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ABSTRACT

Data on funding and manpower are gathered by means of a series of surveys that cover the different performance sectors. This study combines data for 1973 from reports covering state agency expenditures for research and development and a series covering all institutions of higher education expenditures. This joint consideration of state agency and state university R and D efforts can be useful in assessing the factors that contribute to economic and social change within the States. These combined expenditures, representing funds that were disbursed by the budget offices of state agencies and universities, amounted to $1,990 million in 1973. The report compares and contrasts the R and D emphases of the state universities and agencies noting the sources of the funds as well as the areas of distribution: life sciences, engineering, social sciences, physical sciences, and others. The ranking of states by expenditures shows a strong correlation between the leadership of states in public R and D expenditures and their relative rankings in state population, total personal income, and total state government general expenditures. Finally, the report shows the growing recognition in both government and university circles that university expertise could be further extended into the public sphere with benefit to both groups. (JMF)

Reviews OF DATA ON SCIENCE RESOURCES

NATIONAL SCIENCE FOUNDATION, WASHINGTON, D.C. 20550 NSF 75-311 No. 23 May 1975

R&D Expenditures of State Public Institutions, Fiscal Year 1973

Introduction

The National Science Foundation (NSF) has the mission of conducting a continuing measurement of the national resources devoted to scientific activities. Data on funding and manpower are gathered by means of a series of surveys that cover the different performance sectors. The R&D activities of Federal agencies, industrial firms, and universities and colleges are covered on an annual basis, and those of nonprofit institutions are covered every few years. In the 1964-73 decade the R&D activities of State government agencies were also reported on three occasions.

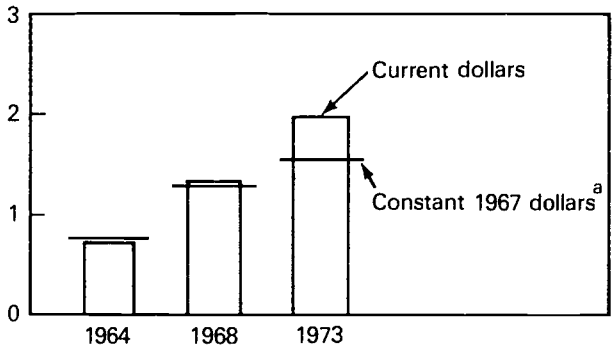
The latest of these reports, *Research and De velopment in State Government Agencies, Fiscal Years 1972 and 1973* (NSF 75-303), provides data on State agency R&D funding and manpower. This report does not, however, combine such data with similar data on State universities and colleges, even though these institutions constitute another arm of the State government apparatus. Data on universities and colleges are collected and published in a separate NSF series covering all institutions of higher education. The latest report from this series is *Expenditures for Scientific Activities at Universities and Colleges, Fiscal Year 1973*, to be published at a later date.

To close an analytic gap, the present study combines data for 1973 from both reports, showing State public R&D expenditures in the aggregate and by individual States. A joint consideration of State agency and State university R&D efforts can be useful in assessing the factors that contribute to economic and social change within the States. These combined expenditures, representing funds that were disbursed by the budget offices of State agencies and universities, amounted to $1,990 million in 1973 — or 6.5 percent of the national $30,427 million R&D expenditure total.[1]

Between 1964, the first year comparable data were collected, and 1973, the average annual rate of growth was 11 percent (chart 1). When converted to constant dollars, the amounts reflect a 7-percent average annual increase, which contrasts with a constant dollar increase for overall national R&D expenditures of 1 percent per year.

[1]See National Science Foundation, *National Patterns of R&D Resources: Funds & Manpower in the United States, 1953-1974* (NSF 74-304) (Washington D.C. 20402: Supt. of Documents, U.S. Government Printing Office, 1974).

Chart 1. R&D expenditures of State public institutions, FY 1964, 1968, and 1973



[a]Based on GNP implicit price deflator.
SOURCE: National Science Foundation

in the Government Studies Group, Division of Science Resources Studies)

The basic data are as follows:

	R&D expenditures (millions of dollars) 1964	1973
Total, State public institutions	$710.5	$1,989.5
State universities and colleges	[1]638.5	[1]1,725.7
State government agencies	72.0	263.8

[1]Excludes sums directed to State universities and colleges by State government agencies for R&D performance.

The first category in the tabulation above shows R&D performance by State universities and colleges for all sponsors except State government agencies. The second category represents all the research and development sponsored by State government agencies in 1964 and 1973, respectively, whatever organizations may have performed the actual work.

