest Industry Consultant, Tacoma, WA, and David B. McKeever, Research Forester, Timber Demand and technology Assessment Research Work Unit, Forest Products Laboratory, Forest Service, U.S. Department of Agriculture.

Mr. Anderson was formerly Director of Market Research and Economic Services for the American Plywood Association, and has more than 40 years of experience in market research and planning in the wood products industry.

Mr. McKeever has been with the Forest Service for 15 years, conducting many studies on wood products use in industry and construction.

REFERENCES

- Carney, Michael J. Softwood Plywood Used in New Residential Construction - 1976-1977. American Plywood Assoc. Market Research Rpt. R38. Tacoma, WA: American Plywood Assoc.. Marketing Group. 45 p.
- McKeever, David B.; Martens, David G. 1983. Wood Used in U.S. Manufacturing Industries. 1977. USDA For. Serv. Resource Bulletin FPL-12. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Prod. Lab. 56 p.
- Phelps, Robert B. 1970. Wood Products Used in Single-Family Houses inspected by the Federal Housing Administration. 1959, 1962, and 1968. Statistical Bull. No. 452. Washington, DC: U.S. Department of Agriculture, Forest Service. 29 p.
- U.S. Department of Commerce, Bureau of the Census. 1989. Characteristics of New Housing. 1988. Current Construction Rpts. C25-88-13. Washington. DC: U.S. Department of Commerce. Bureau of the Census. 62 p.
- U.S. Department of Commerce, Bureau of the Census. 1988. New One Family Houses Completed by Foundation Type, Number of Stories, Sq. Ft. Area, and Region 1988. Unpublished data. Washington, DC: Department of Commerce, Bureau of the Census. 1 p.

Table C-1.--Characteristics of new housing units built in the United States, by type of unit and region, 1988

Housing type/ region	Number of housing units completed	Floor area	
		Average per unit	Total completed
	(Thousands)	(Sq. ft.)	(Million sq. ft.)
Single family			
North	380	2,010	763.7
South	457	1,985	908.2
West	248	1,995	495.0
Total	1,085	1,995	2,166.9
Multifamily	445	990	440.6

Census Data on Total Single Family
Housing Volume and Floor Area by Region
1988
(Millions of Units)

<u>Region</u>	<u>Total Units</u>	<u>Total Floor Area</u>
North	380	763.7
South	457	908.2
West	248	495.0
Total	1,085	2,166.9

Source: U. S. Bureau of Census

Table C-2.--Wood products used in new residential construction in the United States, by type of structure, application and wood product, 1988

