TRENDS IN U.S. WOOD-BASED INDUSTRIAL TECHNOLOGY: AN EVALUATION OF ASSIGNED PATENTS[1]

by

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

American industry of the 1950's and 1960's was buoyed by an era of economic euphoria; responding to such conditions with a variety of strategies and tactics that promoted product sales in the market place. In the 1970's and early 1980's, however, steadily enlarging markets that could absorb ever growing industrial output was no longer the case. Even more alarming, foreign competitors began to exercise considerable strength in U.S. markets, a condition brought about largely by their ability to supply superior quality products at lower prices. Clearly, new strategies had to be developed, better products had to be devised, and greater attention had to be directed to the consumer.

Part of the problem facing many U.S. industries was a perceived erosion of one of the nation's great strengths: technological inventiveness. According to the Stanford Research Institute, the United States initiated more than 80 percent of the world's major innovations in the 1950's; today it is close to 50 percent -- and foreign interests are acquiring a larger share of U.S. patents. The domestic firms' share of U.S.-issued patents fell from 78 to 63 percent between 1967 and 1977, while during the same period Japan's share increased from 2 to 10 percent and West Germany's from 6 to 8 percent. After years of leading the world in the proportion of gross national product devoted to research and development, U.S. firms' average yearly investment in such activities (excluding military research and development) during the early 1980's, fell to 1.5 percent of gross national product, trailing both West Germany (2.0 percent) and Japan (1.9 percent) (Lewis 1982). In more recent years, this trend has somewhat reversed as U.S. companies begin to invest more heavily in research and development activities. Such is a reflection of their interest in becoming more "innovative."

Research and development investments can be very informative indicators of the actual output of a research program. They do not, however, provide a very clear indication of the type of technologies that are being produced. One means of securing a more refined understanding of new technologies flowing from research and development investments is to identify and evaluate technologies that are being patented. Such was the intent of the research presented here, namely, to evaluate patents as a measure of technical progress within the U.S. wood-based industry.

U.S. PATENT SYSTEM

Historical Development

The development of civilization has been aided over the centuries by many discoveries and inventions. Thousands of years before the dawn of history (i.e., the development of writing, circa 2500 B.C.), fire had been tamed, wheels had been developed, animals had been domesticated, and a variety of other discoveries had been made in such diverse fields as construction, mining, agriculture and metallurgy. These seemingly basic inventions took literally thousands of years to bring to fruition. With the emergence of the Greek civilization, however, the pace of discovery accelerated considerably. Among the many inventions coming forth during the Greek era were water clocks, balances, levers, surveyor instruments, water wheels and the catapult. The governing body in ancient Athens, Greece, granted franchises to persons inventing or introducing new products or systems. Such franchises are the first recorded instance where patent-like instruments were used.

With the advent of the Renaissance (end of the 13th century), the notion of "patents" became more widespread. The Mediterranean area (especially Italy) was dominant in this respect, having craftsman working on products from metal, glass and textiles is such cities as Florence and Venice. The first record of a patent was that issued by the Republic of Florence in 1421 for a barge fitted with hoisting gear to load and unload marble. The inventor was rewarded with a three year monopoly for use of the system. The Republic of Venice granted similar monopolies -- called privileges -- which were viewed as means of fostering new enterprises. The first such privilege was granted for a printing process in 1469; by 1550 more than 100 privileges had been granted in Venice.

The Mediterranean area's dominance in the field of craftmanship and inventions did not last for long. Lucrative offers from other regions and religious persecution at home persuaded many Italian craftsmen to take their technologies elsewhere. From the 15th through the 17th century, craftsmen and inventors were a highly mobile group that moved throughout Europe and the American colonies in response to more lucrative rewards for their talents. The granting of monopolies was a major means of reward. Since such monopolies were granted by local units of government or countries, no invention of any merit was confined to any one location for very long. Johann Gutenberg's invention of moveable type spread throughout Europe in less than 30 years -- all without gain to Gutenberg. Meanwhile, patent systems were introduced in Germany (1484) and France (1543).

