Professional Affairs

FOREST PRODUCTS RESEARCH AT U.S. UNIVERSITIES IN 1982[1]

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ABSTRACT

This is a survey of professional staffing, research emphasis, and funding levels of the 37 universities in the United States that conduct forest products research. The survey was conducted by the Subcommittee on Forest Products Research, National Planning Group for Forestry (NPG-2).

Keywords: Products research, utilization research, university research.

INTRODUCTION

This report presents findings of a survey on professional staffing, research emphasis, and funding levels of the 37 universities in the United States that conduct forest products research. The goal was to provide an overview of the "critical mass" of wood science and technology research at U.S. universities.

Much of forest products research in academia is conducted by individuals either working alone or with the assistance of a few other researchers. In the late 1970's, however, the Forest Products Laboratory (U.S. Department of Agriculture, Forest Service) in Madison, Wisconsin, initiated a number of cooperative studies with universities, thereby attracting additional talent for conducting high priority research. At the same time, the idea of increased cooperation among universities became attractive.

To help guide cooperative research between the Forest Products Laboratory and the university community, the Forest Service established a Subcommittee on

[1] At the time this report was prepared, the authors were members of the Subcommittee on Forest Products Research, National Planning Group for Forestry (NPG-2).

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TABLE 1. *North-Central Region. Scientist years for 1981–1982 by research areas.*

University	Funda-mental	Manage-ment	Pro-cessing	Products	Total
Illinois	0.5			0.8	1.3
Southern Illinois			0.2	0.4	0.6
Iowa State			0.4	0.2	0.6
Kansas State		0.2			0.2
Michigan State	0.6	0.2	0.2	0.9	1.9
Michigan Technological	0.7		0.3		1.0
Michigan		0.1			0.1
Minnesota	1.4	1.4	2.9	2.0	7.7
Missouri	1.0		0.5		1.5
Ohio State		0.2	0.2		0.4
Purdue	1.2	0.2	0.7	1.7	3.8
Wisconsin	0.7	1.8	0.4	0.2	3.1
Total	6.1	4.1	5.8	6.2	22.2

Forest Products Research. This subcommittee exists under the structure of the Forest Service's National Planning Group, which is concerned with forestry planning in general and was organized in response to the 1974 Resources Planning Act.

Subcommittee members consisted of the authors, who represented universities from the Western, Northeastern, North-Central, and Southern Regions, respectively, and four Forest Service representatives. One of the authors' tasks was to survey forest products research capabilities at U.S. universities. To this end, they conducted a preliminary survey in 1981 to determine areas of research covered by universities with forest products programs.

The results were presented at the Forest Products Utilization Research Conference held in that year at the Forest Products Laboratory. In 1982, authors conducted a second survey of the same institutions in their respective regions to determine professional staffing, research emphasis, funding, and to some extent, facilities, the major results of which are reported here. Of course, the actual level of research within a university is determined by appropriations both at state and federal levels under McIntire-Stennis (M-S) legislation. In addition, cooperative aids, grants, and contracts are also an important element of university research funding.

North-Central Region

Programs.—During 1982–1983, 18.8 Scientist Years (SY's) were devoted to forest products and utilization research at 12 universities (Table 1) in the North-Central Region. This is a 15% decline in effort since 1981–1982. This reduction is the result of research retrenchments at four of these institutions.

Research areas.—Table 2 breaks out the areas of research effort during Fiscal Years (FY's) '82 and '83. The reduction of 3.4 SY's in the total effort in the region is distributed across nine different research interests. The greatest reduction of effort was in Economics and Financial Management, which dropped from 2.8 to 1.1 SY's. Note that many research areas are allocated less than 0.5 SY's total. This likely reflects the varied teaching commitments of faculty and the diverse

TABLE 2. *North-Central Region. Scientist years by research subject matter.*

	1981–1982	1982–1983	Increased	Decreased
Fundamental				
Biology	0.8	0.8		
Chemistry	2.5	2.4		0.1
Physics	0.5	0.2		0.3
Mechanical prop. and eng.	2.3	2.3		
Management				
Application of technology	0	0.7	0.7	
Economic and financial	2.8	1.1		1.7
Marketing	0.7	0.3		0.4
Production mgt.	0.6	0.6		
Processing				
Drying	1.9	1.7		0.2
Energy conservation	0.9	0.2		0.7
Gluing	0.5	0.6	0.1	
Fastening	0.1	0.1		
Process control	0.2	0		0.2
Timber production	2.2	1.2		1.0
Products				
Construction plywood	0.4	0.4		
Fiberboards	0.4	0.4		
Engineered structures	0.2	0.2		
Particleboard	3.4	3.4		
Treated products	0.1	0.1		
Bark and residues	0.2	0.5	0.3	
Furniture and millwork	0.9	0.8		0.1
Hardwood lumber	0.4	0.4		
Pulp and paper	0.2	0.4	0.2	
Total SY	22.2	18.8		3.4 (15%)

interests of graduate students rather than institutional or regional plans or priorities. As such, these small research efforts may be well justified, but may not be generally recognized by research administrators as parts of research plans.

