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THE PULP AND PAPER INDUSTRY IN THE NORTHWEST

By

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B.S., Quincy College, 1966

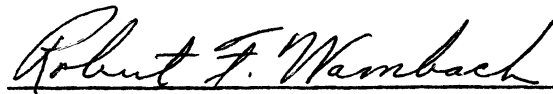
Presented in partial fulfillment of the requirements for the degree of

Master of Forestry


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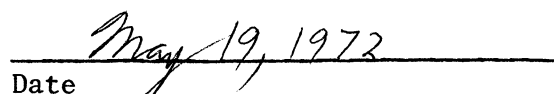
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Chapter 1

INTRODUCTION

In recent years, national, state and local authorities have placed considerable emphasis on industrialization as a key to economic development. This may be especially true in the Northwest¹ where the economies of many local areas are largely dependent upon declining agricultural and/or mining activities.

One candidate for consideration by such authorities is the pulp and paper industry. In the first place, increasing emphasis on such things as communication, education, data processing and product packaging has provided an expanding market for this industry's products. For example, per capita consumption of pulpwood² in the United States has increased from practically none to nearly 41 cubic feet in a little over 100 years. Per capita consumption of woodpulp has increased to nearly 410 pounds, and paper and board to almost 560 pounds during this same period (Table 1). As a result, the pulp and paper industry has emerged as one of the most significant of the forest products industries.

¹In this paper the Northwest region includes Oregon, Washington, Idaho and Montana.

²Pulpwood includes roundwood and by-products or residues from lumber, plywood and small dimension stock mills used in the production of woodpulp. Woodpulp is pulp which is produced either from softwood or hardwood trees or both by mechanical or chemical means or a combination of the two. It is the material from which paper and paperboard products are manufactured.

Table 1. Per capita consumption of pulpwood, woodpulp, paper and board in the United States, 1869-1970.^a

	Pulpwood (cubic feet)	Woodpulp (pounds)	Paper and Board (pounds)
1869	0.0 ^b	0.0 ^b	19.8
1879	0.1	0.9	18.4
1889	1.2	9.9	30.3
1899	3.4	32.5	58.0
1910	5.7	65.6	88.8
1920	7.4	88.2	143.5
1930	7.5	104.2	200.2
1940	13.3	146.5	253.0
1950	19.9	217.4	382.1
1955	25.9	260.0	420.7
1960	28.8	285.6	434.9
1965	34.3	350.9	506.7
1970	40.6	408.7	558.5

^aSource: Adapted from U.S. Bureau of the Census, Historical Statistics of the United States, Colonial Times to 1957 (Washington: Government Printing Office, 1960); and U.S. Bureau of the Census, Statistical Abstract of the United States: 1971 (92d ed.; Washington: Government Printing Office, 1971).

^bData rounded to one decimal. Actual consumption was 0.007 cubic feet for pulpwood and 0.051 pounds for woodpulp.

Secondly, the Northwest region is well suited to the production of wood fiber. Forests accounted for 39 percent of all land in this region in 1962, of which 81 percent was commercial forest. Softwoods predominated, covering 94 percent of the region's commercial forests. Although only 11 percent of the land area in the United States is located in the Northwest, this region had 15.6 percent of the United States commercial forest land in 1962, and 19 percent of the total pulpwood supply in the United States in the same year (Table 2).

Objectives

Economic relationships existing in the pulp and paper industry are neither well defined nor well understood. Empirical analyses of the importance and structure of this industry are few in number and limited primarily to analyses for specific regions and sectors such as the pulpwood procurement sector (see Blyth, 3; and, Bones and Dickson, 4).

The objectives in this study are: 1) to outline some of the structural characteristics of the pulp and paper industry, 2) to analyze the contribution of this industry to the economy of the Northwest, and 3) to examine this industry's likely future in the Northwest.

This paper is not intended to provide complete answers for all questions concerning the pulp and paper industry in the Northwest. It will not, for example, provide in-depth information on questions concerning economics of plant location, economies of size, efficiency of production, concentration of market power or profitability of individual mills. It is recognized that these are important questions deserving attention in future research, but they are beyond the scope of this paper.

Table 2. Total land area, forest land and pulpwood supply in the Northwest, 1962.^a

	Total Land Area (1000 acres)	Forest Land (1000 acres)				Pulpwood Supply ^b	
		Total	Commercial	Reserved	Unproductive	Softwoods (1000 cords)	Hardwoods
Oregon	61,599	30,739	26,613	681	3,445	2,013	115
Washington	42,694	23,050	19,510	1,312	2,228	4,813	304
Idaho	52,933	21,815	15,823	1,867	4,125	592	... ^c
Montana	93,271	22,048	17,300	1,356	3,392	367	...
Total Northwest	250,497	97,652	79,246	5,216	13,190	7,785	419
Total United States	2,271,343	758,865	508,845	16,008	234,012	33,212	9,914
Northwest as percent of United States	11.0%	12.9%	15.6%	32.6%	5.6%	23.4%	4.2%

^aSource: Adapted from U.S. Department of Agriculture, Timber Trends in the United States, Forest Resource Report No. 17 (Washington: Government Printing Office, 1965).

^bIncludes roundwood and plant by-products.

^cRepresents zero.

Chapter 2

ECONOMIC IMPORTANCE OF THE PULP AND PAPER INDUSTRY

To measure an industry's economic importance, it is necessary to determine its direct contribution to the total output of the economy as well as its contribution to other industries producing a portion of that total output. It is also important to know what proportion of the economy's labor force is employed by that industry. This section, therefore, will be devoted to a description of the pulp and paper industry in the Northwest in terms of products produced and industries served, number and types of plants located in the region, contribution to total output of the region, and contribution to employment.