Monopoly, not invention, was the underlying principle of the patent concept. Originally the word "patent," derived from the Latin Literae patentes, referred to the granting of a special privilege by a monarch to a subject, usually of the nobel class. English rules often exercised the monopoly principle as a right of the crown to regulate details concerning trade. This practice was widely abused and eventually curtailed

by Parliament (Statute of Monopolies of 1623). A major exception was the protection of patents; to this day, English law considers the granting of a patent to be the prerogative of the crown, not the right of the inventor (Skolnik 1977).

Interest in encouraging development of new industries lead American colonies to invoke the exercise of monopoly. By 1787, all but one state had enacted a copyright law. These laws were superseded by the United States Constitution which gave the federal government the power "... to promote the progress of science and useful arts by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries." The first U.S. patent law (April 10, 1790) granted patents for up to 14 years and placed administrative responsibility for granting patents in the Department of State. The law required inventors to file a specification in writing, a drawing, and, if feasible, a model.

The current numbering system for U.S. patents was initiated in 1836; by that date some 4,000 patents had been issued. On August 8, 1911, the one millionth patent had been issued; the two millionth on April 30, 1935; the three millionth on September 12, 1961; and the four millionth on December 28, 1976. The latter patent covered a process for recycling asphalt-aggregate compositions.

The first U.S patent law has over the years been modified by successive laws and amendments. Some of the more notable are:

- Patent Act of 1836. Established the U.S. Patent Office and Commissioner of Patents under the Secretary of State. The Act required systematic examination of patent applications.

- Patent Act of 1861. Extended the term for which a patent was granted to 17 years.

- Patent Act of 1870. Authorized the printing and distribution of patent descriptions, patent laws and patent decisions. The law made printed information about patents available to the public at low cost.

The requirement that models be part of a patent application was waved after 1880, except when specifically required by the patent office (Patent Office Society 1966).

The first U.S. Patent Office classification of patents was initiated in 1830 with identification of 16 patent classes. Currently, U.S. patents are classified according to about 400 main classes and 100,000 subclasses. By law, patent classification systems are to serve persons charged with examining patent applications. They are also very useful tools for researchers interested in assessing changes in technology (Skolnik 1977).

Rationale for Patents

A patent is a limited government grant to inventors whereby they may exclude others from making, selling or using an invention. In exchange for such rights, inventors must agree to make their invention known to the public. In order for an invention to be patentable, an applicant must demonstrate that the invention passes criteria concerning novelty, usefulness and obviousness. In addition, the invention must fall into one of the following categories:

- process -- method or steps for achieving a result.
- machine -- an operable structure.
- manufacture -- an object made by man or machine.
- composition of matter -- a homogeneous compound of two or more ingredients.
- improvement of something in the preceding classes.

The "novelty" criteria requires that an invention be demonstrably different from the prior art. This implies that an inventor know all prior art in the field being addressed -- such being no easy task. To satisfy the "usefulness" criterion, inventors must demonstrate accomplishment of some desirable objective. Patentable uses, however, need not be profitable or commercially desirable. And the "obviousness" criterion implies that an invention not be obvious to a person of ordinary skill in the particular art at the time of invention (Joenk 1979).

The most common rationale for granting patents is that without monopoly protection, an inventor has no incentive to risk time and money in developing a new product or process. The path from conception of an idea to its realization as a profitable product involves substantial risk, as Wolber (1979) notes in the case of the xerographic copying process:

> "Chester Carlson, the inventor; Battelle, the developer; and the Haloid Corporation (which evolved into the Xerox-Corporation) all reaped rewards for their ingenuity, daring, hard work, and persistence -- but only after nearly a decade of effort. The protection afforded by patents was crucial to their success."

The issuing of patents to an individual or corporation in effect turns patented technology into property (for a period of time). Thus, as with other properties, patent rights may be assigned, sold, licensed, or traded to others. Therein lies another reason for their existence. If inventors do not have the resources necessary to bring an invention to market, they can license it to an entity which is able to do so. As a result, the inventor, the licensee (or buyer), and the public all benefit.