Application	Units	Single family			Multifamily			Total use, all new residential construction
		Total	Use per unit	Use per sq. ft. floor area	Total	Use per unit	Use per sq. ft. floor area	
		(Million)			(Million)			(Million)
FLOOR SYSTEMS								
Lumber	(Bd. ft.)	3,276.6	3,019.9	1.51	549.7	1,235.3	1.25	3,826.3
Structural panels								
Plywood	(Sq. ft., 3/8-in.)	2,685.2	2,474.8	1.24	509.1	1,144.0	1.16	3,194.2
OSB/waferboard	(Sq. ft., 3/8-in.)	470.1	433.2	0.22	71.3	160.2	0.16	541.4
Total, structural	(Sq. ft., 3/8-in.)	3,155.2	2,908.0	1.46	580.4	1,304.2	1.32	3,735.6
Nonstructural panels	(Sq. ft., 3/8-in.)	573.6	528.7	0.26	96.4	216.6	0.22	670.0
Total, all panels	(Sq. ft., 3/8-in.)	3,728.8	3,436.7	1.72	676.7	1,520.8	1.54	4,405.6
WALL SYSTEMS								
Lumber								
Framing, sheathing, etc.	(Bd. ft.)	5,740.8	5,291.0	2.65	1,080.2	2,427.5	2.45	6,821.0
Siding	(Bd. ft.)	511.2	471.1	0.24	75.4	169.5	0.17	586.6
Total, lumber	(Bd. ft.)	6,251.9	5,762.2	2.89	1,155.7	2,597.0	2.62	7,407.6
Structural panels								
Plywood	(Sq. ft., 3/8-in.)	818.5	754.4	0.38	123.2	276.8	0.28	941.7
OSB/waferboard	(Sq. ft., 3/8-in.)	227.0	209.2	0.10	35.8	80.4	0.08	262.8
Total	(Sq. ft., 3/8-in.)	1,045.5	963.6	0.48	159.0	357.2	0.36	1,204.5
Plywood/OSB siding	(Sq. ft., 3/8-in.)	870.1	801.9	0.40	96.8	217.6	0.22	1,467.3
Total, structural	(Sq. ft., 3/8-in.)	1,915.6	1,765.5	0.88	255.8	574.8	0.58	2,671.8
Nonstructural panels								
Panels	(Sq. ft., 3/8-in.)	420.4	387.5	0.19	43.7	98.2	0.10	464.2
Siding	(Sq. ft., 3/8-in.)	423.5	390.3	0.20	66.2	148.9	0.15	489.7
Total, nonstructural	(Sq. ft., 3/8-in.)	843.9	777.8	0.39	110.0	247.1	0.25	953.9
Total, all panels	(Sq. ft., 3/8-in.)	2,759.6	2,543.4	1.27	365.7	821.8	0.83	3,125.3
ROOF SYSTEMS								
Lumber	(Bd. ft.)	4,119.5	3,796.8	1.90	455.9	1,024.6	1.03	4,575.5
Structural panels								
Plywood	(Sq. ft., 3/8-in.)	2,460.4	2,267.6	1.14	366.0	822.6	0.83	2,826.4
OSB/waferboard	(Sq. ft., 3/8-in.)	663.3	611.3	0.31	73.6	165.4	0.17	736.9
Total	(Sq. ft., 3/8-in.)	3,123.7	2,879.0	1.44	439.6	987.9	1.00	3,563.3
Plywood/OSB siding	(Sq. ft., 3/8-in.)	184.0	169.6	0.08	--	--	--	--
Total, structural	(Sq. ft., 3/8-in.)	3,307.7	3,048.6	1.53	439.6	987.9	1.00	3,747.3
Nonstructural panels	(Sq. ft., 3/8-in.)	121.3	111.8	0.06	15.7	35.2	0.04	137.0
Total, all panels	(Sq. ft., 3/8-in.)	3,429.0	3,160.4	1.58	455.3	1,023.2	1.03	3,884.3
GARAGES, CARPORTS, PORCHES AND DECKS								
Lumber	(Bd. ft.)	2,255.9	2,079.2	1.04	167.2	375.8	0.38	2,423.1
Structural panels								
Plywood	(Sq. ft., 3/8-in.)	356.5	328.5	0.16	85.8	192.8	0.19	442.2
OSB/waferboard	(Sq. ft., 3/8-in.)	96.8	89.2	0.04	18.1	40.6	0.04	114.9
Total	(Sq. ft., 3/8-in.)	453.3	417.8	0.21	103.9	233.4	0.24	557.1
Plywood/OSB siding	(Sq. ft., 3/8-in.)	250.0	230.4	0.12	--	--	--	--
Total, structural	(Sq. ft., 3/8-in.)	703.3	648.2	0.32	103.9	233.4	0.24	557.1
Nonstructural panels								
Panels	(Sq. ft., 3/8-in.)	177.4	163.5	0.08	3.4	7.6	0.01	180.7
Siding	(Sq. ft., 3/8-in.)	121.7	112.2	0.06	--	--	--	--
Total, nonstructural	(Sq. ft., 3/8-in.)	299.0	275.6	0.14	3.4	7.6	0.01	302.4
Total, all panels	(Sq. ft., 3/8-in.)	1,002.3	923.8	0.46	107.2	241.0	0.24	1,109.5

Table C2.-Wood products used in new residential construction in the United States, by type of structure, application and wood product, 1988-cont.