State Agency/State University Comparisons

The R&D operations of State government agencies and those of State universities are conducted under different conditions and with different points of view. An overlap between the two worlds occurs in the area of State university R&D performance under State agency sponsorship, but this area is not a large one. A trend is developing, however, toward increased cooperation between State and local governments and university departments, and one measure of this trend is the increasing dollar level of State agency R&D program performance by State universities, a figure which rose from $8 million in 1964 to $28 million in 1973.

The major difference in R&D emphases between State universities and State government agencies is that the former, aside from the teaching function, have the dual role of developing a knowledge base and contributing expertise to public service projects, while the latter are focused almost entirely on practical problems. The laboratories at the State agency level are mainly organized to find answers to needs that arise in program administration and for the most part are not geared to long-range or broadly based investigations.

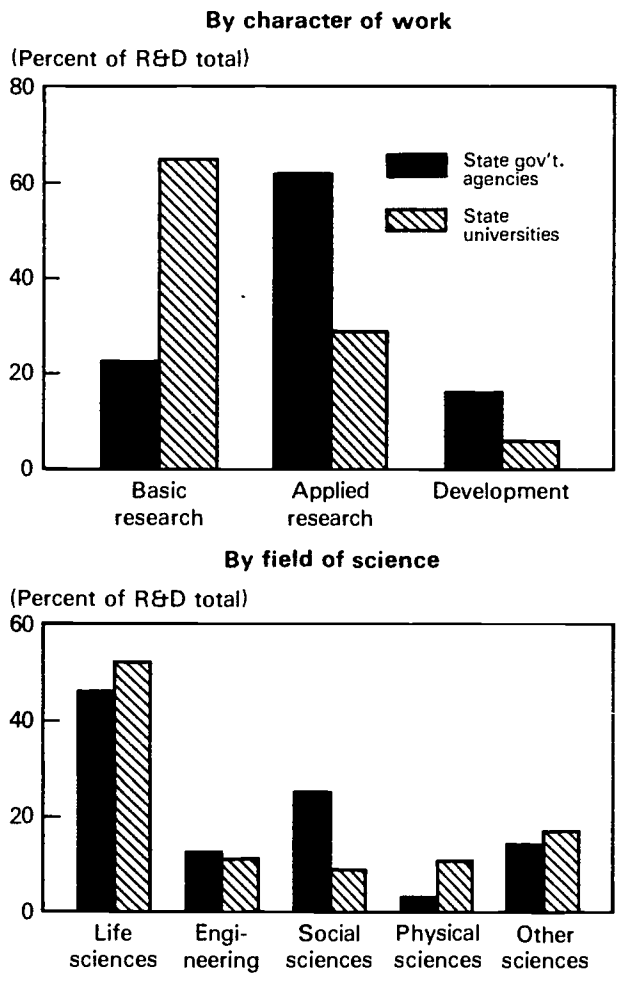
Both State government agencies and State universities and colleges are primarily funded by the Federal Government, to the extent of 51 percent of the State agency R&D effort and 64 percent of the State university R&D effort in 1973. Beyond that point, however, State agencies are almost entirely funded by State appropriations for the remainder of their work, whereas State universities draw support from a number of sources. In 1973 the second most important R&D source for State universities was their own unrestricted funds that were derived from a variety of original sources, such as tuition, endowment, and general-purpose grants and appropriations. These funds were budgeted by the universities for R&D purposes and constituted an R&D source that is university-controlled. This source for the universities was closely followed in 1973 by funds from State government appropriations that were earmarked for R&D purposes: funds to agricultural experiment stations and funds from State agencies for R&D work. Most of the rest of the funding was provided by private industry and nonprofit organizations. Although small in the State university R&D total, these private sources played a more important part than in the case of State government agency R&D funding, where these sources were insignificant.

Sources of support affect the scope and nature of the work undertaken. The Federal funds to State government agencies are mostly transferred under categorical grants on a matching basis, requiring some degree of financial commitment on the part of the States and the meeting of specified program requirements. All of the work of State government agencies, whether financed by Federal or State sources, is restricted to the achievement of specific State goals, even though these goals may fit into a Federal framework. On the other hand, Federal monies flowing into State universities and colleges are transferred under a variety of agreements: contracts, matching grants, and outright grants.

Most of the R&D work of State universities and colleges is comparatively unrestricted. Since so much of their effort is commissioned by Federal agencies, it is primarily addressed to issues of a national nature. Many federally supported programs are dependent on the extension of fundamental scientific knowledge across a broad front. Much work supported by university-controlled funds is also of this nature. Only a small portion of the university R&D total is derived from State-appropriated funds earmarked for R&D purposes. Thus, the R&D support given to universities tends to underwrite basic research rather than applied research or development.