Four areas of research appeared to be of major interest in the North-Central Region. These four areas (particleboard, chemistry, wood engineering/mechanics, and drying) constituted over one-half the total research effort. All appeared to be justified in terms of regional problems or national priorities.

Particleboard research was largely directed to the rapidly growing structural particleboard industry. It varied between the five institutions involved, from engineering-oriented work to process technology to basic microbiological problems. Chemical research is largely fundamental, including lignin chemistry, cellulose pulp production, and surface chemistry. These projects were based upon the need for chemical feedstocks and liquid/gas fuels from lignocellulosics and have potential importance for future utilization of agricultural as well as forest biomass.

It appeared from the general description of research interests we compiled that 35–40% of the research being conducted by universities in the North-Central

TABLE 3. *North-Central Region. Research funding source for fiscal year 1983.*

Source of research funds	% Distribution within each institution			
	Avg. % for 9 universities	Avg. % for programs over $100 M (4)	Range of % for 9 universities	Number of programs receiving funds
State appropriations	47	45	3–100	9
USDA Forest Service	29	24	0–53	7
McIntire-Stennis	17	18	0–50	6
Other federal	0	7	0–16	2
Industry	7	6	0–21	6

Support for research programs	
	$1,000/yr
Range for 9 institutions	8–502
Avg. for largest 4	251

* Eleven institutions are involved in forest products research but two of the smaller programs did not provide fiscal data.

Region might be classified as basic or fundamental. This suggests that a gradual shift is underway from basic research toward research with applicable technology as a goal. This will be a slow change, but it probably will continue because of philosophical, if not fiscal, encouragement from within the academic community.

Funding.—Table 3 breaks down funding by major source categories. All institutions, of course, received state funds, which typically provide slightly less than one-half the total. However, one institution allocated almost no state funds to forest products research, while at another, state money funded all forest products research. The other source of recurring (hard) funds for forest products research, McIntire-Stennis typically provided about one-fifth of the research support, although at one institution it funded one-half of the research program. United States Forest Service support for forest products research plays a very important funding role and averaged about one-fourth of the total support. Because of its short term (soft) nature, it often provided the money for research assistants and operating expenses, from travel to computer costs. Only two institutions received federal research funds outside of USDA. In these cases, however, that support was significant.

The industry provided some assistance to most of the research programs, but in most cases only for short-term projects on a contract basis. The working relationship with industry was generally looked upon, however, as being important beyond its apparent financial impact. The liaison that develops as a result of this support increases the likelihood of commercial application of new technology and also helps the researcher assess the research needs and priorities of his or her clientele. Often industry can influence, with considerable leverage, the research emphasis or at least the interest of the researchers. Research administrators should see this as a positive influence unless institutional goals are being circumvented. None of the forest products research programs in the North-Central region was large—the largest being supported by a total of about $500,000 per year. Only 4 of the 12 universities surveyed are investing over $100,000 in forest products research. The support per SY varied widely from $115,000 at one institution down to $20,000. The average support per SY was about $50,000. Problems in

TABLE 4. *North-Central Region. Major research program areas for fiscal year 1982–1983.*

Research area[1]	SY's	Number of institutions involved
Particleboard	3.4	5
Chemistry	2.4	3
Wood engineering and mechanical properties	2.3	3
Drying	1.7	6
Timber production	1.2	3
Economics and financial management	1.1	3

[1] All other research areas less than 1 SY.

comparability of data between institutions probably explains a portion of this variability. Nevertheless, this range of support per SY indicates a serious problem that many institutions suffer. A major portion of the funds was being devoted to faculty salaries, while the money available for technicians, support services and equipment was inadequate to provide a highly productive environment for research.

Northeastern Region

Programs.—There were six, out of seven, universities with active forest products research programs in the region and the survey data are summarized below.

Table 5 lists the institutions and the total number of forest products research projects in the six active research programs in the Northeast. All of the programs, except that at Syracuse, were administered within schools of forest resources or departments of forestry. At Syracuse, the Wood Products Engineering Department and the Paper Science and Engineering Department are in the School of Environmental and Resource Engineering, College of Environmental Science and Forestry. In addition, the Chemical Engineering Department in the College of Engineering at the University of Maine had an active pulp and paper research program and preliminary data from this program were included in this report.