Businesses also patent inventions for various tactical reasons, including (Dorl 1967):

- means of fencing off fields of research.
- purposes of trading and cross-licensing.
- enable engineers and scientists the opportunity to freely disclose and discuss their inventions.
- protection of incomplete research inventments.
- guide to where a company can prudently invest.

Other business uses of patents include improving corporate image, rewarding employees, and attracting government research and development grants.

Lastly, governments have historically been satisfied that patent protection of inventions has quickened the pace of innovation. This has been termed the "free transfer of information" effect, the lack of which is said to be a hindrance in centrally planned economies (Wolber 1979).

Classification System

The U.S. Patent and Trademark Office (PTO) has primary responsibility for administrating the patent system. Its two primary functions are to determine the patentability of applications submitted by inventor, and to collect, classify and disseminate the technical information disclosed in patents. Huge amounts of information are stored at the Office's Arlington, Virginia, headquarters. For the more than 4 million patents issued to date, two sets of files are retained, namely, one for the general public, the other for the more than 1,000 patent examiners that search the files in their quest to determine the patentability of new inventions (Dood 1979).

The vast amount of information available in the files of the Patent and Trademark Office would be of little use without efficient means of identifying it, locating it and retrieving it. Such is the function of the U.S. Patent Classification System. Under the system, all patented technology is categorized according to approximately 400 technology classes which in turn are subdivided into an additional 100,000 subclasses. Classes and subclasses are continually being changed in order to accomodate new technologies. The position of subclasses within a class is hierarchical in form (Table 1). All subclasses with titles beginning in vertical alignment are said to be "coordinate" with each other; titles beginning farthest to the left are termed "mainline" and serve as headings for the primary divisions of each class. The subject matter of any subclass includes not only that denoted by its own title, but also that of all subclasses in which it is nested. For example, the subject matter described by classification 229-31.0FS is understood to be folded blank boxes: trays: corner folds: infolded sides. More elaborate definitions of patent subclasses are contained in the Classifications Definitions Manual (Patent and Trademark Office 1982).

An inventor's field of search may be assisted by the Index to U.S. Patent Classification (Patent and Trademark Office 1981a), a manual which presents an alphabetic listing of subject material covered by the patent classification system. Relevant classes and subclasses are listed for each topic (Table 2). Once topical areas have been identified, specific patents can be located by referring to the Index of Patents: Part II - Index to Subject of Invention (Patent and Trademark Office 1981c). In the latter, patents issued in a particular year are listed according to class and subclass (Table 3). A description of the patent of interest can then be referenced in the appropriate (Patent Gazette or purchased from the Patent and Trademark Office.

