5-1968

The Feasibility of Pulp and Paper Production in Utah

Thomas Meyer
Utah State University

THE FEASIBILITY OF PULP AND PAPER PRODUCTION IN UTAH

by

Thomas Meyer

A thesis submitted in partial fulfillment
of the requirements for the degree

of

MASTER OF SCIENCE

in

Economics

UTAH STATE UNIVERSITY
Logan, Utah

1968

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ABSTRACT

The Feasibility of Pulp and Paper

Production in Utah

by

Thomas Meyer, Master of Science

Utah State University, 1968

Major Professor: Professor R. S. Whaley
Department: Economics

The objectives of this study are:

1. To determine the adequacy of markets for paper products.

2. To identify and quantify the costs of the factors affecting pulp and paper production.

The available information indicates that adequate markets exist for paper produced in Utah.

Chemicals, water, labor, and power are available at costs low enough not to prohibit pulp and paper production. An adequate, low priced supply of wood could be purchased from the United States Forest Service. Intermountain and national paper markets would enable a paper producer in Utah to take advantage of lower comparative transportation costs.

(55 pages)

INTRODUCTION

During 1852, construction began on a paper mill near a stream close to Salt Lake City. This was the first paper mill west of the Rocky Mountains; forty-one years later it was destroyed by fire. There were probably two reasons for establishing a pulp mill near Salt Lake City: the high cost of transporting paper from the East across the mountains, and the availability of aspen and spruce, both of which are suitable for making high quality paper.

Today, a comparable situation exists in Utah. There is a large, readily available timber supply, and substantial cost savings might be realized if paper were manufactured in Utah and sold in the Intermountain West.

What would a pulp and paper mill mean to Utah? A pulp and paper mill of the size dictated by the economies of scale would employ as many as 900 people and have an annual payroll of three million dollars. Utah's tax base would expand, rail and truck volume would increase, and an overmature timber supply would be utilized. With proper planning, this could be accomplished with minimal air and water pollution. To discover whether or not paper production is an economic possibility was the goal of this study.

The available literature was thoroughly examined. This included review of textbooks, industry and government publication, advertising material supplied by the paper and pulp industry and by correspondence and interviews with the personnel from industries which supply goods and services to paper and pulp manufacturers.

Operating under the assumption that a company would not even consider expansion until the adequacy of present and future markets was established, the paper market situation was investigated.

After market adequacy was established, the representatives of the companies which could supply the factors vital to paper and pulp production were interviewed. These included: two railroads, chemical supply houses, paper distributors in Salt Lake City, power supply companies, box converting plants, the United States Forest Service, state air and water pollution control agencies, lumber mills large enough to produce chips suitable for pulping, and finally, state agencies administering water use and appropriation.

In order to assure that our approach to the location decision was a correct one, managers of three paper and pulp mills were interviewed. One mill was not operating, and the other two were in full production. These interviews confirmed the writers' interpretation of how location decisions are made.

Finally, market and factor cost data were integrated to facilitate a conclusion about the feasibility of paper and pulp production in Utah. This was accomplished by evaluating sites that had adequate potential supplies of water, were located next to a railroad, and due to pollution problems, were not located in a densely populated area. The site chosen for detailed evaluation is Green River, Utah.

DESCRIPTION OF THE INDUSTRY

In order to evaluate the feasibility of pulp and paper production in Utah, it is necessary to understand the idiosyncrasies of the industry, the structure of the pulp and paper market, its pricing policies, and its contribution to the economy.

At the beginning of 1967 there were 806 primary producers of pulp, paper, and paper board, and 3,424 converting plants in the United States. The paper and allied products industry employs approximately 640,000 people, with an annual payroll in 1963 of 3.5 million dollars (American Paper Institute, May 1967). In 1963 the pulp and paper industry added 7.4 billion dollars to our gross national product (American Paper Institute, May 1967).

Historical Perspective

Historically, the pulp industry has been raw material oriented. It has tended to locate where total costs were lowest. Total costs primarily depend upon raw material prices. When paper was made from rags, mills were located in or near large cities. As straw became widely used, new mills were built in the straw-producing agricultural areas. After the sulfite process was developed and wood cellulose became the major source of paper fiber, new pulp mills followed in the wake of lumber mills (Slatin, 1962). At the turn of the century, Maine and New York led in pulp and paper production. But the lumber industry had already moved to the Midwest. By the late 1930's Wisconsin was the largest pulp producer in the United States, and the lumber

industry had shifted from the South to the Pacific Northwest. Today, the South and Pacific Northwest produce the majority of pulpwood for primary paper production (Slatin, 1962).

Within each of the above regions, pulp mills were usually located on rivers at the perimeter of the United States and Canada. Fresh water is necessary for the pulping and paper-making process, as well as for power. The major water arteries also offered easy access to the population centers which constituted the major markets for paper products.

But as the better tidewater sites became exhausted, and with the advent of rapid rail and truck transportation, mills were built in the interior of the South, and very recently the industry has expanded into the interior of Canada and the western United States.

Changes in the geographic distribution of the industry have probably also been, at least partially, due to advances in technology. The location of the cheapest supply of raw material changed due to changes in the proportion of rags and straw used in paper, and to an expansion in the species of wood considered suitable for use in manufacturing paper. The introduction of the mechanical, soda, and sulfite pulping processes in the middle of the 19th century enabled pulp manufacturers to use hardwoods and non-resinous conifers. The introduction of the sulfate process made it possible to use almost any species of wood (Libby, Vol. I, 1962). For example, the southern, high resin pine species were completely excluded from use prior to the development of the sulfate process.

Other technological improvements helped to stimulate the paper and pulp industry. The development of high-speed paper machines, and the

advent of a relatively rapid and well-dispersed transportation system, coupled with more efficient pulping processes, made it possible to supply an ever-increasing population. In addition to the population increase causing an expansion of paper consumption, changes in consumption patterns and the use of paper for industrial packaging led to larger paper markets.

So it may be easily said that technological innovation and social change have fostered the development of a pulp and paper industry in the United States.

While pulp and paper manufacturing concentrated near the needed resources, secondary paper manufacturers, box converting plants, bag plants, and the printing and newspaper industry developed and expanded near market centers. The reasons for this pattern are many: lower transportation rates for lower-priced goods; volume changes due to secondary processing; and the advantage of personal service with the purchaser of the finished paper product.