Application	Units	Single family			Multifamily			Total use, all new residential construction
		Total	Use per unit	Use per sq. ft. floor area	Total	Use per unit	Use per sq. ft. floor area	
		(Million)			(Million)			(Million)
TOTAL, ALL APPLICATIONS, EXCLUDING MILLWORK								
Lumber								
Framing, sheathing, etc.	(Bd. ft.)	15,392.9	14,187.0	7.10	2,253.1	5,063.1	5.11	17,645.9
Siding	(Bd. ft.)	511.2	471.1	0.24	75.4	169.5	0.17	586.6
Total, lumber	(Bd. ft.)	15,904.0	14,658.1	7.34	2,328.5	5,232.6	5.29	18,232.5
Structural panels								
Plywood	(Sq. ft., 3/8-in.)	6,320.5	5,825.4	2.92	1,084.1	2,436.2	2.46	7,404.6
OSB/waferboard	(Sq. ft., 3/8-in.)	1,457.2	1,343.0	0.67	198.7	446.6	0.45	1,655.9
Total	(Sq. ft., 3/8-in.)	7,777.7	7,168.4	3.59	1,282.8	2,882.7	2.91	9,060.5
Plywood/OSB siding	(Sq. ft., 3/8-in.)	1,304.1	1,201.9	0.60	96.8	217.6	0.22	1,400.9
Total, structural	(Sq. ft., 3/8-in.)	9,081.8	8,370.3	4.19	1,379.6	3,100.3	3.13	10,461.4
Nonstructural panels								
Panels	(Sq. ft., 3/8-in.)	1,292.7	1,191.4	0.60	159.2	357.7	0.36	1,451.9
Siding	(Sq. ft., 3/8-in.)	545.2	502.5	0.25	66.2	148.9	0.15	611.4
Total, nonstructural	(Sq. ft., 3/8-in.)	1,837.9	1,693.9	0.85	225.4	506.5	0.51	2,063.3
Total, all panels	(Sq. ft., 3/8-in.)	10,919.7	10,064.2	5.04	1,605.0	3,606.8	3.64	12,524.7
MILLWORK AND MISC. USES								
Lumber	(Bd. ft.)	1,264.4	1,165.4	0.58	190.6	428.3	0.43	1,455.0
Plywood	(Sq. ft., 3/8-in.)	68.8	63.4	0.03	25.0	56.1	0.06	93.8
Nonstructural panels	(Sq. ft., 3/8-in.)	1,388.8	1,280.0	0.64	285.0	640.5	0.65	1,673.8
Total, all panels	(Sq. ft., 3/8-in.)	1,457.6	1,343.4	0.67	310.0	696.6	0.70	1,767.6
TOTAL, ALL APPLICATIONS, INCLUDING MILLWORK								
Lumber								
Framing, sheathing, etc.	(Bd. ft.)	16,657.3	15,352.3	7.69	2,443.7	5,491.5	5.55	19,101.0
Siding	(Bd. ft.)	511.2	471.1	0.24	75.4	169.5	0.17	586.6
Total, lumber	(Bd. ft.)	17,168.4	15,823.5	7.92	2,519.1	5,660.9	5.72	19,687.6
Structural panels								
Plywood	(Sq. ft., 3/8-in.)	6,389.4	5,888.8	2.95	1,109.1	2,492.3	2.52	7,498.4
OSB/waferboard	(Sq. ft., 3/8-in.)	1,457.2	1,343.0	0.67	198.7	446.6	0.45	1,655.9
Total	(Sq. ft., 3/8-in.)	7,846.5	7,231.8	3.62	1,307.8	2,938.9	2.97	9,154.3
Plywood/OSB siding	(Sq. ft., 3/8-in.)	1,304.1	1,201.9	0.60	96.8	217.6	0.22	1,400.9
Total, structural	(Sq. ft., 3/8-in.)	9,150.6	8,433.7	4.22	1,404.6	3,156.4	3.19	10,555.2
Nonstructural panels								
Panels	(Sq. ft., 3/8-in.)	2,681.5	2,471.4	1.24	444.2	998.1	1.01	3,125.7
Siding	(Sq. ft., 3/8-in.)	545.2	502.5	0.25	66.2	148.9	0.15	611.4
Total, nonstructural	(Sq. ft., 3/8-in.)	3,226.7	2,973.9	1.49	510.4	1,147.0	1.16	3,737.1
Total, all panels	(Sq. ft., 3/8-in.)	12,377.3	11,407.6	5.71	1,915.0	4,303.4	4.35	14,292.3

Table C-3.--Lumber used in new single family residential construction in the United States, by region and application, 1988