In 1973 State universities and colleges reported 65 percent of their R&D expenditures as basic research, whereas State government agencies reported only 22 percent of their R&D expenditures in that category (chart 2). By contrast, the university share for applied research was 29 percent and the State government agency share was 62 percent.

Chart 2. · Distribution of R&D expenditures of State government agencies and State universities and colleges, FY 1973



SOURCE: National Science Foundation

Between the two groups fields of science distribution showed some similarities and some marked differences. In the case of both State universities and State government agencies the life sciences (biology and clinical medical sciences) made up approximately one-half of the total (chart 2). The engineering sciences also received similar shares (11 percent and 12 percent). The chief difference was found in the social sciences, which accounted for only 9 percent of State university and college expenditures but 25 percent of State government agency R&D expenditures. Also, the physical sciences accounted for 11 percent of the State university and college total against 3 percent of the State government agency total.

The dominance of the life sciences stems primarily from the extensive concern with health on the part of both Federal and State governments. The chief Federal sponsor of State university R&D work is the Department of Health, Education, and Welfare (HEW), and this agency also is the chief Federal sponsor of work at the State agency level. State agencies additionally place a large portion of their own funds in health R&D programs. In contrasting field-of-science areas, the high share for the social sciences in State government agency support is influenced by agency investment in education R&D programs, and the low share in State university support is partly a reflection of the far greater emphasis placed on other fields by sponsors of university R&D projects. As to the physical sciences, a sizable portion of the State university R&D effort is directed to work on defense, space, and atomic energy programs, all of which are closely involved with the physical sciences; such is not the case with State agencies.

The Public Sector

R&D expenditures of State public institutions are concentrated to a degree among a few leading States. In 1973 California led by a significant margin with 15 percent of the total, and the five leading States — California, Texas, Michigan, New York, and Wisconsin — accounted for 38 percent. The share of the next ranking States, however, were fairly evenly distributed (table 1). The 25th State, Hawaii, still accounted for 1½ percent.

As might be expected, considerable correlation can be found between the leadership of States in public R&D expenditures and their relative rankings in State population, total personal income, and total State government general expenditures. The leading 15 States in public R&D expenditures included 11 that were among the leading 15 States in population, 10 that were among the leading 15 in total personal income, and 12 that were among the leading 15 in State government general expenditures.

This correlation is not quite as close, however, as in the case of State government agency R&D expenditures.[2] State university and college R&D activity, which is heavily dependent on Federal support, is somewhat less tied to the population and wealth of individual States than is the R&D activity of State agencies, although more populous and wealthy States are likely to foster the growth of State universities able to offer greater capabilities for R&D performance.

[2]See National Science Foundation, *Research and Development in State Government Agencies, Fiscal Years 1972 and 1973* (NSF 75-303) (Washington, D.C. 20402: Supt. of Documents, U.S. Government Printing Office, 1975.)

TABLE 1. DISTRIBUTION OF R&D EXPENDITURES OF STATE PUBLIC INSTITUTIONS AS COMPARED WITH OTHER STATE INDICATORS: FISCAL YEAR 1973