MARKET STRUCTURE AND PRODUCT PRICING[1]

The market structure of the paper and pulp industry can best be described as oligopolistic. Though the market structure of the retail paper distributors approaches monopolistic competition, it is difficult to separate the retail distributors from the manufacturers because of the extensive horizontal and vertical integration of the industry.

Under conditions of oligopoly, the number of firms is small enough to enable a single firm to influence product prices and provoke reactions from the other firms. Prices are usually uniform or clustered. Products are either homogeneous or exhibit a small degree of differentiation, and the differentiation may be imaginary. Non-price competition is common, and entrance into the industry may be difficult (Leftwich, 1966).

The fact that one firm in the paper industry can influence the competitive position of the other firms necessitates relative price uniformity if profits are to be maintained. If one firm lowers its prices, in order to maintain their share of the market, the other producers are obligated to lower their prices too. Since specific paper products are similar, and in most cases interchangeable, there is no deterrent to switching producers in response to price changes. The industry and the individual firms do not benefit from price competition. Consequently, it has used several methods to moderate price competition:

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[1]Market Structure can be defined as the characteristics of the market organization which seem to influence strategically the nature of competition and pricing policy of the industry.

open-price filing, trade association, collusion, Canadian provincial activity, and price leadership (Guthrie, 1946). Presently, price leadership is the method used to assure price uniformity.

Non-price competition is evident in the paper industry. The larger companies resort to advertising. This creates imaginary product differentiation, which allows slight variation in prices. In the West, the largest newsprint producer offers free efficiency studies and market prediction analyses to its customers. Another firm has installed a bag conversion plant in the Salt Lake City area to enable them to give rapid, personal service to their customers, although the bags could be manufactured in Washington and transported to Salt Lake City at less cost. Also, significant differences exist in the services provided by the various manufacturers, i.e., regularity of service and financial agreements.

Entry of new firms into the industry is difficult for three reasons. Entry costs may be as high as 40 million dollars. The economies of scale dictate a mill able to produce 300 to 400 tons of paper per day. According to the Forest Products Laboratory (1962), investment costs average about 100,000 dollars per ton-day of capacity. Contracts between producers and consumers of paper products often run from 5 to 10 years. This practice, which is common in the newsprint industry, hinders the entry of new firms into the industry. The relationship between manufacturer and retailer is further strengthened by financial ties. The fact that existing firms own or lease large tracts of timber and have contracts with the lumber mills for wood residues pre-empts other mills from locating in the immediate area (Guthrie, 1941).

As was mentioned earlier, the dominant force in the pricing policy of the pulp and paper industry is the role played by the price leaders

(Guthrie, 1950). Except for the newsprint industry, empirical evidence indicating price leadership is hard to find. The practice of announcing prices and using long-term contracts makes it possible to analyze newsprint prices and their changes. Guthrie (1950) found that price uniformity was lacking one-third of the time between 1919 and 1949. This, he said, was due to periods when little, if any, excess capacity existed in the industry. Strong demand permitted inter-firm price differences. Firms charging higher than average prices were able to maintain sales when demand exceeded supply. Furthermore, variations were stimulated by the efforts of the provincial governments of Quebec and Ontario to maintain higher prices for Canadian pulpwood exports. Probably the first factor had the greatest impact on the price variations.

Information regarding the 1950's indicated a high degree of price uniformity (American Newspaper Publishers Association, Newsprint Statistics, Feb. 28, 1967). The prices listed were almost invariably the same -- the minor differences being due to policy differences regarding freight and delivery distance to purchasers.

A very recent price increase was examined through the use of a trade association bulletin (American Newspaper Publishers Association, Newsprint Bulletin, 1967). International and Consolidated Paper Corporation Ltd. announced price increases and a majority of the newsprint producers in the East soon announced similar price increases.

The evidence indicates a pricing policy dependent on price leadership in the newsprint industry. Early in 1967 the prices were five dollars higher in the East than the West (American Newspaper Publishers Association, Newsprint Statistics, Feb. 28, 1967), and a price differential usually exists.

In the kraft paper and paperboard industry, price leadership is more difficult to substantiate. It is likely, however, that prices are "led" by a few of the larger companies.

In the book and fine paper industry a statement about price leadership would be even more tenuous. However, the kraft and newsprint industries make up the largest portion of the pulp and paper industry.

Paper pricing policies are not only affected by the structure of the industry, but also by the nature of the demand for paper. Inelasticity of demand is an important factor influencing manufacturers' desires or willingness to cooperate with price leaders. By inelastic demand for paper is meant that increases in prices do not proportionately reduce the quantity sold. Doubling the price of newsprint would not reduce the quantity sold by one-half. Several conditions, common to paper, usually result in the product having an inelastic demand. There are a limited number of substitute products for paper. Demand for the finished factor, such as newspapers, is inelastic. And only a small proportion of the total cost of the final product consists of the cost of paper. For example, container products, paper bags, wrapping paper and paperboard constitute a very small portion of the total costs of the product they contain. Guthrie (1941) estimated that the cost of newsprint in a newspaper is 33% of the publisher's total costs.

For newsprint, a good substitute is not available at a reasonable price; other grades of paper suitable for printing are higher priced. Kraft paper, used extensively for packaging, adds to the convenience of handling the material it contains. Rigid paper containers are more difficult to replace than kraft, particle board and wood both are heavier, and are more expensive.

The significance of inelasticity is that manufacturers, realizing that a price reduction will reduce total industry revenue, are more willing to accept price uniformity, even though the demand curve faced by the individual is elastic. A price reduction by one firm invites retaliation, and consequently, total industry revenue would decline.

It should be noted that prices are influenced by supply as well as demand. Variations in prices will tend to be more severe when current inventories exceed sales. Prices are most likely to increase and follow price leadership when supply exceeds demand.

MARKETS FOR UTAH-PRODUCED PAPER

The existence of adequate national and regional paper markets is the primary factor to be evaluated before a firm will consider expansion.