The pulp and paper industry, for the purposes of this paper, includes all firms producing woodpulp and/or finished paper or board products. Activities related to the transportation of pulpwood, woodpulp, various paper and board products, associated retailing or service activities are not included.¹

Woodpulp Production and Utilization

Woodpulp is the basic raw material used in the production of finished products in the pulp and paper industry. Basically, there are seven different types of woodpulp--dissolving and special alpha; sulfite;

¹For consideration of these activities see Hair (7).

sulfate; soda; groundwood; semichemical; defibrated, exploded and screenings.² Both softwoods and hardwoods are used in the manufacture of each type. Softwood produces pulp with excellent strength characteristics due to its long fiber lengths while hardwood, with its shorter length fibers, provides excellent bulking or matting qualities for a smooth texture in book and fine writing paper and softness and absorbency in tissue paper and toweling.

Although softwood predominates in the majority of pulp manufacturing processes, technological advances in recent years, spurred on by the higher yield obtainable per unit of hardwood, have increased the importance of this latter type within the industry. The result has been a gradual increase in the amount of hardwood utilized in pulp production (Table 3). As may be expected, due to the relatively low supply of hardwood in this region, the Northwest does not utilize as large a percentage of hardwood as the Lake States, the Northeast or the South.

Dissolving and special alpha pulps are highly refined bleached white sulfite or sulfate pulps with a high content of alpha or pure cellulose fibers. They are used primarily in the manufacture of such nonpaper products as plastics, rayon, cellophane and explosives.

Sulfite pulp is used either bleached or unbleached in nearly all classes of papers. Although some bleached sulfite pulp is made from hardwoods, it is usually manufactured from softwoods of low resin content, such as spruce, fir and hemlock by dissolution of the lignin with calcium bisulfite cooking acid.

²See Libby (10); and, Macdonald and Franklin (11) for detailed descriptions of the pulping processes.

Table 3. Proportion of softwood to hardwood pulpwood consumed in the manufacture of woodpulp in the United States, 1950-1970.^a

	Softwood	Hardwood
	(percent)	
1950	86.4	13.6
1955	83.1	16.9
1960	79.2	20.8
1961	78.4	21.6
1962	77.6	22.4
1963	76.8	23.2
1964	77.6	22.4
1965	76.3	23.7
1966	76.2	23.8
1967	76.3	23.7
1968	76.0	24.0
1969	75.2	24.8
1970	74.6	25.4

^aSource: U.S. Bureau of the Census, Statistical Abstract of the United States: 1971 (92d ed.; Washington: Government Printing Office, 1971).

Sulfate pulp is the term commonly used for all grades of pulp cooked by the process in which the makeup chemical is essentially sodium sulfate. Sodium sulfide is the product of reduction of the sodium sulfate in the recovery furnace where this makeup chemical is added. Unbleached sulfate pulp is brown in color and is used in making wrapping paper, paper bags, and container and liner boards where physical strength is of primary importance and dark color is not objectionable. Bleached and semibleached sulfate pulps are used in the manufacture of some of the same products, but are seeing increased use in writing, book, absorbent tissue and wax papers. Although the stronger grades are made from softwood, large quantities of hardwood pulp are used in this latter group as a finer texture is desirable and more hardwood can be tolerated in its manufacture.

Soda pulp is the term used for the pulp in which the active cooking agent is caustic soda, the digestion taking place at fairly high temperatures. It is made principally from hardwoods such as aspen, birch, maple, gum and tulip poplar. Upon bleaching it reaches a fairly white color. Generally, due to the natural shortness of the fibers from which it is manufactured, it possesses very little physical strength but imparts the desirable properties of smoothness, bulk, opacity and the uniformity required for printing. Some soda pulp is also produced from softwoods. The pulp is soft in texture and is stronger than that produced from hardwoods.

Groundwood, or mechanical pulp, is produced by taking short logs after they have been barked and cleaned, and forcing them sideways against a rapidly revolving grindstone. This process utilizes nearly

all of the wood fiber in the log, both cellulose and lignin, while the chemical processes described above dissolve the lignin to varying degrees so that the yield of chemical pulp is about one half of that obtained in the mechanical process. Since the fibers are literally torn from the pulpwood in this process, they vary in length and composition, and discolor in time on exposure to light and air. The wood is usually softwood but hardwood is used in some pulps. Groundwood pulp is used to make paper where permanence and strength are not needed, but where absorbency, bulk and opacity are sought, as in newsprint.

Semichemical pulp is so-called because only a portion of the ligneous part of the wood is removed during cooking, and consequently, high yields are obtained from this process. The term "semichemical" indicates a relatively mild degree of cooking, such as a quick-cook sulfite or sulfate cook, and is not specific to any one chemical pulping process. After cooking, the softened chips are mechanically disintegrated by a suitable refiner. Semichemical pulp is used to produce board and coarse, heavy building paper and felt.

Defibrated pulp is produced mechanically by means of a machine known as a defibrator. Wood chips are continuously fed into a steam-heated chamber and the mechanical separation of the fibers occurs at elevated temperatures. Exploded pulp is produced by subjecting wood chips to very high steam pressure for a short time, usually less than a minute. Sudden release of the pressure produces a violent internal explosion in the cell spaces of the wood, tearing the fibers apart. Screenings are the rejects and off-quality materials removed from unbleached wood pulp of all grades except dissolving pulp. Defibrated and

exploded pulps and screenings are used in the manufacture of hardboard, insulating board and roofing felt. The proportion of softwood to hardwood consumed in each of the above pulping processes is shown in Table 4.