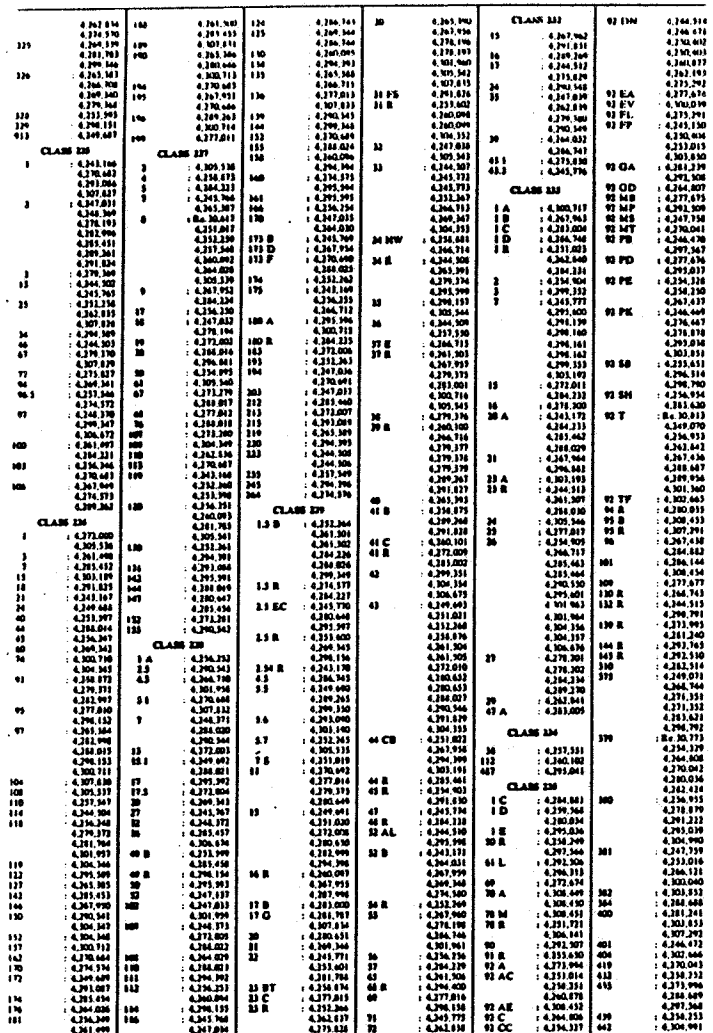
The process of patent search can be very time consuming and tedious, especially when a large number of patents and technology areas are to be investigated. The Index of Patents: Part I - List of Patentees can be of considerable help (Patent and Trademark Office 1982b). The Index contains an alphabetical listing, by inventor, of all patents issued in a particular year (Table 4). Patents assigned to corporations as well as the actual inventor are listed. By looking up the name of a corporation (or research institution, government, etc.) which operates in a particular field, a researcher can cross reference to the inventor and determine the nature of the patented technology. Included in the listing for each patent is a one-line description of the invention's technology, the date of issuance, and the patent's classification number. In such fashion, specific technologies developed at a specific point in time can be readily identified. The process of subjectively deciding the class and subclass to be searched as identified in the Classifications Definition Manual can be circumvented. Doing so, however, would not be applicable in technical fields where formally recognized institutions are not the principle producers of patents.

CLASS 229 PAPER RECEPTACLES

16	N	FOLDED BLANK BOXES
16	A	..Tabs in front and back
16	C	..Berry boxes, inner piece
16	D	..Display
24		.Buckets
25		..Closures
26		...Integral cover
30		.Trays
31	R	..Corner folds
31	FS	....Infolded sides
32		..Corner flaps
33		...Cover extension
34	R	...Infolding side
34	A	.....Outfolded sides
34	B	.....Collapsible infolded flap
34	HW	.....Hollow wall
35		...Interlocking
36		....Cover extension
37	R	.Tubes
37	E	...Reinforced end of rim
38		..Closures, inserted flaps
39	A	...Interlocking
39	B	.....Bulbs
40		.Wrappers
19		.Slide
20		..Dispensing
27		.Compartment
28	R	..Cells
28	BC	....Bottle carriers
29	B	...Wrapper
29	B	.....Integral transverse partition
29	C	.....Integral longitudinal partition
29	D	.....Integral transverse and longitudinal partitions
29	E	.....And separate partition
29	F	.....Apertured
29	M	.....Molded
17	R	.Dispensing
17	B	...Gravity feed to bottom
17	G	...Gable top
17	M	...Metered closures
17	SC	...Slide closures
17	S	...Rolls and sheets
23	R	.Multiple
23	A	...Multiple bottom
23	AB	...Crossed blanks
23	BT	...Telescoping
23	C	...Wood reinforced
18		.Sectors
22		.Triangular
21		.Cylindrical
6	R	BOXES
6	A	..Ventilating spacers, chick boxes
8.5		.Sayings
9		.Slide
10		..Compartment
11		..Dispensing
15		.Compartment
42		.Division plates
7	R	.Dispensing
7	S	...Straw
7	SC	...Slide closures
8		.Ornamental
41	R	.Collapsible
41	B	...Blanks
41	C	...Six or more sides
41	D	...Truncated (usually hexagonal)
43		.Closures
44	R	..Hinged
44	CB	....Lid (cigarette box type)
44	M	....Metal hinge
44	EC	....Egg carton
45	R	..Fasteners
45	EC	....Egg carton
46		...Cord
47		...Metallic
52	R	.Handles
52	A	...Attached
52	AC	...Cord
52	AL	...Loop
52	AM	...Metal
52	AW	...Wire
52	B	...Integral
52	BC	...Bottle carrier
48	R	.Seams
48	SA	...Permanent seal
48	SB	...Tacky adhesive
48	SC	...Waterproof coating
48	T	...Thermoplastic seal
49		.Stays
50		..Cord
53		BAGS
54	R	.Satchel
54	C	...Cord handle
55		.Reenforced
56		.Compartment
57		.Bottoms
58		..Perpendicular to sidewalls
59		...Corner slits
60		...Diamond fold
61		...Seamless
62		.Closures
62.5		..Valve type
63		..Cord
64		..Fluted
65		..Metallic
68	R	ENVELOPES
68	C	..Carrying handles
69		.Series
70		.Coupon
71		.Display
72		.Compartment
73		.Return
74		.Tag
75		.Blanks
76		.Closures
77		...Fasteners
78	R	...Metallic
78	A	.....Detachable fastener
78	B	.....Inseparable fastener
79		...Seal
80		..Sealing
81		...Perforated
82		...Tongues
83		...Soluble dye
84		..Tongue
87	R	WRAPPERS
87	A	..Apparel and accessories
87	B	..Baked goods (e.g., bread)
87	C	..Cigars, cigarettes, tobacco
87	F	..Food (other than bread)
87	G	..Gum
87	H	..Hardware
87	P	..Plants and flowers
87	J	..Razor blades
87	S	..Shirt
87	T	..Tires
87.2		.Coin type
87.5		.Pocketed
88		.Bag
89		.Bottle
90		..Corrugated
91		..Padded
92		.Mailing sheets
92.1		.Letter sheets
92.3		..Display
		..Closures
92.5		...Fasteners
92.7		...Flap
92.8		POSTAL CARDS OR PACKETS
92.9		COIN CARDS
93		TUBES, CYLINDRICAL
67		BARRELS
1.5	R	MISCELLANEOUS
1.5	B	..Cups
1.5	C	...Spoon attached