National Markets

Paper markets are usually analyzed on the national level. Pulp and Paper (July 17, 1967) presented the most recent paper consumption figures. Per capita, paper consumption in the United States during 1966 was 530 lbs. For the nation, consumption was 52 million tons of paper and paper board. Approximately 50% of this was paper board and 20% newsprint (Landsberg, 1963). The U.S. Forest Service (1965) states that 90% of domestic paper consumption is supplied by firms located in the United States. With the exception of newsprint, paper markets were supplied primarily by domestic producers. On the other hand, 75% of our newsprint is imported from Canada. The American Newspaper Publishers Association (Newsprint Statistics, Feb. 28, 1967) calculates that the U.S. imports 6.5 million tons of newsprint from Canada.

Table 1 lists domestic paper production by types, and the change in production between 1965 and 1966. Substantial increases were noted for all paper types except construction paper and board and coarse papers. Though domestic production of newsprint only increased 4.8%, the total increase in U.S. consumption was 7.3%. The difference resulting from increased Canadian imports. At the present time, the U.S. Gross National Product is increasing at a rate of 5.1%, after a

Table 1. Apparent Paper Production in the United States - 1966

Paper Type	Weight-million tons	% Increase Over 1965
Construction paper and board	3.7	-3.0[a]
Newsprint	2.2	4.8
Printing papers	6.4	8.0
Coated papers	3.0	6.8
Fine papers	2.6	9.4
Coarse paper	4.7	2.7
Sanitary tissue	2.8	5.5
Paper board	22.5	8.3
Paper	20.2	6.2
Paper and Board Total	68.1	Average 6.4%

Source: Pulp and Paper - Vol. 41 #29, July 17, 1967. p. 92.
[a]The low magnitude of this figure is due to a construction slow down.

price index adjustment, while paper consumption is increasing at an average rate of 6.4% (Paper and Pulp, Feb. 17, 1967). Thus, paper markets are expanding more rapidly than the economy as a whole.

Recent predictions of future paper consumption have been made by Dwight Hair of the U.S. Forest Service. Hair (1967) relates paper and board consumption to estimated changes in population, number of households and per capita growth in gross national product or disposable income. By regression techniques, he developed the consumption predictions found in Tables 2 and 3. According to his figures, the greatest growth can be expected for container board, bending board, and newsprint. Expressed by production process, the greatest increase is expected to be for sulfate grade pulps, though groundwood and semi-chemical pulps are expected to show substantial growths.

These figures may be conservative in terms of their implication for expanded production opportunities in the U.S. There is evidence that the relative importance of imports in supplying U.S. markets is on the decline. The U.S. may turn from being a net importer to a net exporter of paper (Table 4). Considering the differences between per capita paper consumption in this country and the rest of the world, it seems logical that the international use of paper may expand more rapidly than U.S. consumption. This will have a two-pronged effect. First, it will offer other market opportunities for countries now supplying the U.S. and secondly, will offer our domestic producers expanded market opportunities.

Regional Markets

Traditionally, regional paper consumption has been estimated by multiplying per capita paper consumption figures times regional

Table 2. Apparent United States consumption by paper types.

	1966	1975	1985
	--Millions of Tons--		
Newsprint	9.2	11.0	14.3
Book paper	5.5	7.8	11.4
Fine paper	2.6	3.7	5.6
Coarse paper	5.6	7.4	9.8
Sanitary tissue	3.0	4.7	7.1
Construction paper	1.8	1.8	2.0
Groundwood paper	1.1	1.3	1.5
Total paper board	23.9	34.4	49.8
Total paper and board	49.8	69.0	98.0

Source: Hair (1967, p. 5)

Table 3. Apparent United States consumption of pulpwood by processes.

	1966	1975	1985
	--Millions of Tons--		
Dissolving	1.3	1.7	2.2
Sulfite	3.3	3.3	3.8
Sulfate	23.7	38.0	59.0
Soda	.2	.2	.2
Groundwood	4.3	5.7	7.7
Semi-chemical	3.2	6.4	10.9
Exploded	1.5	2.0	2.6
Total wood pulp	37.5	57.3	86.4

Source: Hair (1967, p. 6)

Table 4. United States paper exports and imports 1950-1985

Year	Imports	Exports	Net Imports
		--Thousands of tons--	
1950	2,400	100	2,300
1960	2,400	1,100	1,200
1970	3,800	2,400	1,400
1975	4,400	3,200	1,200
1980	5,100	4,000	1,100
1985	5,800	5,000	800

Source: Hair (1967, p. 7)

populations. This, of course, assumes homogeneous consumption patterns for varying population centers. Using this technique, estimated Utah consumption for 1966 would be approximately 47,000 tons of newsprint. This is calculated by multiplying average per capita newspaper consumption, 94 pounds per person, times Utah's estimated one million population.

This procedure may overestimate Utah newsprint consumption. A survey conducted by the American Newspapers Publishers Association (Feb. 28, 1967) indicated that Utah consumed 31,656 tons of newsprint in 1966. Table 5 shows newsprint consumption for Utah and the surrounding states during 1966. Because the survey was only able to account for 86.3 percent of total U.S. newsprint consumption, we feel that the estimate in Table 5 is probably low. Utah consumption is probably closer to 36,800 tons of newsprint and the regional consumption approaches 260,000 tons.

Using the method of multiplying population figures by the average per capita consumption, the Pacific Power and Light Co. (1965), estimated that Wyoming, Utah, Colorado, and Idaho consume 395,180 tons of paper board per year. This is well over 1,000 tons per day. There is reason to believe that this procedure may overestimate paper consumption in the Intermountain area, particularly for coarse papers and board used in the packaging industry. The direct correlation between container board consumption and manufacturing activity means that per capita consumption of container board should be higher in the industrial Midwest than in the mountain states. Evidence of this is seen from the fact that an abnormally high proportion of the Nation's paper converters are located in the Chicago area. The inaccuracies

Table 5. Newsprint consumption in the Intermountain Region, 1966

State	Consumption
	Tons
Utah	31,656
Arizona	58,899
Nevada	15,081
Wyoming	3,016
Colorado	104,444
New Mexico	13,918
Idaho	10,132
Total	237,146

Source: American Newspaper Publishers Association, Feb. 28, 1967, p. 18.

inherent in this method of prediction are probably less severe when estimating regional consumption of fine papers and newsprint.