Total woodpulp production and the relative importance of the different types of pulp in the United States and the West are shown in Tables 5 and 6 for selected years between 1960 and 1969. Table 7 is a further refinement of these data, indicating the West's contribution to the nation as a whole for each type of pulp produced.

It should be noted, that while the data in Tables 6 and 7 are not a true representation of the Northwest's woodpulp production per se, they do establish a general trend for the region.³ In the West, as well as the United States, total woodpulp production and production per capita have increased since 1960. Furthermore, increases in woodpulp production in the West have remained slightly ahead of those in the nation as a whole. Total woodpulp production in the West in 1969 exceeded that of 1960 by 72.4 percent while the comparable figure for the entire United States was 71.5 percent.

In terms of tonnage produced, the most important types of pulp for the nation are the sulfate pulps. As measured by the percentage of total pulp produced in the United States, they have been increasing in relative importance since 1960. Increasing demand for products manufactured from the sulfate pulps would seem to be a trend continuing well into the next decade (see Chapter 3). Although data limitations prevent

³Certain states consider this proprietary information and do not disclose the actual production figures. Consequently, specific data for the Northwest are not available.

Table 4. Proportion of softwood to hardwood pulpwood consumed in the production of various types of woodpulp in the United States, 1969.^a

	Softwood	Hardwood
	(percent)	
Dissolving and special alpha	b	b
Bleached sulfite	69.0	31.0
Soda and unbleached sulfite	b	b
Bleached and semibleached sulfate	66.3	33.7
Unbleached sulfate	91.0	9.0
Groundwood	85.8	14.2
Semichemical	8.4	91.6
Defibrated, exploded and screenings	54.0	46.0
Total, all processes	75.2	24.8

^aSource: U.S. Bureau of the Census, Current Industrial Reports Series M26A-13, Pulp, Paper, and Board: 1969 (Washington: Government Printing Office, 1971).

^bInformation withheld to avoid disclosing data for individual companies.

Table 5. Production of various types of woodpulp in the United States as a percent of total U.S. woodpulp production and total U.S. woodpulp production per capita, 1960-1969.^a

	1960	1965	1969
		(percent)	
Dissolving and special alpha	4.5	4.4	3.9
Sulfite	10.2	7.9	5.3
Sulfate	57.6	63.3	67.3
Soda	1.6	0.7	0.6
Groundwood	13.0	10.4	10.2
Semichemical	7.9	8.5	8.4
Defibrated, exploded and screenings	5.2	4.8	4.3
Total production, all processes			
1000 short tons	25,316	33,921	43,416
Tons per capita	0.125	0.175	0.216

^aSource: U.S. Bureau of the Census, Current Industrial Reports Series M26A-13, Pulp, Paper, and Board: 1960, 1966, 1969 (Washington: Government Printing Office, 1962, 1968, 1971).

Table 6. Production of various types of woodpulp in the West as a percent of total West woodpulp production and total West woodpulp production per capita, 1960-1969.^a

	1960	1965	1969
		(percent)	
Dissolving and special alpha	11.7	11.1	10.3
Sulfite	26.5	19.7	14.5
Sulfate	41.9	51.5	56.8
Soda	... ^b	...	...
Groundwood	10.6	9.0	10.1
Semichemical	3.3	3.5	4.0
Defibrated, exploded and screenings	6.0	5.2	4.4
Total production, all processes			
1000 short tons	4,644	6,666	8,004
Tons per capita	0.164	0.208	0.236

^aSource: U.S. Bureau of the Census, Current Industrial Reports Series M26A-13, Pulp, Paper, and Board: 1960, 1966, 1969 (Washington: Government Printing Office, 1962, 1968, 1971).

^bRepresents zero.

Table 7. Production of woodpulp in the West as a percent of United States production for each type of pulp, 1960-1969.^a

	1960	1965	1969
		(percent)	
Dissolving and special alpha	47.9	49.8	49.0
Sulfite	47.8	48.9	50.3
Sulfate	13.3	16.0	15.6
Soda	... ^b	...	...
Groundwood	14.9	16.7	18.2
Semichemical	7.7	8.2	8.7
Defibrated, exploded and screenings	21.3	21.1	18.7
Total for all processes	18.3	19.6	18.4

^aSource: U.S. Bureau of the Census, Current Industrial Reports Series M26A-13, Pulp, Paper, and Board: 1960, 1966, 1969 (Washington: Government Printing Office, 1962, 1968, 1971).

^bRepresents zero.

any precise statements, it appears that, in 1969, the most important pulp for the Northwest was also sulfate, with sulfite in second place.

The number of pulp mills located in various states of the Northwest, together with their pulping capacity, is shown in Table 8 for the years 1955 and 1965 (data for years following 1965 are unavailable).

Several points are clear from these data. First, with the exception of soda pulp, the Northwest has the capability to produce all of the major types of pulp, but has substantially greater capacity to produce sulfate, sulfite and groundwood pulps, in that order.

Second, total pulping capacity in the Northwest has increased at a slightly faster pace than that of the United States as a whole. Between 1955 and 1965, the Northwest's capacity increased by 72.9 percent while the comparable figure for the United States was 69.2 percent. Accordingly, the Northwest's pulping capacity, as a percent of the total United States pulping capacity, rose from 15.9 percent in 1955 to 16.4 percent in 1965.

Third, the number of pulp mills in the Northwest increased by 16.7 percent while the number of pulp mills in the United States increased by only 6.8 percent during this same 10 year period.