State	State public R&D expenditures		Population		Total personal income		Total State government general expenditures	
	Rank	Percent of total	Rank	Percent of total	Rank	Percent of total	Rank	Percent of total
Total, all States [in millions]	$1,990		[1] 210		[2] $1,032,045		$108,086	
California	1	15.5	1	9.82	1	10.86	2	10.6
Texas	2	6.0	4	5.62	6	4.96	6	4.0
Michigan	3	5.9	7	4.31	7	4.77	5	4.8
New York	4	5.6	2	8.70	2	10.02	1	12.2
Wisconsin	5	4.7	16	2.18	16	2.05	11	2.5
Washington	6	4.0	22	1.63	20	1.66	16	2.1
Illinois	7	3.2	5	5.35	3	6.26	4	5.2
Colorado	8	3.1	28	1.16	26	1.19	28	1.1
North Carolina	9	2.9	12	2.51	14	2.11	14	2.2
Minnesota	10	2.8	19	1.86	18	1.86	12	2.3
Indiana	11	2.7	11	2.53	11	2.53	19	1.8
Florida	12	2.6	8	3.66	9	3.46	9	3.1
Pennsylvania	13	2.6	3	5.67	4	5.64	3	5.8
Georgia	14	2.2	14	2.28	17	1.97	15	2.1
Ohio	15	2.2	6	5.11	5	5.21	7	3.8
Virginia	16	2.1	13	2.29	12	2.20	17	2.1
Oregon	17	1.9	31	1.06	29	1.01	29	1.0
Missouri	18	1.8	15	2.27	13	2.15	20	1.6
Utah	19	1.8	36	.55	37	.45	37	.6
Iowa	20	1.7	25	1.38	23	1.37	26	1.2
Kansas	21	1.6	30	1.09	27	1.12	33	.9
Arizona	22	1.6	32	.98	31	.90	32	1.0
New Jersey	23	1.6	9	3.51	8	4.11	10	3.0
Maryland	24	1.5	18	1.94	15	2.10	13	2.2
Hawaii	25	1.5	40	.40	38	.43	34	.8
Alabama	26	1.3	21	1.69	25	1.28	23	1.5
Louisiana	27	1.2	20	1.79	22	1.40	18	1.9
Oklahoma	28	1.1	27	1.27	28	1.08	25	1.2
Kentucky	29	1.0	23	1.59	24	1.28	21	1.6
Alaska	30	1.0	50	.16	49	.18	38	.6
Mississippi	31	1.0	29	1.09	32	.76	30	1.0
Connecticut	32	1.0	24	1.47	19	1.76	22	1.5
New Mexico	33	1.0	37	.53	39	.40	36	.6
Nebraska	34	1.0	35	.73	34	.72	39	.6
Massachusetts	35	.8	10	2.77	10	2.95	8	3.2
Tennessee	36	.8	17	1.97	21	1.58	24	1.5
South Carolina	37	.6	26	1.30	30	1.01	27	1.2
Arkansas	38	.6	33	.97	33	.73	35	.7
Idaho	39	.5	42	.37	42	.32	43	.4
Montana	40	.5	43	.34	44	.31	44	.4
West Virginia	41	.5	34	.85	35	.67	31	1.0
Rhode Island	42	.5	39	.46	36	.45	41	.5
Vermont	43	.4	48	.22	48	.18	46	.3
Maine	44	.4	38	.49	40	.39	40	.5
South Dakota	45	.4	44	.33	47	.29	47	.3
Wyoming	46	.4	49	1.7	50	.16	50	.2
North Dakota	47	.4	45	.31	45	.30	45	.3
Nevada	48	.4	47	.26	46	.30	49	.3
Delaware	49	.3	46	.27	43	.31	42	.4
New Hampshire	50	.2	41	.38	41	.35	48	.3

[1] Provisional estimate of resident population as of July 1, 1973 (209,851,000).

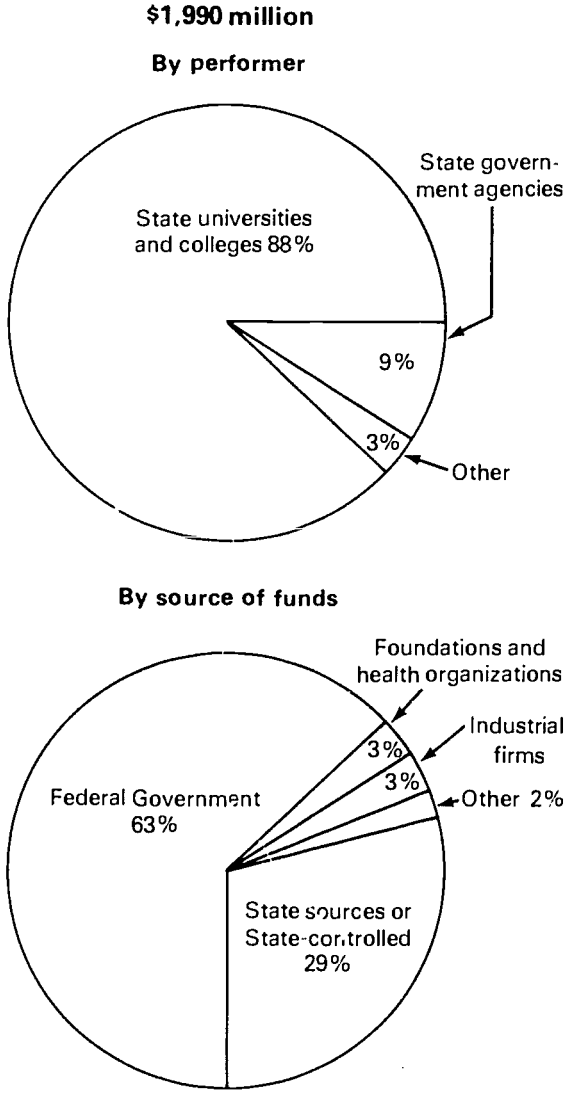
[2] Both population and personal income totals include data for the District of Columbia. Therefore the shares of total shown for the States within these two categories do not add up quite to 100 percent since the District of Columbia is omitted.

SOURCES: U.S. Department of Commerce, Bureau of the Census, *Current Population Reports*, Series P-25, No. 520, July 1974; U.S. Department of Commerce, Bureau of Economic Analysis, *Survey of Current Business*, Volume 54, No. 4, April 1974; U.S. Department of Commerce, Social and Economic Statistics Administration, Bureau of the Census, *State Government Finances in 1973*, Series GF73, No. 3, August 1974.