Though per capita consumption of paper board may be less in this region than in other regions of the U.S., it is still significant from a feasibility standpoint that all of the paper currently used to package bentanite, cement, fertilizers, sugar, and other locally manufactured products is being imported from outside the region. It can be concluded that the market for kraft paper or newsprint is completely adequate to support a mill in Utah. Markets alone, however, do not justify Utah as a potential site.

LOCATION FACTORS -- RESOURCES

Assuming that the market is adequate to absorb the production of a mill located in Utah, it is still necessary to analyze other specific location factors. Hagenstein (1964) listed raw materials, transportation, labor, and power as the most important factors affecting mill location. In addition, transportation facilities, utility costs, and waste disposal facilities are important location determining factors. Chemicals tend to play a less important role in location decisions because of the consistency in prices between diverse geographic areas.

Letters and interviews with the management of several inter-mountain pulp mills, indicated that raw materials, transportation, water, and labor are particularly relevant in the West.

Chemicals

Although chemicals are not considered extremely variable, their prices, origin, and S.L.C. prices are listed below. (Table 6) The prices were supplied by Van Waters and Rogers, Inc. and Wasatch Chemical Co. Both offices are in S.L.C. Mr. Sherman B. Hinkley of Rico Argentine Mining Co. predicted that Great Salt Lake brine could, after electrolysis, supply chlorine at $3.05/cwt. in the near future.

It is also important to remember that the ground wood pulping process does not use chemicals. Homer Gardner (1966) stated that 85 to 90 percent of the chemicals used for pulp production are recoverable in the unbleached sulfate process.

Table 6. Place of supply and prices for chemicals used in pulp production

Chemical	Cost at Origin	F.O.B. S.L.C.
Caustic soda	$58.00/ton Henderson, Nev.	$90.00/ton
Salt cake	28.50/ton Tona, Cal.	48.00/ton
Limestone	21.00/ton Dolomite, Utah	
Hydrated lime	21.00/ton Dolomite, Utah	
Chlorine		6.75/cwt.
Sulfur		6.00/cwt.
Soda ash	29.00/ton Green River, Wy.	30.00/ton

Source: Interview with Van Waters and Rogers, Inc., and Wasatch Chemical Co.

Labor

Due to unionization in the pulp and paper industry, labor costs are uniform on the Pacific Coast and relatively similar throughout the country. The average earning for production workers in the U.S. is $2.61 per hour in manufacturing industries compared to an average of $2.65 per hour for workers in the pulp and paper industry for the year 1966. Workers on the Pacific Coast in this industry receive $3.05 per hour (Monthly Statistical Summary, April, 1967). The average hourly wage paid in the manufacturing industries in Utah in 1965 was $2.84 (Bureau of Labor Statistics, 1966). The management of the pulp and paper mills interviewed indicated that competition for skilled technicians is on a national basis, and that local people filled the unskilled positions and gradually ascended to the skilled jobs. The fact that the pulp and paper industry's average wage is above the national average should make it easy for a firm to find sufficient labor supplies. The rapidity at which the unskilled employee can learn the skills necessary to assume a skilled position depends upon the individual's adaptability. Adaptability would most certainly be influenced by the education level of the working force. Utah has the highest education attainment in the nation, with a median school years completed of 12.2 as compared to the national average of 10.9 (Comparative Educational Data, 1962).

Power

Power requirements are large for a pulp and paper mill. The Forest Products Laboratory (1962) reports electrical requirements of about 250 kilowatt-hours per ton of chemical pulp and 900 to 1,800

kilowatt-hours per ton of ground wood pulp. The stream requirements range from 2,500 to 7,500 lbs. per ton of chemical pulp.

In evaluating which type of power is the cheapest, it is necessary to consider three factors:

1. Annual fixed charges (interest, taxes) on the power plant.
2. Annual fuel cost.
3. Annual labor, operation, and maintenance costs.

The scope of this study permitted evaluation only of fuel costs. The total fuel cost is the fuel cost at the point of sale plus the cost of transporting the fuel to plant site. A comparison will be made between gas, electric, oil, and coal. Interviews were conducted with the American Oil Co., Standard Oil of California, Utah Power and Light Co., Mountain Fuel Supply Co., Spring Canyon Coal Co., and Independent Coal and Coke Co. The results are tabulated below.

Electric power is supplied by Utah Power and Light Co. Transmission lines run through Green River, Utah. For a new installation Utah Power and Light will construct the power lines if the prospective customer will sign a contract for an adequate period of time. This time period would be determined through negotiations. The customer must pay for the equipment on the customer's side of the point of delivery. The power specifications are (Electric Service Schedule No. 23, State of Utah, 1967):

1. High load factor industrial service - 138,000 volt delivery.
2. More than 8,000 kw.
3. Power factor 85%.
4. Minimum monthly charge of $17,200.

5. Rate:

   a. $1.53/kw for all kw of demand.

   b. $0.57/kwh for first 200 kwh per kw of demand.

   c. $0.40/kwh for next 200 kwh per kw of demand.

   d. $0.30/kwh for all additional kwh.

Crude oil is refined in Salt Lake City, and the F.O.B. price is $2.70 per 42 gallon barrel. There are approximately 150,000 BTU's per gal. in #6 fuel oil. Number 6 fuel oil is an industrial oil of high viscosity which must be heated to 225 degrees before it can be pumped; it also must be atomized in order to be combustible. Truck transportation to Green River costs $0.025 per gal. Truck transportation is cheaper than rail, and insulated trucks do not require steam heating facilities at the destination. This information was supplied through interviews with Standard Oil of California and the American Oil Co.

Gas is almost as inexpensive as coal. Mountain Fuel Supply Co. does not have a gas line running through Green River, Utah, and the customer would have to finance the gas line from the area of use to the supplier's pipe line. However, to the extent that the gas purchases by the customer warrant, the gas company reimburses the customer for the pipe line installation expense. Gas fields are located in the eastern section of Utah and could be tapped if a pipe line existed. The terms for non-interruptible-industrial gas service, Rate Schedule F-4 are listed below:

1. One point of delivery.

2. Minimum consumption of 132,000,000 cu. ft. per year.

3. Maximum of 7,000,000 cu. ft. per day from Nov. 1 to April 30.

4. Minimum yearly bill of $40,000.

5. Base rate:

   a. First 1,000,000 cu. ft. per month - $0.3315 per M cu. ft.

   b. Over 1,000,000 cu. ft. per month - $0.2863 per M cu. ft.