Finally, the data in Table 9 suggest that pulp mills are becoming larger in the United States as a whole, the largest of all being the sulfate mills. While the average size of sulfate mill in the United States continues to exceed the average throughout the Northwest, it appears that the Northwest has reduced this lead by a significant margin between 1955 and 1965.

Table 8. Number and pulping capacity (tons per 24 hours) of woodpulp mills in the Northwest and the United States, 1955-1965.^a

		Total		Sulfite		Sulfate		Soda	
		Mills	Capacity	Mills	Capacity	Mills	Capacity	Mills	Capacity
Oregon	1955	16	2,412	6	660	2	575	... ^b	...
	1965	20	5,370	6	810	5	3,265	...	...
Washington	1955	31	7,087	13	3,392	7	2,655	...	...
	1965	34	10,350	13	3,920	8	4,755	...	...
Idaho	1955	1	400	...	...	1	400	...	...
	1965	1	700	...	...	1	700	...	...
Montana	1955	...	...	...	...	...	...	...	...
	1965	1	700	...	...	1	700	...	...
Northwest	1955	48	9,899	19	4,052	10	3,630	...	...
	1965	56	17,120	19	4,730	15	9,420	...	...
Total United States	1955	323	61,798	67	10,018	70	32,264	13	1,645
	1965	345	104,595	61	11,550	99	63,595	7	1,125
Northwest as percent of United States	1955	13.9%	15.9%	28.4%	40.4%	14.3%	11.2%	...	...
	1965	16.2%	16.4%	31.1%	41.0%	15.2%	14.8%	...	...

^aSource: U.S. Department of Agriculture, Forest Service, Woodpulp Mills in the United States and Canada (Washington: U.S. Department of Agriculture, Forest Service, 1955, 1965).

^bRepresents zero.

Table 8. (Continued)

		Groundwood ^c		Semichemical		Miscellaneous ^d	
		Mills	Capacity	Mills	Capacity	Mills	Capacity
Oregon	1955	2	595	...	...	6	582
	1965	2	685	2	280	5	330
Washington	1955	8	830	1	100	2	110
	1965	9	1,175	4	500	...	...
Idaho	1955	...	...	...	...	...	...
	1965	...	...	...	...	...	...
Montana	1955	...	...	...	...	...	...
	1965	...	...	...	...	...	...
Northwest	1955	10	1,425	1	100	8	692
	1965	11	1,860	6	780	5	330
Total United States	1955	93	9,558	39	4,970	41	3,342
	1965	80	13,310	48	9,605	49	5,410
Northwest as percent of United States	1955	10.8%	14.9%	2.6%	2.0%	19.5%	20.7%
	1965	13.8%	14.0%	12.5%	8.1%	10.2%	6.1%

^cIncludes chemi-groundwood.

^dIncludes mills producing defibrated and exploded types of pulp used largely in the manufacture of insulating board, hardboard and roofing felt. Mills manufacturing particle board are not included.

Table 9. Average mill capacity (tons per 24 hours) of woodpulp mills in the Northwest and the United States, 1955-1965.^a

		All Mills	Sulfite	Sulfate	Soda	Ground-wood	Semi-chemical	Misc.
Oregon	1955	150.8	110.0	287.5	... ^b	297.5	...	97.1
	1965	268.5	135.0	653.0	...	342.5	140.0	66.0
Washington	1955	228.6	260.9	379.3	...	103.8	100.0	55.0
	1965	304.4	301.5	594.4	...	130.6	125.0	...
Idaho	1955	400.0	...	400.0	...	...	...	...
	1965	700.0	...	700.0	...	...	...	...
Montana	1955	...	...	...	...	...	...	...
	1965	700.0	...	700.0	...	...	...	...
Northwest	1955	206.2	213.3	363.0	...	142.5	100.0	86.6
	1965	305.7	248.9	628.0	...	169.1	130.0	66.0
United States	1955	191.3	149.5	460.9	126.5	102.8	127.4	81.5
	1965	303.2	189.3	642.4	160.7	166.4	200.1	110.4
Northwest as percent of United States	1955	107.8%	142.7%	78.8%	...	138.6%	78.5%	106.2%
	1965	100.8%	131.5%	97.8%	...	101.6%	65.0%	59.8%

^aSource: U.S. Department of Agriculture, Forest Service, Woodpulp Mills in the United States and Canada (Washington: U.S. Department of Agriculture, Forest Service, 1955, 1965).

^bRepresents zero.

Production of Finished Products

In addition to woodpulp, the pulp and paper industry produces literally thousands of products ranging from fine stationeries and industrial papers to materials for the construction trades. Classified according to three major categories, the percent increase in production of these products, in the United States and the West, between 1960 and 1969, is shown in Table 10. A further breakdown of the production of paper and board products in the United States is shown in Table 11 for selected years between 1960 and 1969.

As in the case of woodpulp production, production of paper and board products in the West has increase since 1960. This holds true not only in the aggregate, but also in each of the major categories of paper and board products (Table 10).

Table 10. Percent increase in production of major paper and board categories in the United States and the West between 1960 and 1969.^a

	United States	West
	(percent)	
Paper	52.5	76.2
Paperboard ^b	65.3	109.5
Construction Paper and Board	36.5	42.0
Total	56.9	87.1

^aSource: U.S. Bureau of the Census, Current Industrial Reports Series M26A-13, Pulp, Paper, and Board: 1960, 1969 (Washington: Government Printing Office, 1962, 1971).

^bIncludes wet machine board.