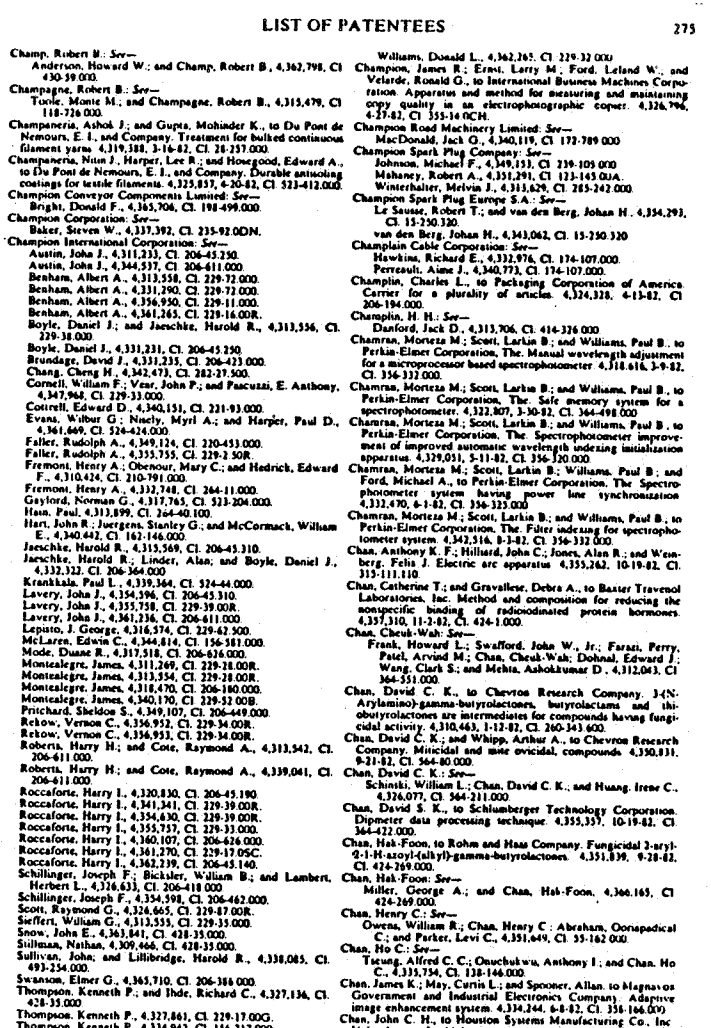
Table 1. Patent classification system, example subclasses for paper receptacles.