Application	North			South			West			Total, all regions/1		
	Total	Use per unit	Use per sq. ft. floor area	Total	Use per unit	Use per sq. ft. floor area	Total	Use per unit	Use per sq. ft. floor area	Total	Use per unit	Use per sq. ft. floor area
	(Million bd. ft.)	(Board feet)		(Million bd. ft.)	(Board feet)		(Million bd. ft.)	(Board feet)		(Million bd. ft.)	(Board feet)	
FLOOR SYSTEMS												
Wood foundations/2	--	--	--	--	--	--	--	--	--	75.9	70.0	0.04
Floor framing	1,342.9	3,534.0	1.76	916.7	2,005.9	1.01	478.8	1,930.8	0.97	2,738.4	2,523.9	1.26
Floor decking	90.6	238.4	0.12	17.9	39.3	0.02	16.1	64.8	0.03	124.6	114.9	0.06
Interior stairways	152.4	401.0	0.20	120.2	263.1	0.13	65.0	262.2	0.13	337.6	311.2	0.16
Total, lumber	1,585.9	4,173.4	2.08	1,054.9	2,308.3	1.16	559.9	2,257.8	1.13	3,276.6	3,019.9	1.51
WALL SYSTEMS												
Exterior framing	1,194.3	3,142.9	1.56	1,243.8	2,721.6	1.37	798.5	3,219.7	1.61	3,236.6	2,983.0	1.49
Exterior sheathing	6.6	17.3	0.01	15.5	34.0	0.02	18.1	72.8	0.04	40.1	37.0	0.02
Interior framing	888.4	2,338.0	1.16	1,030.3	2,254.5	1.13	545.3	2,198.8	1.10	2,464.0	2,271.0	1.14
Total	2,089.3	5,498.2	2.74	2,289.6	5,010.1	2.52	1,361.8	5,491.3	2.75	5,740.8	5,291.0	2.65
Siding	209.4	551.0	0.27	213.1	466.2	0.23	88.7	357.8	0.18	511.2	471.1	0.24
Total, lumber	2,298.7	6,049.1	3.01	2,502.7	5,476.4	2.76	1,450.6	5,849.1	2.93	6,251.9	5,762.2	2.89
ROOF SYSTEMS												
Framing	1,235.0	3,250.0	1.62	1,733.7	3,793.7	1.91	712.2	2,871.9	1.44	3,681.0	3,392.6	1.70
Decking	9.4	24.7	0.01	70.7	154.7	0.08	34.8	140.5	0.07	114.9	105.9	0.05
Facia and soffits	90.1	237.0	0.12	132.7	290.3	0.15	100.9	406.9	0.20	323.7	298.3	0.15
Total, lumber	1,334.4	3,511.7	1.75	1,937.1	4,238.7	2.13	848.0	3,419.3	1.71	4,119.5	3,796.8	1.90
GARAGES, CARPORTS, PORCHES AND DECKS												
	847.9	2,231.2	1.11	887.1	1,941.1	0.98	521.0	2,100.7	1.05	2,255.9	2,079.2	1.04
TOTAL, ALL APPLICATIONS, EXCLUDING MILLWORK												
	6,066.9	15,965.4	7.94	6,381.8	13,964.4	7.03	3,379.5	13,626.9	6.83	15,904.0	14,658.1	7.34
MILLWORK AND MISC. USES												
	427.7	1,125.6	0.56	491.4	1,075.3	0.54	345.3	1,392.2	0.70	1,264.4	1,165.4	0.58
TOTAL, ALL APPLICATIONS, INCLUDING MILLWORK												
	6,494.6	17,091.0	8.50	6,873.2	15,039.8	7.57	3,724.7	15,019.1	7.52	17,168.4	15,823.5	7.92

1/ Includes lumber use for applications without regional data.

2/ Regional data not available.