Unless a change would be negotiated, this type of industrial gas service would not be acceptable. A maximum of 7,000,000 cu. ft. per day is only approximately one-third of the power requirements of a mill the size dictated by the economies of scale and completely powered by gas. It is technically possible for a power plant to operate on more than one fuel.

Independent Coal and Coke Co. and Spring Canyon Coal Co. estimated that the bid price for large volumes of coal would be between 4.00 and 4.50 dollars. It appears that $4.00 is the most likely price, and this would make coal the cheapest of power supplies. Coal prices, even bid prices, are tied to labor and welfare costs paid by the coal companies. The rail tariff from Spring Canyon to Green River, Utah, is $2.78 per ton; however, this is a "paper rate" not in use and could possibly be reduced. It must be emphasized, however, that fly ash is a problem that accompanies coal burning. Unless it is rigidly controlled, the ash can affect the color of the pulp or paper. Some older coal burning mills have switched to gas or electricity for this reason.

Table 7 summarizes power costs.

Water

Water is one of the prime determinants in selecting a potential pulp and paper mill site. Water is used in the pulping process as a cooling agent, and for effluent disposal. A rough minimum of about

Table 7. Cost of Fuel

Fuel type	Price	Transportation	BTU	$/BTU F.O.B. Mill
Gas	$ .3272/MMBTU		.3272MM	$.3272/MM BTU
Oil	.643/gal.	$ .025/gal.	.15MM	.594/MM BTU
Electricity	.0183/kwh		3.413M	.534/MM BTU[a]
Coal	4.00/ton	2.78/ton	25.6MM	.261/MM BTU

[a]Certain assumptions had to be made regarding the quantity of power required. 1 kilowatt equals 3413 BTU/hour.

10,000 acre-feet per year would be required to supply a mill producing 500 ton per day of unbleached kraft paper board.

The industry average for this type of mill is 33,000 gals. of water per ton of paper (Forest Products Laboratory, 1962). The Hoerner-Waldorf Corp. mill, at Missoula, Montana, uses approximately 18,000 gals. per ton of paper, but they believe that this figure could be reduced by one-half. It is assumed that a mill in Utah would use the same quantity of water. If newsprint were produced, the groundwood portion would require a minimum of 1,000 gals. per ton. If water proved expensive to buy, newsprint would be the logical product to produce.

Not only is water use in production high, but large volumes of water are necessary for effluent disposal. Effluent disposal is the greatest single item which may discourage the development of a potential mill site (Gehm). For this reason the Utah State Committee on Water Pollution was interviewed.

Protection of health and welfare necessitates regulating wastes which might lower the quality of water. On the state level, the State Board of Health and the State Committee on Water Pollution have the responsibility and authority to regulate effluent quality. Unless pollutants create a serious health problem, pollution control is primarily regulated by the State Committee on Water Pollution (Utah Code, 73-14-2.5).

On the national level, pollution control is directed by the Federal Water Pollution Control Administration. The 1965 Water Quality Act directed the FWPCA to request that the states submit water quality standards for approval by the Federal agency. Included in this man-

date was the direction for river basin standards. So Utah's water quality will have to be compatible with the standards set by the Colorado River Compact States. If adequate standards are not established by the states and river basins, the Federal Government is committed to creating standards.

The biggest pollution problem on the Colorado River is that of soluble salts. Soluble salts have already affected the domestic quality of water and the higher the soluble salts content, the less efficient is water used for irrigation. A very tentative figure of 1,000 ppm at Imperial Dam has been proposed as the maximum allowable concentration of soluble salts; however, this figure has already been exceeded. It is likely that negotiations will establish reasonable standards.

The State Committee on Water Pollution, therefore, believes that it cannot allow any additional soluble salts into the Colorado River system. Consequently, a chemical pulp and paper mill would probably be prohibited from discharging effluent into a water course. The Federal agency has police powers to control pollution if the state neglects its duty. In addition, money probably would not be forthcoming for reclamation projects if reasonable standards were not set and enforced by the state.

Utah has submitted standards to the FWPCA, but concrete standards have not yet been established for the river basin.

The State Committee on Water Pollution has adequate (though unused) police powers to prevent pollution of state waterways (Webb, 1966). The committee chairman has indicated that it would be particularly restrictive regarding new sources of pollution. The opinion

was rendered even though there had been no discussion of the major pollution problem from pulp and paper mills, and biochemical oxidation demand. Normally, pulp effluent stimulates algae growth. When the algae die, they deplete the water's oxygen and produce a terrible odor. The odor and color of the effluent would adversely affect recreation users.

The best way to solve the pollution problem would be to dispose of the effluent in a desert depression and let it evaporate. Experience in Arizona (Southwest Forest Industries interview) has shown that the effluent does not infiltrate fast enough to affect the quality of the ground water. Evapo-transportation in the Green River area is 30-33 inches a year (Utah Water and Power Board, 1966). To evaporate all the effluent from a previously described pulp and paper mill would require a surface of about 4,000 acres. The State Water Pollution Control Board said that this method of waste disposal would be acceptable. In some areas pulp effluent has been used for irrigation.

The mill must also be adjacent to one or more major transportation routes and close to a wood and power supply. The most logical place is Green River, Utah. There are also locations in Sanpete County, but the area is closed to further water appropriation.

At a gaging station in Green River, Utah, the Dept. of Interior, Geological Survey (1966) has measured the river's discharge. In 1965 the minimum flow was 1,920 cu. ft. per second or .044 acre-feet per second. The hypothetical pulp and paper mill might require 30 acre-feet per day, while the minimum flow was 4,241 acre-feet per day. The average discharge per day over a 67-year period was 1,300 acre-feet per day. The high flow in 1965 was 6,500 acre-feet per day. There is

an adequate volume of water in the river. The state engineer's office said that it would be possible to buy the 10,000 acre-feet or more of water required.

Natural water is almost never pure. Even falling rain contains dissolved gases and dust picked up from the atmosphere; and as water runs off or infiltrates, it picks up additional impurities.