Table 2. Patent classification system, example of alphabetical listings for packaging.



CLASSIFICATION OF PATENTS 51

Table 3. Patent classification system, example of annual listings for paper receptacles (Class 229, year 1981).



LIST OF PATENTEES 275

Table 4. Patent classification system, example of patent listings assigned to institutions (Chanpion International, 1982).

PATENTS AND THE U.S. WOOD-BASED INDUSTRY

The U.S. wood-based industry reported $603 million of inventments in research and development activities in 1979. Of this total, $454 million -- 75 percent -- originated with activities of the paper and allied products group. The remainder was invested by the lumber and wood products group or the wood furniture and fixtures group (Table 5). During the period 1977 to 1982, research and development investments by wood-based companies was generally in the range of 1.0 to 1.5 percent. Such was below the average recorded for 776 companies of all types during the same period (Ellefson and Stone 1984). The level of investment in research and development by the wood-based industry continues to be below that of many other industries (Table 6). In 1983, the building materials and the paper industries were below the all industry average for research and development expenditures as a percent of sales and a percent of profit. The paper industry did, however, exceed all industry averages for such expenditures per employee -- not so for building materials.

Industry Sales Relative to Research and Development Investments

An industry's investments in research and development could be hypothesized as being related to an industry's sales growth record. The industry with stagnate or declining sales would be less likely to invest in new product development than the industry facing a promising future in the market place. Analysis of industry-wide data in Table 6 results in a fairly strong positive correlation (0.715) between research and development investments as a percentage of sales and percentage growth in industry sales over a five year period (1979-1983) (Appendix A). Such is a positive sign that industry sales and industry research and development investments move hand in hand. Such would also be expected of the wood-based industry in general.

Patents Relative to Research and Development Investments

Patents can be viewed as a product of research and development investments. In fact, several studies have shown the relationship to be rather strong (Scherer 1975). What of the wood-based industry? Company data for two time periods were analyzed, namely, 1982 patents and 1976 research and development investments, and 1982 patents and 1983 research and developments (Tables 7 and 8). The former involved 12 companies; the latter 15.

Table 5. Investments in research and development, by major US industrial group. 1979.

SIC Code	Major Industry Group	Research and Development Investments (million dollars)
20	Food and Kindred Products	480
22, 23	Textile Mill Products and Apparel, Other Textile Products	91
24, 25	Lumber and Wood Products and Furniture and Fixtures	149
26	Paper and Allied Products	454
28	Chemicals and Allied Products	4,035
29	Petroleum and Coal Products	1,224
30	Rubber, Miscellaneous Plastic Products	551
32	Stone, Clay, Glass Products	348
33	Primary Metal Products	612
34	Fabricated Metal Products	467
35	Machinery, Except Electrical	5,126
36	Electric, Electronic Equipment	7,646
37	Transportation Equipment	13,036
38	Instruments, Related Products	2,050
21, 27, 31, 39	Tobacco Products, Printing & Publishing, Leather & Leather Products, and Miscellaneous Manufacturing Industries	304
	Total Manufacturing	36,573
	Nonmanufacturing Industries	1,380
	Total	37,453

Source: Ellefson and Stone 1984.

Table 6. Industry sales and research and development expenditures, by major US industry group. 1983.