Table C-4.--Panel products used in new single family residential construction in the United States, by region and application, 1988

Application	North			South			West			Total, all regions/1		
	Total	Use per	Use per									
		unit	sq. ft.									
	(Million sq. ft., 3/8-in.)	(Sq. ft., 3/8-in.)	(Sq. ft., 3/8-in.)	(Million sq. ft., 3/8-in.)	(Sq. ft., 3/8-in.)	(Sq. ft., 3/8-in.)	(Million sq. ft., 3/8-in.)	(Sq. ft., 3/8-in.)	(Sq. ft., 3/8-in.)	(Million sq. ft., 3/8-in.)	(Sq. ft., 3/8-in.)	(Sq. ft., 3/8-in.)
FLOOR SYSTEMS												
Wood foundations/2												
Plywood	--	--	--	--	--	--	--	--	--	80.6	74.3	0.04
Floor decking												
Structural panels												
Plywood	1,257.7	3,309.7	1.65	908.2	1,987.3	1.00	369.1	1,488.3	0.75	2,535.0	2,336.4	1.17
OSB/waferboard	241.6	635.9	0.32	153.0	334.8	0.17	75.3	303.8	0.15	470.0	433.1	0.22
Total, structural	1,499.3	3,945.5	1.96	1,061.2	2,322.0	1.17	444.4	1,792.1	0.90	3,004.9	2,769.5	1.39
Nonstructural panels	217.5	572.4	0.28	215.4	471.4	0.24	139.8	563.6	0.28	572.7	527.9	0.26
Interior stairways												
Structural panels												
Plywood	0.3	0.7	0.00	0.2	0.5	0.00	0.1	0.5	0.00	0.6	0.5	0.00
OSB/waferboard	0.1	0.1	0.00	0.0	0.1	0.00	0.0	0.1	0.00	0.1	0.1	0.00
Total, structural	0.3	0.8	0.00	0.2	0.5	0.00	0.1	0.5	0.00	0.7	0.6	0.00
Nonstructural panels	0.4	1.0	0.00	0.3	0.7	0.00	0.2	0.7	0.00	0.9	0.8	0.00
Floor framing												
Plywood	27.4	72.1	0.04	22.4	49.1	0.02	19.2	77.4	0.04	69.0	63.6	0.03
Total												
Structural panels												
Plywood	1,285.3	3,382.4	1.68	930.8	2,036.9	1.02	388.4	1,566.2	0.78	2,685.2	2,474.8	1.24
OSB/waferboard	241.7	636.0	0.32	153.0	334.8	0.17	75.4	303.9	0.15	470.1	433.2	0.22
Total, structural	1,527.0	4,018.4	2.00	1,083.9	2,371.7	1.19	463.8	1,870.1	0.94	3,155.2	2,908.0	1.46
Nonstructural panels	217.9	573.5	0.29	215.7	472.1	0.24	139.9	564.3	0.28	573.6	528.7	0.26
WALL SYSTEMS												
Structural panels												
Plywood/3	267.5	703.9	0.35	330.8	723.8	0.36	219.4	884.5	0.44	818.5	754.4	0.38
OSB/waferboard	122.7	322.8	0.16	68.5	149.9	0.08	35.8	144.5	0.07	227.0	209.2	0.10
Total	390.1	1,026.7	0.51	399.3	873.7	0.44	255.2	1,029.0	0.52	1,045.5	963.6	0.48
Plywood/OSB siding	--	--	--	--	--	--	--	--	--	870.1	801.9	0.40
Total, structural	390.1	1,026.7	0.51	399.3	873.7	0.44	255.2	1,029.0	0.52	1,915.6	1,765.5	0.88
Nonstructural panels												
Panels	102.8	270.5	0.13	220.0	481.5	0.24	97.6	393.6	0.20	420.4	387.5	0.19
Siding/2	--	--	--	--	--	--	--	--	--	423.5	390.3	0.20
Total, nonstructural	102.8	270.5	0.13	220.0	481.5	0.24	97.6	393.6	0.20	843.9	777.8	0.39
ROOF SYSTEMS												
Decking												
Structural panels												
Plywood	655.8	1,725.8	0.86	863.2	1,888.9	0.95	478.8	1,930.5	0.97	1,997.8	1,841.3	0.92
OSB/waferboard	271.0	713.2	0.35	235.7	515.7	0.26	139.5	562.6	0.28	646.2	595.6	0.30
Total, structural	926.8	2,439.0	1.21	1,098.9	2,404.5	1.21	618.3	2,493.1	1.25	2,644.0	2,436.9	1.22
Nonstructural panels	35.7	94.1	0.05	22.1	48.3	0.02	10.8	43.6	0.02	68.7	63.3	0.03
Facia and soffits												
Structural panels												
Plywood	65.2	171.7	0.09	131.6	287.9	0.14	49.5	199.7	0.10	246.3	227.0	0.11
OSB/waferboard	0.0	0.0	0.00	1.1	2.5	0.00	0.9	3.5	0.00	2.0	1.8	0.00
Total	65.2	171.7	0.09	132.7	290.3	0.15	50.4	203.2	0.10	248.3	228.9	0.11
Plywood/OSB siding/2	--	--	--	--	--	--	--	--	--	184.0	169.6	0.08
Total, structural	65.2	171.7	0.09	132.7	290.3	0.15	50.4	203.2	0.10	432.3	398.4	0.20
Nonstructural panels	10.5	27.7	0.01	28.2	61.7	0.03	13.9	56.0	0.03	52.6	48.5	0.02