Table 11. Production of paper and board in the United States, 1960-1969.^a

	1960	1965	1969
	(1000 short tons)		
Paper	15,414	19,114	23,505
Newsprint	2,004	2,170	3,253
Groundwood	931	1,041	1,215
Coated printing and converting	1,874	2,752	3,345
Uncoated book	1,862	2,113	2,668
Fine	1,771	2,442	4,001
Coarse and industrial	4,754	5,690	5,524
Sanitary and tissue	2,218	2,906	3,499
Paperboard	15,835	21,010	26,170
Container board	8,649	12,331	16,808
Folding boxboard	2,904	3,452	4,310
Special food board	1,478	1,880	1,984
Other board ^b	2,804	3,347	3,068
Construction Paper and Board	3,211	3,925	4,384
Construction paper	1,422	1,575	1,573
Insulating and hardboard	1,789	2,350	2,811
Total Paper and Board	34,460	44,049	54,059

^aSource: U.S. Bureau of the Census, Current Industrial Reports Series M26A-13, Pulp, Paper, and Board: 1960, 1966, 1969 (Washington: Government Printing Office, 1962, 1968, 1971).

^bIncludes tube, can and drum stock, building board stock, setup boxboard, cardboard and wet machine board.

Again, the reader is cautioned to observe that these data in Table 10 are representative of the West in the aggregate, rather than the Northwest, specifically. While all of the data for the Northwest are not available for disclosure, it is known that, in 1969, Oregon and Washington, collectively, accounted for 9.6 percent of all paper and board products produced in the United States and 11.2 percent of all products classified as paper.

Most firms in the United States operating a pulp mill also operate a paper or board mill at the same location. These establishments are termed "integrated" pulp and paper mills. A detailed breakdown of the number of manufacturing establishments in various sectors of the pulp and paper industry is provided by the Census of Manufacturers (18). These data are shown in Table 12 for the United States and the Northwest in 1963 and 1967.

Markets Served

In the preceding section, the nature of the pulp and paper industry from the standpoint of firms involved and products produced was indicated. To gain a full appreciation of the nature of the market for this industry's output, it is necessary to examine the interdependence of the pulp and paper industry with the rest of the economy. For this purpose, the U.S. Department of Commerce's (24) input-output analysis of the 1963 Census of Manufacturers is used.

Input-output analysis is a tool of economic analysis which provides quantitative estimates of the links between the final demand sectors of the economy and the outputs of all industries or sectors

Table 12. Number of establishments in various sectors of the pulp and paper industry in the Northwest and the United States, 1963 and 1967.^a

	SIC ^b Code	1963		1967	
		United States	Northwest	United States	Northwest
Paper and Allied Products	26	5,713	144	5,887	150
Pulpmills	2611	45	12	61	13
Pulpmills, except building paper	2621	325	16	354	19
Paperboard mills	2631	271	12	282	14
Paper coating and glazing	2641	387	6	397	6
Envelopes	2642	230	3	228	3
Bags, except textile bags	2643	586	13	557	10
Wallpaper	2644	79	1	75	1
Die-cut paper and board	2645	425	6	440	6
Pressed and molded pulp goods	2646	59	4	58	5
Sanitary paper products	2647	119	7	125	8
Converted paper products N.E.C.	2649	610	15	610	14
Folding paperboard boxes	2651	636	12	569	10
Setup paperboard boxes	2652	503	6	454	7
Corrugated and solid fiber boxes	2653	923	13	1,071	17
Sanitary food containers	2654	186	7	244	8
Fiber cans, drums and rel. mtl.s.	2655	246	4	268	3
Building paper and board mills	2661	83	7	94	6

^aSource: U.S. Bureau of the Census, Census of Manufacturers, 1963, 1967 (Washington: Government Printing Office, 1966, 1971).

^bStandard Industrial Classification code.

within the economy. Consequently, it brings into focus the anticipated repercussions of changes in final demand on the output of each industry. Specifically, input-output analysis permits the identification of industries which are affected directly and indirectly by specified changes in consumer expenditures, imports or exports, level of defense spending, or level of government expenditures for such programs as education or road building.

The uses of input-output analysis are quite varied. In the first place, once the level of final demand for each industry or sector is specified, the level of output required to meet this final demand can be determined. In such a calculation, all direct demands, as well as all intermediate demands, will be considered. For example, the direct demands of final consumers for the output of the pulp and paper industry will be considered as well as the demands of the food industry, the lumber industry, the printing and publishing industry, and others, for the output of the pulp and paper industry needed to produce their own output.

Also, by the use of data on employment required per unit of output, the output requirements of each industry can be translated into requirements for employment. Similar information on capital and capacity can be translated into needs for additional plants and equipment.

In the Department of Commerce's input-output study, all productive activities in the United States were grouped into 86 industries, in large part, according to the Standard Industrial Classification code (16). In addition, six sectors were defined to represent final demand:

- 1) personal consumption expenditures;
- 2) gross private fixed capital formation;
- 3) net inventory change;
- 4) net exports;
- 5) federal

government purchases; and 6) state and local government purchases.

The pulp and paper industry was divided into two sectors:

1) paper and allied products, except containers (Standard Industrial Classification codes 2611, 2621, 2631, 2641-2649 and 2661); and 2) paperboard containers and boxes (Standard Industrial Classification codes 2651-2655).