Additional forest products research projects were located in non-forest products departments at those six universities (Table 5). However, these projects were few and widely scattered, and data on them were not included in this report. The

TABLE 5. *Northeast Region. Forest products research projects in 1982.*

University	Forest products utilization and marketing projects	Pulp and paper	Harvesting project	Total projects	
				No.	%
1. Maine[1]	8	10	3	21	25
2. Massachusetts	3	—	—	3	4
3. New Hampshire	1	—	—	1	1
4. Pennsylvania State	10	1	—	11	13
5. SUNY–Syracuse[2]	26	13	2	41	49
6. Vermont	—	—	—	—	—
7. West Virginia	6	—	1	7	8
Total	54	24	6	84	100

[1] Includes faculty of the Forest Products Laboratory of College of Forest Resources and Pulp and Paper in Chemical Engineering Department.

[2] Includes the Departments of Wood Products Engineering and Paper Science and Engineering.

TABLE 6. *Northeast Region. Scientist years for 1982.*

University	Teaching[1]		Research[1]		Extension[1]	Total
	FP	PP	FP	PP	FP/PP	
Maine	3.00	3.00	3.00	2.00	0.50	11.50
Massachusetts	2.55	0.00	0.35	0.00	0.20	3.10
New Hampshire	0.50	0.00	0.50	0.00	0.00	1.00
Pennsylvania State	2.10	0.20	1.40	0.30	1.00	5.00
SUNY–Syracuse	6.00	5.00	6.00	5.00	0.50	22.50
Vermont	0.00	0.00	0.00	0.00	1.00	1.00
West Virginia	1.85	0.00	1.62	0.00	0.90	4.37
Total	16.00	8.20	12.87	7.30	3.10	47.47

[1] Includes full-time equivalents for both forest products (FP) and pulp and paper (PP) faculty members.

summary of projects listed in Table 5 represents the overwhelming majority of forest products research projects at the universities.

The number of research projects at the six universities ranged from 1 to 41. Syracuse had the highest number of projects, followed by Maine, Pennsylvania State, West Virginia, Massachusetts, and Vermont. A total of 54 forest products, 24 pulp and paper, and 6 harvesting research projects are active at the universities. Syracuse, with the largest number of faculty members in the Northeast, has approximately 50% of the total utilization and pulp and paper projects in the Northeast.

Table 6 summarizes the teaching, research, and extension SY's at the seven universities in the Northeast. As a group, the universities totaled 48.47 SY's, divided into teaching (24.20), research (20.17), and extension (4.10). The average number of SY's per university (with teaching, research and extension faculty) was 4.0, 3.4, and 0.7 in teaching, research, and extension, respectively.

The overall average number of research projects (Table 5) per research SY (Table 6) in the Northeast was 4.2. However, this number is misleading; another approach to analyzing the data is to examine the budgeted average amount of SY's per project at each institution. This approach produces the following infor-

TABLE 7. *Northeast Region. Number of projects by major research areas.*

Research areas	Number of projects						
	Maine	Mass.	Pa. State	SUNY–Syracuse	N.H.	W.Va.	Total
Utilizing low-value timber	1		1	2		2	6
Reconstituted products	2		2	1			5
Protection in service				1			1
Wood-bark chemistry				1			1
Adhesives-adhesion			1				1
Mechanical properties	1	1	1	1			4
Moisture relations: seasoning	2	2	2	1	1	2	10
Biomass as a fuel			3				3
Anatomy/growth-quality	1			12		1	14
Lumber grade-yield	1		1			1	3
Pulp and paper	10		1	13			24
Environmental				7			7
Harvesting	3			2		1	6
All other areas			1				1

TABLE 8. *Northeast Region. Number of projects by research emphasis and species group.*

Emphasis area	University						
	Maine	Mass.	Pa. State	SUNY–Syracuse	W.Va.	N.H.	Total
Product							
Solid wood products	2		3	2	7		14
Reconstituted wood	2		2	1			5
Pulp and paper	10		1	13			24
Adhesives	1			1			2
Plywood	1						1
Residues	1		1				2
Process							
Milling	1		1		4		6
Preservation	1		1				2
Chemistry			2		1		3
Drying	1	1	1	1	2	1	7
Purposes							
Energy related	1	1	3	4		1	10
Environmental		1		7			8
Species group							
Hardwoods	7	3	11	25	7	1	54
Softwoods	14			12			26

mation: Syracuse—0.27, Maine—0.24, West Virginia—0.23, Vermont—0.20, Pennsylvania State—0.15, and Massachusetts—0.12. While this approach may be meaningful, the numbers probably do not reflect actual scientist involvement because actual time allotments to research were usually different from budgeted SY's.

Research areas.—Major research areas for all projects in the Northeast covered the broad spectrum of traditional forest products research areas and are summarized in Table 7. A few projects at the six universities covered several research areas, while other projects were narrowly focused. Hence, one project may have covered two or more research areas.