Performers

When State public R&D expenditures are studied in terms of performers, the outstanding fact is the extent of the State university effort. In 1973, of the $1,990 million total, the largest share by far — 88 percent — was assigned to State universities and colleges (chart 3). Only 9 percent was expended by State government agencies in direct performance of R&D work, and 3 percent was allotted to other performers (private firms, nonprofit organizations, local government agencies, including local universities and colleges, private universities and colleges, and local and multigovernmental agencies — all under grant or contract from State government agencies).

Chart 3. Distribution of R&D expenditures of State public institutions, FY 1973



SOURCE: National Science Foundation

In every State except four, at least 80 percent of the State public R&D total was performed by State universities and colleges (table 2). In 1973, of the 900 or more State public institutions performing research and development in the United States, the 10 leading institutions were State universities, and these accounted for 27 percent of the State public R&D expenditure total.[3] The top performer was the University of Wisconsin—Madison with R&D expenditures amounting to $84 million, followed by the University of Michigan ($69 million), the University of California—San Diego ($67 million), the University of California—Berkeley ($57 million), the University of Minnesota ($53 million), the University of Washington ($53 million), the University of California—Los Angeles ($52 million), the University of Illinois—Urbana ($42 million), the University of Colorado ($34 million), and Texas A&M University ($34 million).

In 1973 New York was the only State in which State government agencies were responsible for most of the performance — they accomplished 51 percent of the total. In no other State was a high share of the R&D effort carried out by State government agencies. In only six other States — Maine, Alaska, Florida, Massachusetts, Kentucky and Illinois — did State government agencies perform as much as 15 percent of the public R&D expenditure total.

The chief State agency in New York was the Roswell Park Memorial Institute, which spent $23 million, mainly for cancer research, making it the 25th largest State institutional R&D performer nationwide. All the higher ranking performers were State universities. As to nonuniversity performers, the next in rank were the New York Department of Health ($7.4 million) and the New York Psychiatric Institute ($7.1 million). Although these were important in the New York public R&D effort, they ranked 63rd and 65th among all State public institutions in 1973.

New York is in a unique category because the expenditures of New York State agencies for R&D purposes are unusually large. In 1973 they were almost twice those of California, the next State. This fact alone would tend to reduce the share of R&D perform-

[3]Data taken from National Science Foundation. *Expenditures for Scientific Activities at Universities and Colleges, Fiscal Year 1973*, to be published later.

ance on the part of State universities and colleges, which was 46 percent of the New York total in 1973. Another factor is the low level of State university R&D expenditures relative to other leading States (table 2). Although State university R&D expenditures were relatively low in New York, those of the private universities were relatively high, in fact, the highest of any State.[4]

Sources of Funds

As previously mentioned, the Federal Goverment is the chief source of funds for both State government agencies and State universities and colleges (table 3). In 1973 Federal agencies provided 63 percent of the public agency support on an aggregate basis (chart 3). Most of this support was given to State universities and colleges, but approximately one-tenth was directed to State government agencies.

Within the Federal Government, the Department of Health, Education, and Welfare (HEW) accounted for approximately one-half of the Federal support total. The major funding source within HEW was the National Institutes of Health. The National Institute of Mental Health and the Office of Education also provided support. Other Federal funding sources were the National Science Foundation, the Department of Defense, the National Aeronautics and Space Administration, the Department of Agriculture (primarily through the Cooperative State Research Service), and the Atomic Energy Commission.

Funds controlled at the State level, which are divided into two categories, represented 29 percent of the total in 1973. The first category, which made up almost three-fifths of State-controlled funds, consisted of State government funds earmarked for R&D purposes that were appropriated to State universities, including affiliated agricultural experiment stations and medical schools, as well as funds appropriated to State agencies that were used for the performance of State agency R&D programs. The second category, which made up the remaining two-fifths, consisted of State universities' and colleges' own unrestricted funds that were budgeted by the institutions for R&D purposes.