Table 13 indicates the direct distribution of the output of these two sectors to a regrouping of the remaining 84 sectors and the six final demand sectors. This table shows that the pulp and paper industry is the paper and allied products sector's best customer. Slightly more than 31 percent of this sector's product went to the pulp and paper industry. This reflects, in part, the interplant transfers of semi-finished products which are counted as sales in the Census of Manufacturers and, in part, the sales of woodpulp to nonintegrated paper and board mills. But it also reflects the fact that the pulp and paper industry is, itself, an important consumer of many of its own products, including wrapping and packaging paper and board, as well as printing and writing papers.

Outside the pulp and paper industry, the most important market for the paper and allied products sector is the printing and publishing sector. The food and kindred sector, the wholesale and retail trade sector, and the chemicals sector, in that order, were also significant users of the products of the paper and allied products sector.

Shipments of paperboard containers and boxes exhibited quite a different pattern. The transfer problem is minimal here, partly because of the less aggregative nature of this sector, and partly, because of

Table 13. Distribution of the pulp and paper industry's output among selected productive and final demand sectors in the United States, 1963.^a

	Paper and Allied Products	Paperboard Containers and Boxes
	(percent)	
Productive Sectors		
Agriculture, forestry and fisheries	0.10	1.92
Mining	0.08	... ^b
Construction	2.13	0.08
Food and kindred	6.88	23.96
Tobacco	0.27	1.92
Textiles	1.02	5.33
Lumber, wooden containers and furniture	0.24	2.21
Paper and allied products	17.22	8.25
Paperboard containers and boxes	14.40	2.86
Printing and publishing	20.04	1.92
Chemicals, plastics and drugs	3.71	7.26
Petroleum	0.78	1.28
Rubber	0.40	3.39
Glass, stone and clay	1.14	3.68
Metals	0.94	5.41
Machinery, electrical	0.97	4.44
Wholesale and retail trade	5.96	12.21
Finance, insurance and real estate	1.70	0.15
Services	1.46	0.82
All others	6.29	8.73
Final Demand Sectors		
Personal consumption	9.46	1.56
Net inventory change	0.69	0.69
Net exports	3.42	0.48
Federal government purchases	0.36	0.21
State and local government purchases	0.34	1.24

^aSource: U.S. Department of Commerce, Office of Business Economics, Survey of Current Business, Vol. 49, No. 11 (Washington: Government Printing Office, 1969)

^bRepresents less than 0.005%.

the more "finished" nature of the output of this sector. The food and kindred products sector, the wholesale and retail trade sector, the paper and allied products sector, and the chemicals sector, in that order, were the most important users of the output of the paperboard containers and boxes sector.

Also included in Table 13 are data showing the distribution of output directly to the various categories of final demand. While these data are not very impressive, they only tell part of the story. For example, when consumer demand for the output of the food industry increases, this sets off a series of chain reactions throughout the economy. The increased output required of the food industry calls for an increase in demand for paper containers, as well as for an increase in demand for output from the chemical industry, which, in turn, calls for an increase in demand for paper containers, and so on. These are, in the language of input-output analysis, "indirect" demands, that is, the demand for output of some sectors which is generated from other sectors in the economy. Consequently, the total output of any one sector, required to meet the specified final demand of all sectors, consists of the direct demand plus the sum of all "indirect" demands. These data, expressed in percentages, are shown in Table 14 for the two sectors of the pulp and paper industry.

It is clear that the pulp and paper industry is heavily dependent on other industries in the economy, not directly on consumers.

Table 14. Total, direct and indirect demand for the output of the pulp and paper industry required to meet each category of final demand in the United States, 1963.^a

Final Demand Category	Paper and Allied	Paperboard Containers
	Products	and Boxes
	(percent)	
Personal Consumption Expenditures		
Total demand	69.1	72.2
Direct	9.5	1.6
Indirect	59.6	70.6
Capital Formation		
Total demand	9.4	10.3
Direct	0.0	0.0
Indirect	9.4	10.3
Net Inventory Change		
Total demand	2.0	2.2
Direct	0.7	0.7
Indirect	1.3	1.5
Gross Exports		
Total demand	7.9	5.4
Direct	3.4	0.5
Indirect	4.5	4.9
Federal Government Purchases		
Total demand	5.8	5.1
Direct	0.4	0.2
Indirect	5.4	4.9
State and Local Government Purchases		
Total demand	5.7	4.8
Direct	0.3	1.2
Indirect	5.4	3.6

^aSource: U.S. Department of Commerce, Office of Business Economics, Survey of Current Business, Vol. 49, No. 11 (Washington: Government Printing Office, 1969).

Value Added and Employment

"Value added by manufacture" reflects net additions to the value of goods effected by the processes of the manufacturing establishment. It is computed by subtracting the cost of materials, supplies, containers, fuel and electricity, as well as any contract work done by others, from the value of shipments of products manufactured plus receipts for services. Thus defined, "value added by manufacture" measures the sum of an industry's payments for wages, interest, rent and profit, that is, an industry's contribution to the economy.

Value added for the pulp and paper industry, expressed as a percent of the total value added by manufacture in the indicated region, is shown in Table 15 for selected years between 1954 and 1969. Similar data are presented in Table 16 for employment. Three additional industries have been included in these tables for comparison purposes.

Two points are brought out in these tables. First, the relative contribution of the pulp and paper industry, both in terms of value added by manufacture and in terms of employment, has remained quite stable during the period 1954-1969. Secondly, as compared with other industries, the pulp and paper industry contributes significantly to the total economy of the Northwest, as well as to the economy of the entire United States.