The research area on moisture relations and seasoning was the only one addressed by all of the universities with active research programs. Other major research areas investigated by most of the universities included: 1) utilizing low-value timber, 2) reconstituted products, 3) mechanical properties, 4) anatomy/growth-quality, 5) lumber grade-yield, 6) pulp and paper, and 7) harvesting. Most projects were associated with two areas: anatomy/growth-quality and pulp and paper. The high number of pulp and paper projects was associated with the 7.3 research SY's in the pulp and paper area in the Northeast.

Another approach to categorizing research projects is to list project emphasis in the broad classifications of product, process, and purposes (Table 8). Examining the product emphasis area reveals that the highest number of projects was associated with pulp and paper, followed by solid wood products, reconstituted wood, residues, adhesives, and plywood. Under processes, the order was drying, milling, chemistry, and preservation, whereas projects emphasizing energy outnumbered projects emphasizing the environmental area.

TABLE 9. *Northeast Region. Summary*[1] *of in-house research equipment by research areas.*

Research areas	University					
	Maine	Mass.	Pa. State	SUNY–Syracuse	N.H.	W.Va.
Total space (ft^2)	12,000	12,300	12,000	50,900	1,600	12,000
Chemistry	−	−	+	−	−	+
Mechanical						
Small specimen	+	+	+	+	−	+
Lumber	−	+	+	+	−	+
Fatigue	+	+	+	+	+	−
Paints and finishes	+	+	−	+	−	+
Protection/biodeterioration	+	+	+	+	−	+
Microscopy	+	+	+	+	−	+
Processing						
Particleboard	+	+	+	+	−	+
Plywood	−	+	−	+	−	−
Milling	+	+	+	+	+	+
Drying	+	+	+	+	+	+

[1] Additional equipment for conducting research is available on campus in other departments. A plus (+) indicates a significant amount of in-house research equipment and a minus (−) indicates a limited in-house capability.

Project emphasis may indicate the direction of research emphasis at a university and reflect, to some extent, faculty expertise, facilities, and perceived state and regional research needs. The order of emphasis by university was: 1) Maine—products, processes, and purposes; 2) Massachusetts—purposes and processes; 3) New Hampshire—equally divided between processes and purposes; 4) Pennsylvania State—products, processes, and purposes; 5) Syracuse—products, purposes, and processes; and 6) West Virginia—equally divided between processes and purposes.

Hardwoods versus softwoods: The ratio of hardwood projects to softwood projects in the Northeast was about 2:1 (Table 8). In fact, present research projects at Massachusetts, New Hampshire, Pennsylvania State, and West Virginia emphasize only hardwoods. Obviously, the emphasis on hardwoods was directly related to the resource in the Northeast.

Funding.—Research funding and costs per SY are variable and depend on many factors such as state appropriations, federal formula funds, extramural funds, institutional overhead and fringe benefit costs (direct and indirect costs), profes-

TABLE 10. *Southern Region. Universities and forest products research laboratories surveyed.*

Arkansas	Louisiana Technical
Auburn	Mississippi State
Stephen F. Austin State	North Carolina State
Clemson	Oklahoma State
Florida	Tennessee
Georgia	Texas A&M
Kentucky	Texas Forest Products Laboratory
Louisiana State	Virginia Polytechnic Institute and University

TABLE 11. *Southern Region. Number of research projects, full-time faculty, and support personnel affiliated with forest products research programs in 1982. (Full-time equivalents of scientist years.)*

Univ.	Projects	Ext.	Teach.	Res.	Total faculty	Prof. non-faculty	Grad. asst.	Research tech.	Total personnel[a]
1	33	2.5	5.8	2.2	10.5	3.0	15.5	9.0	38.0
2	15	—	9.4	6.6	16.0	4.0	3.5	4.0	27.5
3	11	—	1.7	2.3	4.0	—	1.0	1.0	6.0
4	5	—	0.5	1.9	2.4	—	—	—	2.4
5	6	—	1.5	0.7	2.2	—	—	—	2.2
6	5	—	1.4	1.8	3.2	2.5	0.5	1.0	7.2
7	5	—	—	—	—	5.0	—	1.0	6.0
8	3	1.0	1.2	0.8	3.0	1.0	0.5	1.0	5.5
9	4	—	0.8	1.2	2.0	—	0.5	1.0	3.5
10	6	—	0.8	2.2	3.0	—	1.0	4.0	8.0
11	8	—	1.4	3.6	5.0	1.0	1.5	—	7.5
12	48	—	1.4	12.6	14.0	2.5	5.5	15.0	37.0
13	2	1.5	0.5	1.5	3.5	0.5	—	1.5	5.5
14	2	—	1.5	0.3	1.8	—	0.5	—	2.3
Total	153	5.0	27.9	37.7	70.6	19.5	30.0	38.5	158.6

[a] Half-time assistantships were assumed in computing SY's for graduate assistants. All FTE's rounded to nearest 0.1.

sional and nonprofessional support staff (permanent and nonpermanent), research facilities, maintenance and operational funds, and institutional research policies. The cost accounting for these variables depended on the policies of the institution. Hence, any cost estimation of SY's must not be accepted as an absolute value for any university. Based on the total estimated research funding and research SY's in the forestry schools and departments, the costs per SY in the Northeastern region averaged about $117,900.