The qualitative requirements of water for paper production vary with the use to which the water will be put. Process water requirements are controlled by the type of paper being produced. Boiler water has more stringent requirements, and cooling water needs little treatment.

Process water also varies with the pulping process. Some elements, like manganese and iron, affect the color of the paper; other impurities such as calcium affect the process equipment. The standards for process water are listed in Table 8 (Mussey, 1962). Certain papers, such as cigarette or food container paper, must also be free of bacteria, tastes, and odors. The quality of the paper may affect the quality of the food it contains.

Rigidly high boiler water standards are necessary to reduce the cost of maintenance and replacement of steam making and steam using equipment. Boiler water standards are listed in Table 9 (Mussey, 1961).

For cooling, fresh or salt water may be used. Brackish water is used in some areas. Brackish or salt water can increase maintenance and replacement costs, but in some cases its use is economically justified.

Table 10 lists the chemical qualities of Green River water (Criddle, 1958). This analysis does not list turbidity, but it seems

Table 8. Specifications for process water

	Groundwood paper	Sulfate paper - unbleached
Turbidity	50	100
Color	30	100
Total hardness $CaCO_3$	200	200
Alkalinity $CaCO_3$	150	150
Iron	.3	1.0
Manganese	.1	.5
Silica	50	100
Dissolved solids	500	500
Carbon dioxide	10	10
Chloride	75	200

Source: Mussey (1961, p. 39)

Table 9. Chemical and physical characteristics of ideal boiler water

Characteristic	ppm
Hardness	0
Sodium chloride	0
Sodium sulfate	0
Silica	0
Sodium hydroxide	40
Suspended matter	0
pH	11.0

Source: Mussey (1961, p. 41)

Table 10. Chemical analysis of Green River at Green River, Utah

Characteristic	ppm
Silica	--
Iron	--
Calcium	35
Magnesium	10
Sodium	24
Potassium	3.9
Bicarbonate	128
Sulfate	63
Chloride	8.2
Nitrate	.2
Floride	--
Total dissolved solids	--
Total hardness $CaCO_3$	128
% Sodium	28
Specific conductance (micromhos 1@ 25°C)	380

Source: Criddle (1958, p. 248)

logical to assume that the turbidity rating would be high due to the suspended matter in the water. The other impurities are not common enough to require extensive treatment.

Pulpwood

Choate (1965) supplied all the statistics regarding wood availability. Approximately 28% of 15 million acres of Utah's land area is classified as forest. Of this forest land, only 4 million acres are classified as commercial forest. The U.S.F.S. (1964) administers 70% of the commercial forest land, which equates with 90% of the timber volume in the State. Aspen and spruce-fir are the largest timber types of the commercial forest which has an average volume of 6,904 board feet per acre. There are 5.8 billion cubic feet and 19.5 billion board feet of wood classified as sound live trees and saw timber. Table 11 lists the volumes by species. It has been established by Zischke (1956), Shafer (1956) and Panshin (1962) that lodgepole pine, aspen, engelmann spruce, subalpine fir and ponderosa pine are all suitable as pulpwood species.

Two-thirds of the commercial forest volume is saw timber. Engelmann spruce, ponderosa pine, and Douglas-fir are the major saw timber species and are not included in estimates of the pulpwood supply. Saw timber commands higher prices than does pulpwood. Aspen, subalpine fir, white fir, and sometimes stagnated lodgepole pine stands are not offered for sale as saw timber because of limited markets, their small size, and undesirable wood properties.

Saw timber trees add 321 million bd. ft. in growth annually, but mortality reduces this growth rate by 70%. The high percentage of old growth makes volume growth very low. If the overmature timber

Table 11. Volume of timber on United States Forest Service land in Utah

Species	Sound live trees	Saw timber trees
Aspen	1.3 billion cu. ft.	2.1 billion board ft.
Englemann spruce	1.2	5.8
Lodgepole pine	1.0	2.5
Douglas-fir	.9	3.9
Subalpine-fir	.6	1.7
Ponderosa pine	.4	1.9
White fir	.3	1.3

Source: Choate (1965, p. 9)

were harvested, the net growth rate would increase, and the allowable cut would also rise.

Annual net growth for saw timber in Utah is 96 million bd. ft. About 12.6 million cu. ft. or 62 million bd. ft. is cut annually. This equals .22% of the 5.8 billion cu. ft. inventory of sound live timber. This figure compares with .69% for the Intermountain states, and 1.62% for the Nation. So, as it stands now, growth exceeds cut by 34 million bd. ft. annually. Annual allowable cut is listed by National Forests in Table 12.

Even the current growth rate is not indicative of the land's capacity to grow wood. The volume of timber harvested is about equal to the annual yield potential of the ponderosa pine type alone (only 10% of the commercial forest area). If the other species have a timber-growing capability similar to ponderosa pine, the entire 4 million acres of commercial forest land has an annual growth potential of 616 million bd. ft. (U.S.F.S., 1966).

Potential pulpwood supply consists of aspen and lodgepole pine pole timber trees. Two-fifths of the 688 million cu. ft. of lodgepole pine classified as saw timber is in pole timber size trees. Some of these stands are currently inoperative for harvesting, due to a low saw timber volume per acre, but would be operable if there were a market for the smaller trees.

Aspen pole timber volume is extensive. Because there currently is no market for aspen, it is listed as part of the non-regulated allowable cut in some national forests. Aspen has the smallest percentage of its total inventory cut annually. Pulpwood producers would have little competition when bidding for aspen.

Table 12. Loggable allowable cut from unreserved Forest Service land in Utah

Working circle	Ponderosa pine	Engelmann spruce	Aspen[a]	Douglas-fir	Subalpine-fir	Lodgepole pine
			--Thousand Bd. Ft. - Scribner--			
Lasal	2,442	1,366	1,623		112	
Cache		323	50	1,726	454	590
Manti	113	5,559	6,226	460		
Uinta		4,213	9,556	630	3,648	191
Dixie	8,866	12,617	1,479	4,195	1,991	
Wasatch	14	5,702	2,289	1,038	385	14,450
Fish Lake	235	2,191	2,159	789	865	
Ashley	967	2,000	5,524	3,504	400	16,836
Total	12,637	33,971	28,906	12,342	7,855	32,067

Source: U.S.F.S. Timber Mgt. Plans. Intermountain Region. 1965.
[a]Aspen and sometimes Subalpine-fir are listed as non-regulated by the Forest Service because a market does not exist for the product.