TABLE 2. R&D EXPENDITURES OF STATE PUBLIC INSTITUTIONS, BY STATE AND PERFORMER: FISCAL YEAR 1973

[Dollars in thousands]

State	R&D total	State universities and colleges	State government agencies	Other performers[1]
Total, all States	$1,989,511	[2]$1,754,218	[3]$178,083	$57,210
California	307,600	275,452	24,023	8,125
Texas	119,124	111,121	4,575	3,428
Michigan	118,324	111,946	5,750	628
New York	110,530	51,006	55,925	3,599
Wisconsin	92,645	89,102	3,147	396
Washington	78,848	69,321	3,716	5,811
Illinois	64,112	53,119	9,334	1,659
Colorado	61,346	56,204	1,824	3,318
North Carolina	57,597	53,762	2,671	1,164
Minnesota	56,469	53,701	840	1,928
Indiana	53,092	51,932	1,014	146
Florida	52,355	42,462	9,388	505
Pennsylvania	52,277	45,931	5,161	1,185
Georgia	44,742	42,268	1,444	1,030
Ohio	43,098	38,155	2,007	2,936
Virginia	40,808	34,331	5,578	899
Oregon	37,770	33,982	1,439	2,349
Missouri	36,119	34,461	1,236	422
Utah	34,889	33,306	670	913
Iowa	33,439	32,073	980	386
Kansas	32,715	31,277	620	818
Arizona	32,417	30,321	904	1,192
New Jersey	31,453	25,913	2,502	3,038
Maryland	30,594	27,717	2,295	582
Hawaii	29,110	26,859	1,860	391
Alabama	26,164	24,878	407	879
Louisiana	23,779	21,953	1,506	320
Oklahoma	21,588	19,633	1,696	259
Kentucky	20,713	17,124	3,065	524
Alaska	20,591	16,560	3,931	100
Mississippi	20,156	19,023	582	551
Connecticut	19,381	16,381	2,698	302
New Mexico	18,970	18,170	740	60
Nebraska	18,008	17,711	285	12
Massachusetts	15,412	10,570	2,667	2,175
Tennessee	15,163	12,356	1,686	1,121
South Carolina	12,889	10,975	1,069	845
Arkansas	11,032	10,185	426	421
Idaho	9,790	8,727	1,018	45
Montana	9,418	8,654	726	38
West Virginia	9,073	6,960	1,080	1,033
Rhode Island	9,058	8,855	193	10
Vermont	8,294	7,188	755	351
Maine	8,292	6,438	1,661	193
South Dakota	7,979	6,711	636	632
Wyoming	7,576	6,678	777	121
North Dakota	7,359	6,701	423	235
Nevada	7,343	6,449	851	43
Delaware	6,004	5,760	165	79
New Hampshire	4,006	3,856	137	13

[1] Private firms and individuals, private nonprofit organizations, local government agencies, universities, and colleges, private universities and colleges, and local and multigovernmental agencies performing research and development under grant or contract from State government agencies.

[2] Includes $28,485 thousand performed for State government agencies.

[3] Research and development performed directly by State agency personnel.

[4] While 60 percent of *all* university and college R&D expenditures, public and private, was accounted for by State universities and colleges in 1973, the State universities and colleges in New York accounted for only 15 percent of the university and college total. At the same time New York was second only to California in the level of its combined public and private university and college R&D support. In 1973 four of the top 20 academic institutions in terms of R&D funding were located in New York State; all of them were private.

Massachusetts was similar to New York in the low ratio of R&D performance on the part of its State universities and colleges to overall university and college R&D performance — 4 percent in the case of this State. In 1973 Massachusetts ranked third after California and New York in *total* R&D expenditures by universities and colleges.

TABLE 3. R&D EXPENDITURES OF STATE PUBLIC INSTITUTIONS, BY STATE AND SOURCE OF FUNDS: FISCAL YEAR 1973

[Dollars in thousands]