See footnotes at end of table.

Table C.4.-Panel products used in new single family residential construction in the United States, by region and application, 1988-cont.

Application	North			South			West			Total, all regions/1		
	Total	Use per	Use per									
		unit	sq. ft. floor area									
	(Million sq. ft., 3/8-in.)	(Sq. ft., 3/8-in.)		(Million sq. ft., 3/8-in.)	(Sq. ft., 3/8-in.)		(Million sq. ft., 3/8-in.)	(Sq. ft., 3/8-in.)		(Million sq. ft., 3/8-in.)	(Sq. ft., 3/8-in.)	
ROOF SYSTEMS, cont.												
Framing												
Structural panels												
Plywood	57.0	150.0	0.07	100.3	219.5	0.11	59.0	237.7	0.12	216.3	199.3	0.10
OSB/waferboard	0.0	0.0	0.00	11.3	24.8	0.01	3.8	15.2	0.01	15.1	13.9	0.01
Total, structural	57.0	150.0	0.07	111.7	244.3	0.12	62.7	252.9	0.13	231.4	213.3	0.11
Total												
Structural panels												
Plywood	778.0	2,047.5	1.02	1,095.1	2,396.3	1.21	587.3	2,368.0	1.19	2,460.4	2,267.6	1.14
OSB/waferboard	271.0	713.2	0.35	248.1	542.9	0.27	144.2	581.3	0.29	663.3	611.3	0.31
Total	1,049.1	2,760.7	1.37	1,343.2	2,939.2	1.48	731.4	2,949.2	1.48	3,123.7	2,879.0	1.44
Plywood/OSB siding/2												
Total, structural	1,049.1	2,760.7	1.37	1,343.2	2,939.2	1.48	731.4	2,949.2	1.48	3,307.7	3,048.6	1.53
Nonstructural panels	46.3	121.8	0.06	50.3	110.1	0.06	24.7	99.6	0.05	121.3	111.8	0.06
GARAGES, CARPORTS, PORCHES AND DECKS												
Structural panels												
Plywood	119.5	314.5	0.16	122.6	268.3	0.14	114.3	461.0	0.23	356.5	328.5	0.16
OSB/waferboard	54.8	144.3	0.07	23.7	51.9	0.03	18.3	73.6	0.04	96.8	89.2	0.04
Total	174.3	458.8	0.23	146.3	320.2	0.16	132.6	534.6	0.27	453.3	417.8	0.21
Plywood/OSB siding/2												
Total, structural	174.3	458.8	0.23	146.3	320.2	0.16	132.6	534.6	0.27	703.3	648.2	0.32
Nonstructural panels												
Panels	46.4	122.2	0.06	82.6	180.8	0.09	48.3	194.6	0.10	177.4	163.5	0.08
Siding/2	--	--	--	--	--	--	--	--	--	121.7	112.2	0.06
Total, nonstructural	46.4	122.2	0.06	82.6	180.8	0.09	48.3	194.6	0.10	299.0	275.6	0.14
TOTAL, ALL APPLICATIONS, EXCLUDING MILLWORK												
Structural panels												
Plywood	2,450.3	6,448.3	3.21	2,479.3	5,425.2	2.73	1,309.4	5,279.6	2.65	6,320.5	5,825.4	2.92
OSB/waferboard	690.2	1,816.3	0.90	493.4	1,079.6	0.54	273.6	1,103.2	0.55	1,457.2	1,343.0	0.67
Total	3,140.5	8,264.6	4.11	2,972.7	6,504.8	3.27	1,583.0	6,382.9	3.20	7,777.7	7,168.4	3.59
Plywood/OSB siding/2												
Total, structural	3,140.5	8,264.6	4.11	2,972.7	6,504.8	3.27	1,583.0	6,382.9	3.20	9,081.8	8,370.3	4.19
Nonstructural panels												
Panels	413.5	1,088.0	0.54	568.7	1,244.5	0.63	310.5	1,252.1	0.63	1,292.7	1,191.4	0.60
Siding/2	--	--	--	--	--	--	--	--	--	545.2	502.5	0.25
Total, nonstructural	413.5	1,088.0	0.54	568.7	1,244.5	0.63	310.5	1,252.1	0.63	1,837.9	1,693.9	0.85
MILLWORK AND MISC. USES												
Plywood	23.5	62.0	0.03	29.1	63.7	0.03	16.2	65.1	0.03	68.8	63.4	0.03
Nonstructural panels	473.9	1,247.2	0.62	586.0	1,282.3	0.65	328.8	1,325.9	0.66	1,388.8	1,280.0	0.64
TOTAL, ALL APPLICATIONS, INCLUDING MILLWORK												
Structural panels												
Plywood	2,473.9	6,510.2	3.24	2,508.4	5,488.9	2.76	1,325.5	5,344.8	2.68	6,389.4	5,888.8	2.95
OSB/waferboard	690.2	1,816.3	0.90	493.4	1,079.6	0.54	273.6	1,103.2	0.55	1,457.2	1,343.0	0.67
Total	3,164.1	8,326.6	4.14	3,001.8	6,568.5	3.31	1,599.1	6,448.0	3.23	7,846.5	7,231.8	3.62
Plywood/OSB siding/2												
Total, structural	3,164.1	8,326.6	4.14	3,001.8	6,568.5	3.31	1,599.1	6,448.0	3.23	9,150.6	8,433.7	4.22
Nonstructural panels												
Panels	887.4	2,335.3	1.16	1,154.8	2,526.8	1.27	639.3	2,578.0	1.29	2,681.5	2,471.4	1.24
Siding/2	--	--	--	--	--	--	--	--	--	545.2	502.5	0.25
Total, nonstructural	887.4	2,335.3	1.16	1,154.8	2,526.8	1.27	639.3	2,578.0	1.29	3,226.7	2,973.9	1.49