Utah's forests have never been heavily exploited for wood products. Size of trees, log grades, low volumes per acre, steep slopes, high road costs, and the distance from large markets have discouraged timber harvesting. Between 1960 and 1962 round wood and lumber production declined 19 and 3 percent, respectively.

Lumber producers suffer because there isn't a market for saw log waste or milling residues. If these by-products could be sold, the return per volume of timber cut would be higher. The lumber industry would also benefit if the smaller trees and saw timber tree tops could be sold as pulpwood. Additional benefits would accrue to existing wood products firms if they could share road construction costs with pulp harvesting firms.

On the other hand, a pulp mill could make profitable use of the wood residue supplied by the lumber industry, and would also benefit from road cost sharing. A market for wood residues would encourage larger, more efficient saw mills with capacities large enough to warrant investment necessary for buying and installing the de-barkers and chippers used in converting wood residue into useable chips. A pulp mill could supply a part of its wood needs by using wood chips.

In the West, chips supply 60% of the wood fiber for pulp manufacturing (Wackerman, 1966) and have increased log utilization from 50 to 80%. Wood chips probably would form a sizeable portion of the wood fiber supply for a mill located in Utah.

Recently the U.S. Forest Service has shown a willingness to commit itself to long-term timber and pulpwood sales. The largest and longest range sale was recently initiated in Alaska. In Arizona the U.S. Forest Service contracted with Southwest Forest Industries, Inc. for

6,000,000 cords of pulpwood over a thirty-year period. The Forest Service is preparing a prospectus for the sale of at least 3,000,000 cords of pulpwood over a thirty-year period in Wyoming and Utah. (U.S.F.S., 1964) One hundred thousand cords a year weighing approximately 2,300 lbs. per cord could produce (assuming a 340 day operating year) about 170 tons per day of chemical pulp or 300 tpd of newsprint.

The Ashley, Bridger, and Wasatch National Forests in Utah will attain optimum growth only after the old growth and young stands are harvested and thinned. The logical market for this wood is as pulpwood. In recognition of these facts, the U.S. Forest Service has indicated that it favors the establishment of a pulp mill in the Uinta area.

It is essential that 150 to 180 miles of road be built during the first five-year period of the pulpwood sale. (Personal interview with C. R. Melvin of the U.S.F.S., 1967). A significant proportion of road use will be extended past the first five years. It will also be possible to take advantage of roads built for other multiple-use purposes.

The stumpage price for the pulpwood will be decided by a competitive bid. The price will be redetermined every five years. Forest Service policy requires a minimum price of $1.00 per cord.

In addition to standing timber, wood residues could add significantly to the over-all wood supply, and do not require de-barking or chipping at the pulp mill, and do not require the red tape of harvesting agreements. In many cases wood residues cost less per cubic foot of wood fiber than pulpwood; and for these reasons it would be expected that wood residues would constitute a substantial portion of a potential pulpwood supply.

The degree to which chips could augment the wood fiber supply depends upon the capacity of the lumber industry. The 48 saw mills and 3 planer mills in Utah produce approximately 4 million cu. ft. of wood residue each year (Interview with W. Johnson, 1967); however, only a small portion of the total would be available for use as pulping material. Only two mills produce more than 10,000,000 bd. ft. per year, with the majority of the mills being substantially smaller. Probably only the two largest mills could justify the large expenditure necessary to install and buy a de-barker and chipper and the loading and transportation facilities necessary for chip production. As was noted earlier, a chip market might encourage lumber mill consolidation. It is also possible for the smaller mills to sell their residues to the mills that are able to afford a chipper.

There are several primary and secondary lumber mills in southern Idaho, Utah, Colorado and northern Arizona which may offer a potential supply of wood chips to a pulp mill located in Utah. One of these firms indicated interest in the sale of wood residues. Kaibab Lumber Company, Phoenix, Arizona, would be able to supply 150 units a day from its mills in Panguitch, Utah, and Frediona, Arizona.[1] It has been estimated that the cost of production from these mills would be approximately $6.50 per unit.

At the present time, some lumber mills in the Intermountain area are selling chips to pulp manufacturers. Certain southern Idaho saw mills sell chips to pulp producers located in Wisconsin; some western

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[1]A unit is equal to 200 cu. ft.

Montana saw mills sell chips to the Hoerner-Waldorf paper mill located in Missoula, Montana. The price is between 8 and 9 dollars per unit at the saw mill. The Southwest Forest Industries paper mill purchases chips in the central Arizona area.

Assuming that a unit of chips is worth $15 (information supplied by W. C. Hodge of Hoerner-Waldorf Corp.), transportation and loading and unloading costs could not exceed $6.00. It would seem likely that lumber mills in southern Idaho, Utah, and western Colorado are close enough to Green River, Utah, to supply chips and receive a return on their investment.

In order to speculate about comparative wood costs, it is necessary to evaluate United States Forest Service stumpage appraisal policy. Because a price established in the market place does not exist, it is necessary for the Forest Service to attempt to estimate a fair market price for the pulpwood stumpage. A reliable market price for specific grades of wood pulp is available; consequently, wood pulp prices are used as the starting point in the stumpage price appraisal. Pulping process and harvesting costs for operators of average efficiency, plus road construction costs are subtracted from the value of the wood pulp to yield what the Forest Service calls the conversion return. A profit margin is subtracted from the conversion return to arrive at the value of pulpwood on the stump. This is the minimum price the Forest Service will accept for a cord of pulpwood stumpage, provided this price exceeds one dollar per cord. One dollar per cord is the return the Forest Service feels is necessary to defray the administrative costs of the sale. The author feels that there are two factors that will tend to minimize the stumpage price near one dollar per cord;

the high harvesting costs due to low density stands and the dispersion of the timber stands to be harvested; and the lack of bidding competition that was evident in a similar sale in Arizona.

This appraisal procedure indicates that only if a firm's internal costs are below the industry average will a pulp and paper mill located in Utah have an advantage in regard to wood costs.