Facilities.—Analysis of existing research projects is important, but future research projects designed to improve or develop products derived from the forest resource base will depend on faculty interest and availability of research equipment. Researcher interest in changing the research direction was somewhat difficult to quantify, but it was relatively easy to quantify equipment availability and capabilities at an institution.

Table 9 summarizes the in-house research equipment by research area at the six universities. It is evident from the data in this table that almost all of the universities had a significant amount of in-house research equipment to conduct research in many of the forest products research areas.

In addition to in-house equipment, the faculty at all six universities have access to research equipment in other departments and thus expand their research capabilities. In addition, interdisciplinary research teams, combining faculty from several departments, can be organized to address complex research areas. Thus, the overall research capabilities at any university are directly related to the resourcefulness of the faculty.

The Southern Region

Programs.—The survey covered 14 forestry schools and 2 separate forest products research laboratories affiliated with public colleges and universities in the South (Table 10). Oklahoma State University and the University of Arkansas did

TABLE 12. *Southern Region. Number of projects by major research area.*

Research area	No. of projects
Utilizing low-value timber	5
Reconstituted products	8
Protection in service	26
Wood-bank chemistry	13
Adhesives-adhesion	6
Mechanical properties	11
Moisture relations: seasoning	20
Biomass as a fuel	8
Anatomy/growth-quality	10
Lumber grade-yield	8
Pulp and paper	8
Environmental	7
Economics-marketing	8
All other areas	15
Total	153

not have forest products research programs, and thus were not included in data tabulations.

A total of 153 research projects were active or planned for initiation during the 1982–1983 fiscal year at the 14 agencies and institutions (Table 11). This number reflected an increase of 12 projects over that for 1981. Number of projects per institution averaged 11 and ranged from 2 to 48. Ten of the 14 institutional programs were represented by 10 projects or less, while the two largest institutions accounted for 53% of the research projects.

A count of research support personnel was also included. The distinction made herein between regular faculty and professional nonfaculty may be of more academic than practical importance as it related to competency in research. Employment of scientists in forest products research, teaching, and extension at the 14 institutions totaled 70.6 (Table 11). The number of SY's in these three job assignments was, in order, 37.7, 27.9, and 5.0. This total represents a reduction of 2.9 SY's, or about 4%, between 1981 and 1982. Whereas there was probably some shifting of personnel between teaching and research during the year, most of the reduction in personnel apparently occurred at the expense of research, which decreased from 41.6 SY's in 1981 to 37.7 in 1982. Number of SY's in teaching increased by 2.3 during this period. Number of SY's per research program for 1982 averaged 2.7 and ranged from 0.3 to 12.6

Support personnel involved in research programs at the various institutions totaled 88 SY's. Included in this number were 19.5 professional nonfaculty, 38.5 technicians, and 60 graduate assistants, who, for purposes of the survey, were assumed to have half-time appointments. The number of support personnel per program averaged 6.3 SY's and ranged from 0 to 27.5 SY's. Thus, the number of support personnel at the typical institution exceeded by a factor greater than two the average number of SY's per research program. This fact unquestionably was responsible in large part for a level of research productivity for some programs that belies the relatively small number of SY's available for research.

Research areas.—Research programs in the south were broad in scope, encom-

TABLE 13. *Southern Region. Number of projects by research emphasis and species group in 1982.*

Emphasis	No. of projects
Products	
Solid wood products	40
Reconstituted wood	16
Pulp and paper	8
Adhesives	5
Plywood	4
Residues	11
Processes	
Milling	8
Preservation/biodeterioration	26
Chemistry	23
Drying	24
Purposes	
Energy related	15
Environmental	8
Basic wood research	30
Economics-marketing	8
Species group	
Hardwoods	37
Softwoods	26

passing most research areas traditionally associated with wood and wood products (Table 12). Major emphasis, based on number of projects, was placed on research in protection, seasoning and wood–moisture relations, wood and bark chemistry, and mechanical properties, which were represented by 26, 20, 13, and 11 projects, respectively. These four research areas accounted for 46% of the total number of projects.

Between 1981 and 1982, changes in distribution of projects among research areas occurred in economics and marketing, for which the number of projects reported increased from 2 to 8, and in biomass as a fuel, which decreased from 12 to 8 projects. The number of projects on mechanical properties also decreased—from 20 in 1981 to 11 in 1982.