1/ Includes panel use for applications without regional data.

2/ Regional data not available.

Table C-5.--Lumber used in new multifamily residential construction in the United States, by application, 1988

Application	Total	Use per unit	Use per sq. ft. floor area
	(Million bd. ft.)	(Board feet)	
FLOOR SYSTEMS			
Floor framing	484.0	1,087.6	1.10
Floor decking	26.2	58.9	0.06
Interior stairways	39.5	88.8	0.09
Total	549.7	1,235.3	1.25
WALL SYSTEMS			
Exterior framing	424.9	954.8	0.96
Exterior sheathing	6.0	13.4	0.01
Interior framing	649.4	1,459.3	1.47
Total	1,080.2	2,427.5	2.45
Siding	75.4	169.5	0.17
Total	1,155.7	2,597.0	2.62
ROOF SYSTEMS			
Framing	443.6	996.9	1.01
Decking	12.3	27.7	0.03
Facia and soffits	/1	--	--
Total	455.9	1,024.6	1.03
GARAGES, CARPORTS, PORCHES AND DECKS/2			
	167.2	375.8	0.38
TOTAL, ALL APPLICATIONS, EXCLUDING MILLWORK			
Framing, sheathing, etc.	2,253.1	5,063.1	5.11
Siding	75.4	169.5	0.17
Total	2,328.5	5,232.6	5.29
MILLWORK AND MISC. USES			
	190.6	428.3	0.43
TOTAL, ALL APPLICATIONS, EXCLUDING MILLWORK			
Framing, sheathing, etc.	2,443.7	5,491.5	5.55
Siding	75.4	169.5	0.17
Total	2,519.1	5,660.9	5.72

1/ Facia and soffits included with roof framing.