Table 15. Value added by manufacture for selected industries in the Northwest and the United States as a percent of total value added by manufacture in the region, 1954-1969.^a

		Food and Kindred Products 20 ^b	Lumber and Wood Products 24 ^b	Paper and Allied Products 26 ^b	Printing and Publishing 27 ^b
(percent)					
1954	United States	13.2	2.7	3.9	5.4
	Northwest	15.1	34.9	9.8	3.8
1958	United States	12.4	2.2	4.0	5.6
	Northwest	16.0	25.1	9.3	3.7
1963	United States	11.4	2.1	3.8	5.4
	Northwest	14.9	24.1	8.8	3.4
1967	United States	10.2	1.9	3.7	5.5
	Northwest	14.2	21.3	8.0	3.4
1969	United States	9.9	2.1	3.7	5.4
	Northwest	12.2	21.3	7.2	3.0

^aSource: Adapted from U.S. Bureau of the Census, Census of Manufacturers, 1954, 1958, 1963, 1967 (Washington: Government Printing Office, 1957, 1961, 1966, 1971); and U.S. Bureau of the Census, Annual Survey of Manufacturers: 1969 (Washington: Government Printing Office, 1971).

^bStandard Industrial Classification code.

Table 16. Employment in selected industries in the Northwest and the United States as a percent of all employees in manufacturing firms in the region, 1954-1969.^a

		Food and Kindred Products 20 ^b	Lumber and Wood Products 24 ^b	Paper and Allied Products 26 ^b	Printing and Publishing 27 ^b
(percent)					
1954	United States	10.2	4.0	3.3	5.0
	Northwest	15.2	37.9	5.9	4.1
1958	United States	10.6	3.6	3.5	5.4
	Northwest	14.6	31.9	5.7	4.2
1963	United States	9.7	3.3	3.5	5.4
	Northwest	14.2	31.2	6.2	4.0
1967	United States	8.5	2.9	3.3	5.3
	Northwest	13.3	26.8	5.8	3.8
1969	United States	8.3	2.8	3.3	5.4
	Northwest	13.1	26.2	5.6	4.0

^aSource: Adapted from U.S. Bureau of the Census, Census of Manufacturers, 1954, 1958, 1963, 1967 (Washington: Government Printing Office, 1957, 1961, 1966, 1971); and U.S. Bureau of the Census, Annual Survey of Manufacturers: 1969 (Washington: Government Printing Office, 1971).

^bStandard Industrial Classification code.

Chapter 3

PULP AND PAPER'S FUTURE

As measured by the demands for its products, the future for the pulp and paper industry looks quite promising (see Hair, 8; Resources for the Future, Inc., 14; Stanford Research Institute, 15; and, U.S. Department of Agriculture, 22). Based largely on consumption, population and income trends in the post World War II period, Hair (8) has projected substantial increases in demand for all major types of paper and board products (Table 17), as well as all types of woodpulp, except soda, (Table 18) to 1985.

The demand for paper and board products emanates from several sources, as illustrated in the section dealing with input-output analysis. The demand for a commodity is, in most cases, dependent upon the price of the commodity, as well as consumer income.

The projections shown in Tables 17 and 18 were made, however, on the basis of many simplifying assumptions. This approach was taken, in part, because of data limitations and, in part, because it was felt that consumer or national income and population growth are the two variables that would be most indicative of future consumption levels.

As indicated earlier, the pulp and paper industry is closely integrated with the rest of the economy and is not highly dependent upon one or a very few other sectors. Consequently, the pulp and paper industry's future can, to a large extent, be expected to rise and fall

Table 17. Consumption of paper and board in the United States, 1950-1970, with projections to 1985.^a

	1950	1955	1960	1965	1970	1975	1980	1985
	(million tons)							
Paper	15.5	17.9	20.6	25.1	29.7	35.9	42.5	49.7
Newsprint	5.9	6.5	7.4	8.4	9.8	11.0	12.5	14.3
Groundwood	0.7	0.9	0.9	1.0	1.4	1.3	1.4	1.5
Coated printing and converting	1.0	1.3	1.8	2.8	3.3	5.0	6.3	7.8
Uncoated book	1.6	1.8	1.9	2.2	2.6	2.8	3.2	3.6
Fine	1.2	1.4	1.7	2.4	3.8	3.7	4.6	5.6
Coarse and industrial	3.7	4.2	4.7	5.5	5.2	7.4	8.6	9.8
Sanitary and tissue	1.4	1.8	2.2	2.8	3.6	4.7	5.9	7.1
Paperboard	11.1	14.0	15.3	19.9	23.0	30.5	36.8	44.2
Container board	5.8	7.4	8.2	11.3	13.7	18.2	22.4	27.4
Folding boxboard	2.5	2.8	2.9	3.3	3.6	4.7	5.3	6.0
Special food board	0.7	1.2	1.5	2.1	2.4	3.7	4.6	5.6
Other board ^b	2.1	2.6	2.7	3.2	3.3	3.9	4.5	5.2
Construction Paper and Board	2.6	3.3	3.3	4.1	4.3	5.7	6.6	7.6
Construction paper	1.4	1.6	1.4	1.6	1.5	1.8	1.9	2.0
Insulating and hardboard	1.2	1.7	1.9	2.5	2.8	3.9	4.7	5.6
Total Paper and Board	29.2	35.2	39.2	49.1	57.0	72.1	85.9	101.5

^aSource: Adapted from Dwight Hair, Use of Regression Equations for Projecting Trends in Demand for Paper and Board, Forest Resource Report No. 18 (Washington: U.S. Department of Agriculture, Forest Service, 1967); and American Paper Institute, The Statistics of Paper (1971 ed.; New York: American Paper Institute, 1971).

^bIncludes tube, can and drum stock, building board stock, setup boxboard, cardboard and wet machine board.