LOCATION FACTORS -- TRANSPORTATION

Whether a pulp and paper producer decides to locate near raw materials or near the markets depends on the relative difference between transportation costs for the raw materials and the manufactured product. Mills will tend to locate where the aggregate transportation costs are minimized. The aggregate transportation cost differentials are determined by two factors: the loss of weight resulting from the manufacturing process, and the difference between the transportation tariff on the raw material and the tariff on the manufactured good. Wood-using industries normally locate near raw material supplies due to the large weight loss in primary manufacturing. Chemical pulp mills normally require at least two tons of wood to produce each ton of pulp. (Libby, Vol. 1, 1962)

Originally the tariffs on paper were designed to stimulate the development of the pulp and paper industry and to maximize the volume of paper transported (Gutherie, 1950). Pacific coast rates were intended to make Pacific Northwest paper competitive east of the Mississippi. The rates were also influenced by competition from steamship lines.

Extrapolating, if rail rates to the East were less from the Rocky Mountains than rail rates from the Pacific Coast, then, assuming other factors to be equal, a freight advantage would exist in the Intermountain area.

The acid test of the effect of transportation costs on the pulp and paper industry is an analysis of the degree to which interregional product shipments take place. Although transportation costs

vary between regions, this is offset by distances from markets as well as variations in other factor costs. Of significance, however, are the large volumes of cross shipments of high grade paper and the large volumes of wood pulp and processed paper that move from the Pacific Northwest and the South to the eastern U.S. and from the South to the North.

Slatin (1962) examined data collected by the Interstate Commerce Commission on rail shipments in 1960. This was a one percent way bill sample which indicated the origins and destinations of all rail shipments in the United States. He found little movement of newsprint between major geographic regions within the United States. One-half of the paper board in this country is consumed in the central and eastern U.S. However, one-half of the paper board consumed in this area comes from the Southern Territory. The Southern U.S. exports 75% of its paper board production. Wrapping paper also was shipped in large volumes from the South to the Northern U.S. Sixty-nine percent of the wood pulp produced in the Pacific Northwest was shipped to other territories, almost one-half of which moved to the north-central U.S. Thirty percent of the Pacific Northwest's printing paper came from the Eastern U.S. This indicates that, although technology, tree species, and transportation encourage geographic pulp and paper production specialization, transportation costs are not high enough to prevent movement to wood pulp or paper across the United States. A pulp and/or paper mill located in Utah would be in a competitive location to supply national pulp and paper markets.

Interviews and letters with the management of newspapers located in Utah, Wyoming and Idaho indicated that 20 percent of the price of

newsprint is a hidden transportation cost; Slatin (1962) indicated that the national average is only 10 percent. A newsprint manufacturer located in Utah and selling in the Intermountain area would have a definite transportation cost advantage. Also, large quantities of wood pulp for container board are transported from the Pacific Northwest and South to the Midwest. Assuming that it would cost less to ship this product from Utah and that the value of the products is the same, a transportation cost savings could exist for a pulp mill located in Utah.

For newsprint and wood pulp there is evidence indicating that a transportation advantage might exist for a newsprint manufacturer or wood pulp producer in Utah.

CONCLUSIONS

Before any conclusions are drawn from this study, it is important to recognize its limitations. Though there is sufficient evidence to indicate that a pulp and paper mill located in Utah might have certain factor cost advantages, these factor-costs have not been compared to the costs of mills located in other areas. Most cost data are of a preliminary nature and will require further investigation. It is difficult to say that Utah is a satisfactory location for pulp and paper production if a firm's internal production costs are not known.

Since the local variations of cost for chemicals, labor, capital, water, and power are minor, the importance of the other factor-costs are amplified. Transportation, wood, water, waste disposal and power become more important. Although adequate roads and rail lines exist in Utah, specific cost information is difficult to find. Transportation is probably the area with the least information.

Wood is available from forests which have an annual growth far in excess of the annual cut, and from wood chips which can be produced by the lumber mills located in Utah and the surrounding states. The U.S. Forest Service has indicated a willingness to sell 3,000,000 cords of wood over a 30-year period. The Kaibab Lumber Co. would like to sell wood residues if a purchaser can be found.

Water is a critical factor. Ground water appropriation has been closed in many counties, so the only available water is surface water -- possibly the Green River.

The only legal and logical method of handling pollution is by evaporating effluent from a dry lake.

The last factor, power, is available in many forms: gas, oil, coal and electric. Coal is the least expensive, followed by gas,

The preliminary investigation indicates that the factors of production are available at reasonable costs. Further investigation will indicate whether or not Utah offers a firm, with its unique internal costs, a comparative advantage over other possible mill locations.

Although these specific cost data are not available, and assuming chemical, capital, labor, power, and water costs are similar to costs in other geographic areas, implications can be drawn from the available information concerning the critical factors, wood and transportation costs.

Whether or not society gains from a pulp mill located in Utah will depend upon the cost situation and the procedure the Forest Service uses to appraise pulpwood. If the price marginal resource cost is less than the value of the marginal product, society will gain if the mill is established. The MRC of wood will be reflected through the appraised price of wood; the opportunity cost of pulpwood in Utah being virtually zero and the appraised minimum price would probably reflect administrative costs. So, if the VMP is less than administrative costs, society would not benefit. If the one dollar per cord is a realistic cost and the VMP exceeds one dollar, society would benefit from the sale of the pulpwood for pulp and paper production.

To sum up, if, assuming the transportation cost advantage outweighs the possible wood cost disadvantage, the VMP exceeds the MRC,

a firm, as well as society, will benefit if a pulp and paper mill is established in Utah.

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VITA

Thomas Meyer

Candidate for the Degree of

Master of Science

Thesis: The Feasibility of Pulp and Paper Production in Utah.

Major Field: Economics

Biographical Information:

Personal Data: Born in New York City, N. Y., June 21, 1942, son of Fredrick and Rose Meyer.

Education: Attended elementary and high school in Franklin Lakes, New Jersey; attended Paul Smiths College, located in Paul Smiths, New York; received a Bachelor of Science degree in Forestry from Utah State University in 1966; completed requirements for a Master of Science degree in economics in 1968 at Utah State University.