Projects active in 1982 were again classified by product, species group, process, and purpose to show aspects of research emphasis that are not revealed by a simple categorization based on broad research areas. Results of this classification are given in Table 13. Because it was possible for a single project to be classified in terms of all four of the criteria, the numbers shown cannot be directly related to the total number of projects shown in Tables 12 and 13.

Research emphasis at the various institutions reflected the interests and fields of expertise of the faculty members, as well as the availability of facilities for work in certain areas. Areas of heavy research emphasis under this classification system were solid wood items (products), and preservation, chemistry, and drying (processes). Each of these areas was represented by 23 to 26 projects. Many of the projects had as a major focus the development of basic data on wood. Among the 63 projects with a species orientation, 59% were concerned with hardwoods,

TABLE 14. *Southern Region. Research funding by source and per scientist year for 14 institutions in 1982.*

University	Industry	Federal	State	Total	$1,000/SY
			$1,000		
1	56.0	404.0	148.0	608.0	276.4
2	29.0	284.0	207.0	520.0	78.8
3	0	26.0	101.0	127.0	55.2
4	146.3	23.0	45.0	214.3	112.8
5	0	82.4	0	82.4	117.7
6	17.0	153.0	16.7	186.7	103.7
7	10.0	84.0	156.0	250.0	50.0*
8	30.0	18.0	65.0	113.0	141.2
9	0	331.5	61.8	93.3	77.8
10	0	138.0	95.1	233.1	106.0
11	4.3	167.7	133.0	305.0	84.7
12	187.2	326.4	991.2	1,504.8	119.4
13	0	41.0	58.0	99.0	66.0
14	35.0	0	6.0	41.0	164.0
Total	514.8	1,779.0	2,083.8	4,377.6	
%	11.8	40.6	47.6	100.0	

* Nonfaculty professionals only.

the same percentage as in 1981. A major change revealed by this classification system is in the number of energy-related projects, which declined from 31 to 15 between 1981 and 1982. This change was probably in accord with reductions in funding for energy-based research as a result of changes in federal funding priorities.

Funding.—Presentations of budget data included only those components of salaries and other funds expended in direct support of research. Adjustments in program funding for overhead costs were not made because of differences in overhead between state and extramural budget components and lack of information for some programs. Overhead costs were not included in program budgets for southern institutions 4, 5, 8, 13, 14; budgets for institutions 2 and 7 include overhead costs for some funding components and not for others; and funding data for one institution include all overhead costs. The respondents for the remaining institutions did not indicate whether their research budgets include overhead.

Fiscal support for forest products research during FY 1982 is shown in Table 14 by funding source. Total funding was about $4.4 million. Funding for individual programs ranged from $41,000 to $1.5 million; average funding was $312,686. The seven largest programs accounted for 83% of total funding; the three largest accounted for 60%.

Total funding decreased by approximately $257,000 between 1981 and 1982, a reduction of about 5.6%. Reduced support from industry was responsible for the greater part of this reduction, whereas cuts in state funding accounted for the balance. Federal funding at $1.8 million was essentially unchanged from 1981. State and federal components, expressed as percentages of total funding, changed only slightly between 1981 and 1982; the industry component declined from 15% in 1981 to 11.8% for 1982.

TABLE 15. *Southern Region. Areas of research capability.*

Research area	Institutions													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Wood-bark chemistry	X	X	X	X		X				X	X	X	X	X
Mechanical testing														
Small specimens	X	X	X	X			X	X	X	X	X	X	X	X
Large members	X	X					X				X	X	X	
Fatigue testing											X		X	
Nondestructive testing							X				X			
Paints and finishes														
Laboratory testing	X	X					X			X	X			
Field testing	X						X			X		X		
Wood products biodeterioration														
Soil-block test	X	X					X					X		
Termite test		X					X					X		
Field test	X			X								X		
Microscopy	X	X	X	X			X	X	X	X	X	X	X	X
Processing														
Reconstituted products										X	X	X		
Plywood		X			X					X	X	X		
Sawmilling	X	X	X		X		X	X			X	X		
Preservation treatments		X			X		X		X	X		X		
Seasoning	X	X	X		X			X	X			X	X	X

The relative importance of funding from industry, federal, and state sources varied widely among the 14 research programs. Research funding from industry averaged $36,770 and ranged from $0 to $187,200. Five of the programs receive no support from industry. All except one of the programs received some federal funding. Average federal is $127,000; three programs received more than $250,000 each, while six received less than $50,000 each.

The amount of state funding ranged from $0 to $991,200 and averaged $148,850. Four programs received less than $50,000 from state sources. State appropriations were the most important funding source for only 6 of the 14 programs. The percentage of state funds received by individual programs varied from 0 to 80; for five programs this percentage was less than 25.

Research funding per SY ranged from $50,000 to $276,370 for the 14 institutions. Average support per SY for the 14 programs is $116,100.

Facilities.—Research capability was in part a function of the availability of laboratory space and equipment. Only equipment items available in-house—that is, located within the academic unit in which the various research programs are located—were included in the survey.