Industry	Sales		Research and Development Expenditures			
	1983	Percent Annual Growth 1979-1983	1983 Expense	Percent Of Sales	Percent Of Profit	Dollars Per Employee
	millions	percent	millions	- - percent - -		thousands
Aerospace	56023	11.2	2575.5	4.6	79.2	4.2
Automotive(cars,trucks)	140366	1.4	4905.7	3.5	61.8	4.0
Building Materials	12297	3.1	171.6	1.4	25.6	1.5
Containers	12900	-1.1	103.4	0.8	18.9	0.8
Electronics	39114	9.4	1592.4	4.1	66.7	2.6
Fuel	387557	4.2	2366.6	0.6	6.1	2.9
Information Proc.(Cmptr)	81725	14.3	5853.2	7.2	43.7	6.0
Metals and Mining	19968	-3.1	211.0	1.1	NEG	1.5
Paper	30499	5.2	300.8	1.0	17.0	5.2
Personal & Home Care	32031	6.2	788.7	2.5	22.8	2.9
Semiconductors	8830	11.7	734.8	8.3	NEG	4.1
Steel	27363	2.3	173.6	0.6	NEG	0.8
Telecommunications	88050	11.7	1295.7	1.5	11.0	2.1
Textiles, Apparel	9748	3.5	75.4	0.8	14.7	0.5
All Industry Composite	1528	3.9	39.2	2.6	31.0	3.0

Note: NEG = Negligible

Source: BusinessWeek 1984

Table 7. Patent frequency(1982), company sales (1976) and research and development expenditures (1976), by selected US wood-based companies.

Company	1982 Patents	1976 Sales	Research and Development Expenditures			
			1976 Expense	Percent Of Sales	Percent Of Profit	Dollars Per Employee
		- - - - millions - - - -		- - - percent - - -		
Bemis	1	609	5.2	0.9	33.1	391
Consolidated Papers	3	293	1.9	0.7	8.9	395
Crown Zellerbach	13	2136	9.2	0.4	9.4	289
Hammermill Paper	0	690	1.5	0.2	8.6	136
Hexcel	2	62	2.0	3.2	75.1	1409
International Paper	15	3541	20.1	0.6	7.9	384
Kimberly-Clark	26	1585	21.8	1.4	17.9	787
Potlach	0	624	1.9	0.3	4.1	193
St. Regis	4	1642	7.6	0.5	6.3	270
Scott Paper	16	1374	24.4	1.8	33.4	1185
Union Camp	5	1003	7.9	0.8	6.7	533
Westvaco	14	922	8.5	0.9	15.0	558

Sources: Businessweek 1977
Index of Patents: Part I-List of Patentees 1982

Relating sales and investments in research and development in 1976 to patents assigned in 1982 may appear as a major discrepancy in time (Table 7). Such can, however, be explained by the long-term nature of research and development activities. The period of time between original investment in an idea and its appearance on the market can be one to ten years or longer. In addition, there is typically a two year period during which a patent application is examined. For purposes of analysis, six years was selected as an approximation of the period of time between investment in an idea and issuance of a patent. Using such an average is not without problems. For example, patents issued in any one year may be the result of research investments made over many years. And patents are not always traceable to investments in a specific program, they can result from technologies developed from a variety of research programs brought together from within and out of an industry.

There exists a strong correlation between the number of patents issued to 12 wood-based firms in 1982 and research and development investments made in 1976 (0.87) (Table 7). Similarily, a strong positive correlation exists between 1982 patents and 1983 research and development investments of 15 companies (0.89)[1] (Table 8). The latter does not reflect the lag between time of investment and time of patent issuance; in fact, data for patent numbers and research and development investments may be viewed as being out of sequence (patents issued in 1982, investments made in 1983). What might explain this correlation? Quite possibly, companies may be operating in expectation of future research benefits, i.e., past research and development has been successful so invest more and then anticipate future benefits. Or a more prosaic explanation is that companies have accumulated large amounts of equipment and personnel for research and cannot afford to let such resources lie idle. Whatever the reasons, the strong correlations between research and development investments and patents (regardless of time lags) issued to wood-based companies is supportive of the notion that the two variables are most certainly related (Appendix A).