2/ Siding included with wall siding.

Table C-6.--Panel products used in new multifamily construction in the United States, by application, 1988

Application	Total	Use per unit	Use per sq. ft. floor area	Application	Total	Use per unit	Use per sq. ft. floor area
	(Million sq. ft., 3/8-in.)	(Sq. ft., 3/8-in.)			(Million sq. ft., 3/8-in.)	(Sq. ft., 3/8-in.)	
FLOOR SYSTEMS				GARAGES, CARPORTS, PORCHES AND DECKS			
Floor decking				Structural panels			
Plywood	508.2	1,141.9	1.15	Plywood	85.8	192.8	0.19
OSB/waferboard	71.2	160.1	0.16	OSB/waferboard	18.1	40.6	0.04
Total, structural	579.4	1,302.0	1.32	Total, structural	103.9	233.4	0.24
Nonstructural panels	95.1	213.7	0.22	Nonstructural panels	3.4	7.6	0.01
Interior stairways				Total, all panels	107.2	241.0	0.24
Structural panels				TOTAL, ALL APPLICATIONS, EXCLUDING MILLWORK			
Plywood	0.9	2.1	0.00	Structural panels			
OSB/waferboard	0.1	0.1	0.00	Plywood	1,084.1	2,436.2	2.46
Total, structural	1.0	2.2	0.00	OSB/waferboard	198.7	446.6	0.45
Nonstructural panels	1.3	2.8	0.00	Total	1,282.8	2,882.7	2.91
Total				Plywood/OSB siding	96.8	217.6	0.22
Structural panels				Total, structural	1,379.6	3,100.3	3.13
Plywood	509.1	1,144.0	1.16	Nonstructural panels			
OSB/waferboard	71.3	160.2	0.16	Panels	159.2	357.7	0.36
Total, structural	580.4	1,304.2	1.32	Siding	66.2	148.9	0.15
Nonstructural panels	96.4	216.6	0.22	Total, nonstructural	225.4	506.5	0.51
Total, all panels	676.7	1,520.8	1.54	Total, all panels	1,605.0	3,606.8	3.64
WALL SYSTEMS				MILLWORK AND MISC. USES			
Structural panels				Plywood	25.0	56.1	0.06
Plywood	123.2	276.8	0.28	Nonstructural panels	285.0	640.5	0.65
OSB/waferboard	35.8	80.4	0.08	Total, all panels	310.0	696.6	0.70
Total	159.0	357.2	0.36	TOTAL, ALL APPLICATIONS, INCLUDING MILLWORK			
Plywood/OSB siding	96.8	217.6	0.22	Structural panels			
Total, structural	255.8	574.8	0.58	Plywood	1,109.1	2,492.3	2.52
Nonstructural panels				OSB/waferboard	198.7	446.6	0.45
Panels	43.7	98.2	0.10	Total	1,307.8	2,938.9	2.97
Siding	66.2	148.9	0.15	Plywood/OSB siding	96.8	217.6	0.22
Total, nonstructural	110.0	247.1	0.25	Total, structural	1,404.6	3,156.4	3.19
Total, all panels	365.7	821.8	0.83	Nonstructural panels			
ROOF SYSTEMS				Panels	444.2	998.1	1.01
Decking				Siding	66.2	148.9	0.15
Structural panels				Total, nonstructural	510.4	1,147.0	1.16
Plywood	347.2	780.3	0.79	Total, all panels	1,915.0	4,303.4	4.35
OSB/waferboard	73.1	164.3	0.17				
Total, structural	420.3	944.6	0.95				
Nonstructural panels	13.7	30.8	0.03				
Facia and soffits							
Structural panels							
Plywood	18.8	42.3	0.04				
OSB/waferboard	0.5	1.1	0.00				
Total, structural	19.3	43.4	0.04				
Nonstructural panels	2.0	4.4	0.00				
Total							
Structural panels							
Plywood	366.0	822.6	0.83				
OSB/waferboard	73.6	165.4	0.17				
Total, structural	439.6	987.9	1.00				
Nonstructural panels	15.7	35.2	0.04				
Total, all panels	455.3	1,023.2	1.03				