Many equipment items not owned by a school or department are often available elsewhere on the campuses of large colleges and universities. Because of this, lack of equipment for research in a specific area—analytical chemistry, for example—did not necessarily indicate lack of research capability in that area. Nonetheless, respondents were requested to rate their research capability in various research areas on the basis of in-house availability of appropriate facilities; their response

TABLE 16. *Southern Region. Space available for forest products research.*

Institution	Research area					
	Chemistry	Microscopy	Wood physics mechanics	Processing	Other	Total
1	1,100	500	7,300	13,300	—	22,200
2	5,000	2,000	3,000	25,000	—	35,000
3	900	1,200	1,000	2,500	5,600	11,000
4	600	200	200	4,000	2,000	7,000
5	—	—	500	—	6,000	6,500
6	400	—	2,160	7,740	—	10,600
7	2,000	—	—	—	—	2,000
8	—	800	400	400	—	1,600
9	344	—	688	1,075	1,562	3,669
10	600	350	600	2,000	500	4,050
11	500	300	3,600	3,800	—	8,200
12	5,000	—	—	14,000	5,000	24,000
13	—	150	4,000	14,000	—	18,150
14	300	144	600	625	300	1,969
Total	16,744	5,644	24,348	88,440	20,962	156,138

is reflected in Table 15. Table 16 shows the space that was available for specific types of research activities.

Western Region

Programs.—The Western Region encompasses 13 states, including Alaska and Hawaii. The 16 universities within this region were surveyed by mail. Ten universities indicated in their response that the field of forest products was represented on their campuses (Table 17). Four of these universities had only a very small research program, or none at all: Arizona, Montana, Utah State, and Wyoming.

The largest number of SY's was spent on research, followed by teaching and extension. In total, the 10 listed universities contributed 63.66 SY's to develop and transmit knowledge on forest products. The scientists were almost exclusively faculty members holding the rank of assistant professor or above.

The state of Washington employed the largest number of scientists at its two

TABLE 17. *Western Region. Number of scientist years in 1982.*

University	Research	Teaching	Extension	Total
Arizona	0.05	0.05	—	0.10
California–Berkeley	7.2	1.9	2.0	11.1
Colorado State	3.09	3.50	0.33	6.92
Idaho	4.70	3.30	0.20	8.20
Montana	0.25	0.75	—	1.00
Oregon State	12.60	3.40	1.00	17.00
Utah State	—	0.20	0.20	0.40
Washington	5.64	7.50	—	13.14
Washington State	5.00	0.70	—	5.70
Wyoming	0.10	—	—	0.10
Total	38.63	21.30	3.73	63.66

TABLE 18. *Western Region. Percentage of total forest products research areas and funds for each of the universities in 1982.*

Research area	University						Total funds
	1	2	3	4	5	6	
	%						
Lumber production	1	8	—	—	—	9	4.0
Plywood production	8	8	—	10	—	—	4.4
Reconstituted products	14	8	34	30	—	5	15.3
Pulp and paper	9	12	—	—	—	23	10.3
Mechanical properties	11	—	22	—	30	8	9.8
Timber engineering	15	8	8	—	42	—	8.2
Moisture relations; drying	8	8	2	10	3	16	9.3
Adhesion and adhesives	3	—	32	10	—	5	8.3
Wood and bark chemistry	4	20	—	20	20	10	9.9
Biomass for energy	6	24	2	—	—	—	5.6
Environmental	2	1	—	10	—	—	2.0
Wood preservation and all other areas	20	3	—	10	5	—	12.9

universities. The largest effort in academic instruction was at the University of Washington, mainly because of its Pulp and Paper Foundation program. Oregon State University had the largest research faculty.

The number of SY's may not always reflect the full forest products research program at an institution. At a number of universities, faculty members in wood science and technology cooperate with colleagues across campus when focusing on forest products utilization programs. Good examples are the cooperative ventures in timber engineering at Colorado State University and Oregon State University, in wood machining at University of California–Berkeley, and in pulp and paper technology at the University of Washington.

The 1981 survey outlined titles of studies pursued at various universities. The 1982 survey asked for an indication of each university's proportional efforts in the various research areas listed in Table 18. Multiplying the percentiles of effort in the different research areas with the budgets of institutions permitted a comparison of funds directed to the various research areas. The weighted percentages are shown in the last column. Research on reconstituted products, adhesion, and adhesives, appeared to be dominant, especially considering that some wood and bark chemistry is also directed toward adhesives development. Pulp and paper combined with wood and bark chemistry was second, with mechanical properties and timber engineering combined running a close third. Surprisingly few research funds were directed towards research on the production of lumber and plywood.