Patents as Indicators of Change in Technology

A positive relationship between the frequency of assigned patents and the magnitude of research and development investments leads to the question: if such a relationship is true for the frequency of patents issued to specific companies, can it also be demonstrated to be true for broader areas of technology? Can trends in research and development investments leading to certain types of patents (i.e., patent class or subclass) be a reflection of future technologies as well as the demise of others?

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[1]Residual analysis showed that Mead Corporation was a distant outlier; further research discovered that most of Mead's patents were related to the Company's electronics business. Because of this situation, the Mead Corporation as a case was deleted from the analysis (Appendix A).

Table 8. Patent frequency (1982), company sales (1983) and research and development expenditures (1976), by selected US wood-based companies.

Company	1982 Patents	1983 Sales	Research and Development Expenditures 1983 Expense	Percent Of Sales	Percent Of Profit	Dollars Per Employee
		millions		percent		
Bemis	1	701	8.4	1.2	44.3	1038
Boise Cascade	4	3451	6.0	0.2	6.8	210
Crown Zellerbach	13	2722	12.3	0.5	9.9	659
Fort Howard	0	786	3.4	0.4	1.7	230
Hammermill Paper	0	1623	5.9	0.4	10.9	454
James River	3	1656	18.3	1.1	19.3	989
Kimberly-Clark	26	3274	53.1	1.6	17.6	1569
Masonite	2	419	5.2	1.2	18.0	692
Mead	45	2367	49.0	2.1	128.3	2882
Rexham	3	197	3.1	1.6	23.3	1207
St. Regis	4	2775	13.4	0.5	18.5	516
Scott Paper	16	2465	29.3	1.2	15.8	1723
Union Camp	5	1688	26.6	1.6	16.5	1538
Westvaco	14	1493	19.9	1.3	20.7	1338
Weyerhaeuser	21	4883	46.9	1.0	15.8	1172

Sources: BusinessWeek 1984
Index of Patents: Part I-List of Patentees 1982

Table 9. Frequency of patents granted selected wood-based firms using patent classification analysis, by company division assignment. 1974, 1978 and 1982.

Patent Class Number	Description	Year Of Patent Issue 1974			1978			1982		
		Type Of Forest Products Firm (Division)								
		I	II	III	I	II	III	I	II	III
		percent								
19	Textiles, Fiber Preparation			2.7			8.2			
23	Chemistry, Analytical & Phys.					3.1				
28	Textiles, Manufacturing					6.3				
53	Package Making	6.3					6.1			
57	Textiles, Spinning, Twisting					5.2				
73	Measuring and Testing					2.1				
74	Machine Elements & Mechanisms		4.9							
93	*			5.4						
96	*			2.7						
106	Compositions, Coating/Plastic					2.1				
117	*		24.4	8.1						
128	Surgery			2.7		2.1				
144	Woodworking					5.2			3.2	
156	Adhesives & Misc. Chem.	6.3		9.5		3.1			2.1	
162	Papermaking & Fiber Liber.	4.2		18.9	7.1		8.2	5.8	4.2	
198	Conveyors, Power-driven			2.7						
206	Special Receptacle or Pkg.	10.4		4.1	21.4	15.6	6.1	28.8	20.0	
210	Liquid Purification or Seper.					3.1				
220	Metallic Receptacles	4.2						7.7		
221	Article Dispensing									4.8
222	Dispensing	8.3								
229	Paper Receptacles	27.0	4.9	2.7	45.2	11.5	14.3	25.0	32.6	16.7
252	Compositions								2.1	4.8
260	Chemistry, Carbon Compounds		14.6	10.8		8.3	8.2			4.8
264	Article Shaping/Treating Proc.								3.2	
270	Sheet Mat'l Associating/Fold'g			2.7						
427	Coating Processes									7.1
428	Stock Mat'l or Misc. Article					14.6	16.3		4.2	11.9
493	Mfg. from a Sheet or Web								2.1	
524	Synthetic Resins/Natural Rub'r								2.1	
	Other	33.3	51.2	25.7	26.2	17.7	28.6	28.8	21.1	50.0

* Note: Classes 93, 96, and 117 were not named in the 1982 *Manual of Classification*.