State	R&D total	Federal sources	State sources or State controlled			Foundations and health organizations	Industrial firms	Local government sources	Other
			Total	State government funds	State universities' own funds				
Total, all States	$1,989,511	[1]$1,249,155	$586,136	[2]$340,334	[3]$245,802	$59,670	$52,605	$7,809	$34,136
California	307,600	234,959	57,780	13,780	44,000	12,066	2,184	253	358
Texas	119,124	66,566	37,966	28,870	9,096	6,225	4,832	140	3.395
Michigan	118,324	73,990	28,728	12,552	16,176	6,274	6,389	388	2,555
New York	110,530	53,852	47,441	43,154	4,287	2,488	6,142	496	4,111
Wisconsin	92,645	49,601	36,655	19,066	17,589	2,649	1,210	18	2,512
Washington	78,848	60,372	13,447	10,854	2,593	1,361	1,557	335	1,776
Illinois	64,112	38,602	21,883	11,431	10,452	1,224	777	560	1,066
Colorado	61,346	48,008	5,957	5,305	652	2,066	4,391	431	493
North Carolina	57,597	36,248	16,743	15,235	1,508	2,181	1,546	138	741
Minnesota	56,469	32,183	17,670	6,455	11,215	3,116	1,283	—	2,217
Indiana	53,092	41,343	8,278	1,063	7,215	904	1,754	576	237
Florida	52,355	27,486	21,757	5,958	15,799	1,277	997	146	692
Pennsylvania	52,277	35,306	13,253	4,497	8,756	1,244	1,451	52	971
Georgia	44,742	18,942	22,440	16,161	6,279	493	1,907	406	554
Ohio	43,098	27,004	11,336	8,999	2,337	1,655	2,148	167	788
Virginia	40,808	24,216	12,986	10,127	2,859	1,344	1,257	63	942
Oregon	37,770	26,175	8,474	6,102	2,372	1,320	1,044	152	605
Missouri	36,119	15,645	19,055	6,654	12,401	287	677	15	440
Utah	34,889	27,111	4,760	2,673	2,087	824	850	1,108	236
Iowa	33,43.	20,962	10,494	5,101	5,393	309	919	147	608
Kansas	32,715	21,098	9,707	5,573	4,134	566	804	282	258
Arizona	32,417	18,189	11,218	7,203	4,015	876	946	95	1,093
New Jersey	31,453	16,406	13,197	7,737	5,460	740	236	72	802
Maryland	30,594	20,326	7,787	7,300	487	956	1,546	4	75
Hawaii	29,110	17,362	10,987	10,932	55	363	65	130	203
Alabama	26,164	18,790	6,000	4,096	1,904	371	743	43	217
Louisiana	23,779	9,609	12,659	1,549	11,110	645	804	—	62
Oklahoma	21,588	12,199	7,341	5,517	1,824	345	485	—	1,218
Kentucky	20,713	11,146	8,255	3,390	4,865	662	409	142	99
Alaska	20,591	13,956	5,126	2,126	3,000	207	484	—	818
Mississippi	20,156	9,880	8,400	4,908	3,492	662	720	380	114
Connecticut	19,381	8,367	9,875	2,394	7,481	545	107	47	440
New Mexico	18,970	14,741	2,883	1,682	1,201	182	653	13	498
Nebraska	18,008	7,252	9,869	6,328	3,541	362	431	36	58
Massachusetts	15,412	11,061	3,529	2,792	737	324	395	14	89
Tennessee	15,163	12,373	1,511	980	531	254	560	76	389
South Carolina	12,889	6,010	5,770	5,597	173	589	396	12	112
Arkansas	11,032	5,743	4,635	4,178	457	136	370	—	148
Idaho	9,790	4,284	5,035	4,311	724	28	432	11	—
Montana	9,418	4,212	4,243	2,659	1,584	112	801	—	50
West Virginia	9,073	6,373	2,284	2,217	67	48	128	—	240
Rhode Island	9,058	7,662	1,044	524	520	161	52	100	39
Vermont	8,294	5,862	1,897	737	1,160	228	139	—	168
Maine	8,292	5,138	2,802	1,333	1,469	89	253	10	—
South Dakota	7,979	3,690	3,574	2,976	598	81	219	38	377
Wyoming	7,576	5,022	1,705	1,705	—	41	137	671	—
North Dakota	7,359	3,075	3,035	2,944	91	97	285	—	867
Nevada	7,343	4,218	2,424	1,502	922	149	448	42	62
Delaware	6,004	3,639	1,573	701	872	510	231	—	51
New Hampshire	4,006	2,901	768	506	262	34	11	—	292

[1] Of this total, $1,115,591 thousand was directed to State universities and colleges and $133,564 thousand was directed to State government agencies.

[2] Of this total, $214,816 thousand represented State-appropriated funds that were provided directly to State universities and colleges, largely for work at agricultural experiment stations, and $125,518 thousand represented State-appropriated funds to State agencies that were used for R&D purposes.

[3] Unrestricted funds from all sources except the Federal Government that State universities and colleges were free to spend for R&D purposes and that were so budgeted. These sources included endowment income, tuition and fees, general-purpose State or local government appropriations, and general-purpose grants from industry, foundations, health agencies or other outside sources.

TABLE 4. R&D EXPENDITURES OF STATE PUBLIC INSTITUTIONS, BY STATE AND CHARACTER OF WORK: FISCAL YEAR 1973

[Dollars in thousands]