Research emphasis at the various universities reflected, to some extent, the interests and expertise of faculty members, the objectives set by granting agencies, and the availability of facilities for carrying out the research work. While some institutions concentrated their efforts on a few research areas, the six universities collectively appeared to cover the field of wood science and technology quite well.

Funding.—Research funding for nine institutions is shown by source in Table 19 and totals for these universities amounted to about $4.26 million per annum. There was great diversity of funding sources among states. One university derived

TABLE 19. *Western Region. Research funding by source in 1982.*

University	State	UDSA Forest Service	McIntire-Stennis	Other fed.
		$1,000		
1	4.0	—	—	—
2	97.8	9.6	47.9	48.1
3	127.4	192.0	30.0	189.0
4	—	—	—	—
5	320.0	82.0	50.1	120.0
6	100.0	150.1	201.3	146.6
7	174.0	55.0	27.0	—
8	—	—	—	—
9	884.0	10.0	92.3	—
Totals	1,707.2	498.7	448.6	503.7
Percent	40.1	11.7	10.5	11.8

the major portion of its budget from within its state, while the largest support for another institution came from industry. However, looking at the averages of the different sources for all nine universities, state support dominated slightly with 40.1%. Roughly 23% of monies coming from industry may or may not have originated within the boundaries of the universities' home states. To some extent, western universities competed for industry funds throughout the region. The federal government provided 34.1% of forest products research budgets, on the average. This figure may be compared with nearly 70% of the 127 million acres of commercial forest land that is publicly owned and supplies the trees to be utilized.

Facilities.—Research capabilities are, in part, a function of the availability of laboratory space and equipment. Therefore, the 1982 survey asked for data on research facilities with equipment available in-house. The space available at the six institutions with the largest forest products research programs is shown in Table 20.

Faculty members had, in most cases, the outstanding advantage of being able to use equipment and apparatus of other academic units within the university, as well as of cooperating industries. The equipment surveyed is not reported here in detail because of the magnitude of information. Almost all of the six institutions had conditioning rooms and chambers required for forest products work, as well

TABLE 20. *Western Region. Space available for forest products research.*

University	Area (ft^2) by use				
	Processing	Physics-mechanics	Chemistry	Microscopy	Total
California–Berkeley	6,600	5,900	5,100	268	17,868
Colorado State	2,000	2,500	2,300	150	6,950
Idaho	4,500	2,900	1,750	480	9,630
Oregon State	6,577	6,632	5,918	1,294	20,421
Washington	3,663	2,938	5,473	819	12,893
Washington State	6,000	4,600	4,200	400	15,200
Totals	29,340	25,470	24,741	3,411	82,962

TABLE 21. *Extent of forest products research at U.S. universities in 1982 by Region.*

	North-Central	Northeast	Southern	Western	Total U.S.
Number of universities	11	6	14	6	37
Scientist* years	18.8	19.9	37.3	38.6	114.6
Space, 1,000 ft²	n.a.	100.8	156.1	83.0	
Funding, $1,000	940	2,377.6	4,378.0	4,257.7	11,953.3
State (%)	47	n.a.	48	40	
Federal (%)	46	n.a.	40	37	
Industry (%)	7	n.a.	12	23	
Funding $1,000/SY	50.0	119.7	116.1	110.2	104.3

* Faculty only.

as good-to-outstanding computer facilities. The research capabilities of individual institutions were reflected by the efforts listed in Tables 19 and 21.

SUMMARY

During 1982, wood science and technology research was carried out by the faculty of 37 universities throughout the United States. Our survey of professional staffing, funding levels, and areas of research emphasis at these institutions showed a strong but generally dispersed research interest in forest products (Table 21). Besides carrying out teaching and extension responsibilities, these institutions devoted about 115 SY's (faculty FTE's) to forest products research. A relatively small number of universities have well-staffed research programs, whereas the majority of programs are carried by only one to five faculty members focusing on the field of forest products.

Total funding of forest products research amounted to about $12 million. This figure is only an estimate because in reporting, some institutions included and others excluded overhead expenses. In general, however, this figure covers personnel expenses, services, supplies, travel, and equipment outlays.

Support for individual researchers varied a great deal, averaging about $103,000 per SY.

The sources of support were mainly the states, the federal government, and to a much smaller extent, industry. State and federal government financed the majority of forest products research in the surveyed institutions. Whereas industry support was relatively small, it appeared to have declined further from 1981 to 1982, mainly because of the severity of the recession.

The major focal points of research were wood moisture relations, wood chemistry including pulp and paper, mechanical properties, reconstituted products, and wood anatomy/microscopy. Interestingly, the least amount of research was carried out on processing of lumber (with the exception of drying) and plywood, the major commodity products in the country.

Most laboratories had basic equipment for in-house use by faculty, graduate students, and staff. However, forest products research groups reported that they have the tremendous advantage of being able to use excellent equipment from other parts of the campus, thus increasing their research capabilities.