Table 18. Consumption of woodpulp in the United States, 1950-1970, with projections to 1985.^a

	1950	1955	1960	1965	1970	1975	1980	1985
	(million tons)							
Total Woodpulp	17.2	22.3	26.6	35.1	42.7	57.5	71.3	86.4
Dissolving and special alpha ^b	0.7	1.0	1.0	1.2	1.2	1.7	2.0	2.2
Sulfite	3.2	3.2	3.1	3.3	2.4	3.5	3.7	3.8
Sulfate	8.4	11.9	15.2	21.7	29.4	38.0	47.8	59.0
Soda	0.6	0.5	0.4	0.2	0.2	0.2	0.2	0.2
Groundwood	2.5	3.0	3.6	4.3	4.6	5.7	6.7	7.7
Semichemical	0.7	1.4	2.0	2.9	3.3	6.4	8.6	10.9
Defibrated, exploded and screenings	1.1	1.3	1.3	1.5	1.6	2.0	2.3	2.6

^aSource: Adapted from Dwight Hair, Use of Regression Equations for Projecting Trends in Demand for Paper and Board, Forest Resource Report No. 18 (Washington: U.S. Department of Agriculture, Forest Service, 1967); and American Paper Institute, The Statistics of Paper (1971 ed.; New York: American Paper Institute, 1971).

^bIncludes a number of highly purified types of woodpulp obtained from the sulfite and sulfate pulping processes.

with that of the entire economy. Therefore, a rather high degree of association would be expected between consumption of paper and board products and consumer income or gross national product.

This was verified in the study yielding the projections shown in Tables 17 and 18. These projections could be substantially in error, however, if and when structural changes occur in the economy. Such changes as may occur include technological developments in the pulp and paper industry itself, technological developments in other industries which may have tremendous impact on the demand for paper and board, and changes in consumer tastes and/or product prices.

In this connection, it is important to note one interesting phenomenon of this industry in recent years. While there have been relatively large increases in consumption of most grades of paper and board, prices of these items have not exhibited much variation, relative to the general price level. Consequently, Hair (8) has been unable to establish an estimate of the demand function, that is, a schedule of prices and associated quantities demanded, for individual products of this industry.

Production Facility Location

While a detailed analysis of the economics of pulp and paper mill location is beyond the scope of this paper, several important factors should be mentioned. As noted by Panshin (13), the four main considerations which determine plant location are availability of raw material, power, water, and proximity to markets for the finished products.

In general, pulp mills tend to locate near a source of pulpwood

since the cost of transporting raw materials is greater than the cost of transporting finished products. Because of its proximity to raw material sources, the Northwest appears to be a promising area for future expansion of the pulp and paper industry.

However, to fully evaluate the competitive position of a region, one must evaluate its ability to market its supply locally and in other regions, relative to the ability of other regions to do the same. Such evidence must take into account the size and location of markets, comparative rates of growth in production and consumption, quality of product and costs of transporting the product.

In the pulp and paper industry, the problem is extremely complex because one must deal with three forms of the product, namely, pulpwood, woodpulp and the thousands of products made from woodpulp, all of which can be transported long distances. However, little is known about the extent of interregional shipments of products in this industry at the present time.¹

¹Although Guthrie (6) covers this subject rather completely, he is somewhat out-of-date.

Chapter 4

SUMMARY

The pulp and paper industry is by no means the key industry in the United States economy, but it is, nevertheless, quite important. It produces many different products, some of which are required by other manufacturing establishments, and some of which are purchased by households. In 1969, this industry generated 3.7 percent of the total value added by all manufacturing establishments in the United States. In addition, it employed 3.3 percent of the entire United States labor force in the same year.

For the nation as a whole, the pulp and paper industry's challenge for 1985 is to meet a projected demand for paper and board products of 101.5 million tons, an increase of 78.1 percent over 1970 consumption, and a projected demand for woodpulp of 86.4 million tons, an increase of 102.3 percent over 1970 consumption.

In the recent past, this industry has been able to meet the increase in demand, in part, by plant expansion and, in part, by new plant construction. However, due to the relatively high investments for new pulp and paper mills and to the economies associated with large scale operation,¹ it would appear that the future demand increase will

¹Armstrong (1) cites evidence of substantial cost reduction as mill size increases from a 24 hour pulp capacity of 25 tons to 100 tons per day, and continued decreases in unit costs even to levels of 600 tons per day.

be met, in large part, by the construction of large plants or the expansion of existing facilities.

Another major concern of the industry in the next few years will be pollution control. Due to the nature of the bulk of pulp manufacture, pulp mills produce substantial amounts of both air and water pollution, unless equipped with pollution control devices. While mills have already been required to equip their operations with pollution control devices, increased pressure will be exerted on these mills in the future. While not impossible, pollution control is expensive.

As was the case for the United States as a whole, the pulp and paper industry is quite important to the economy of the Northwest. In 1969, 7.2 percent of the value added by all manufacturing establishments in the Northwest was generated by the pulp and paper industry. In the same year, 5.6 percent of all employees in manufacturing establishments in the Northwest were employed by the pulp and paper industry.

The Northwest has substantial resources on which to base such an industry. Nearly 32 percent of its land area is commercial forest and, in 1962, it had 23.4 percent of the nation's softwood pulpwood supply and 4.2 percent of the hardwood pulpwood supply. In addition, the Northwest has the capability to produce almost all types of pulp, although its major pulps are sulfate, sulfite and groundwood, in that order.

In terms of its position compared with that of the entire United States, the pulp and paper industry's future in the Northwest appears to be quite favorable.

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