State	R&D total	Basic research	Applied research	Development
Total, all States	$1,989,511	$1,193,721	$659,875	$135,915
California	307,600	187,451	102,954	17,189
Texas	119,124	84,121	30,666	4,357
Michigan	118,324	79,608	32,289	6,427
New York	110,530	59,584	45,568	5,378
Wisconsin	92,645	82,043	6,982	3,620
Washington	78,848	47,431	28,086	3,331
Illinois	64,112	40,010	23,482	620
Colorado	61,346	31,916	25,604	3,826
North Carolina	57,597	34,234	17,003	6,360
Minnesota	56,469	23,721	29,261	3,487
Indiana	53,092	33,948	10,911	8,233
Florida	52,355	28,660	16,929	6,766
Pennsylvania	52,277	30,949	17,417	3,911
Georgia	44,742	19,067	22,871	2,804
Ohio	43,098	26,717	15,834	547
Virginia	40,808	23,155	15,481	2,172
Oregon	37,770	21,451	12,761	3,558
Missouri	36,119	25,261	6,163	4,695
Utah	34,889	22,100	10,034	2,755
Iowa	33,439	27,871	4,182	1,386
Kansas	32,715	14,840	15,216	2,659
Arizona	32,417	21,109	7,941	3,367
New Jersey	31,453	17,660	10,084	3,709
Maryland	30,594	21,190	8,517	887
Hawaii	29,110	16,921	9,044	3,145
Alabama	26,164	9,446	15,296	1,422
Louisiana	23,779	16,014	7,421	344
Oklahoma	21,588	12,588	7,091	1,909
Kentucky	20,713	9,314	6,511	4,888
Alaska	20,591	5,796	14,516	279
Mississippi	20,156	9,262	9,274	1,620
Connecticut	19,381	14,664	4,413	304
New Mexico	18,970	10,388	4,845	3,737
Nebraska	18,008	12,549	5,117	342
Massachusetts	15,412	9,976	4,299	1,137
Tennessee	15,163	4,310	9,573	1,280
South Carolina	12,889	6,479	5,279	1,131
Arkansas	11,032	6,749	3,479	804
Idaho	9,790	3,174	3,702	2,914
Montana	9,418	5,990	3,187	241
West Virginia	9,073	4,861	2,974	1,238
Rhode Island	9,058	6,208	1,964	886
Vermont	8,294	3,744	3,397	1,153
Maine	8,292	2,984	3,529	1,779
South Dakota	7,979	3,209	3,950	820
Wyoming	7,576	3,406	3,346	824
North Dakota	7,359	1,414	5,812	133
Nevada	7,343	3,713	2,491	1,139
Delaware	6,004	4,608	1,066	330
New Hampshire	4,006	1,851	2,063	92

Much smaller shares of total State public R&D funds were provided by private sources: foundations and health organizations, 3 percent of the total; industrial firms, 3 percent; "other" (private individuals and professional societies), 2 percent. Less than one-half of 1 percent was provided by local governments.

Character of Work

In 1973, of the State public R&D expenditure total, 60 percent was directed to basic research, 33 percent to applied research, and 7 percent to development (table 4). The greater weight placed on basic research is a reflection of the nature of State university efforts. University research is closely related to the traditional academic role of pursuing knowledge for its own sake and provides, among other things, a method for the training of scientists and engineers.

State government agencies, on the other hand, are primarily interested in solving problems related to program administration, and most of the efforts they sponsor are applied in nature. Nonetheless, the State university effort was of sufficient magnitude in 1973 to make the State university applied research total almost four times the comparable total of State government agencies (table 5).

TABLE 5. R&D EXPENDITURES OF STATE PUBLIC INSTITUTIONS, BY PERFORMER AND CHARACTER OF WORK: FISCAL YEAR 1973

[Dollars in millions]

	Total	Basic research	Applied research	Development
Total	$1,990	$1,194	$660	$136
State universities and colleges	1,754	1,140	516	98
State government agencies	178	50	110	18
Other performers[1]	57	4	34	19

[1] All performers that were under grant or contract from State government agencies except State universities and colleges.

Functional Areas

More R&D work performed by the States in 1973 was in health than in any other area, whether accomplished by State universities or State government agencies. Approximately one-third of all State university and college research and development was addressed to medical and health-related problems. Approximately one-third of State agency R&D expenditures were also assigned to health purposes in 1973.

Another important area is that of natural resources, representing as much as one-fourth of the university R&D total.[5] Agricultural experiment stations have accounted for most of the work at the university level in this category. Approximately one-fifth of the State agency R&D effort was assigned to natural resources in 1973.

Fields of Science

In 1973 the life sciences accounted for 51 percent of State public R&D expenditures. Engineering and the social sciences each accounted for 11 percent, the physical sciences for 10 percent, the environmental sciences for 8 percent, psychology for 3 percent, and mathematics for 2 percent (table 6).

The emphasis on the life sciences is related to the fact that a major portion of the State R&D effort is concerned with activity in the areas of health and natural resources, including agriculture. The remaining funds were rather evenly divided among a number of fields, largely reflecting the State university commitment to support of science as a whole.

R&D Manpower

In 1973 approximately 44,000 scientists and engineers were engaged in research and development on a full-time-equivalent basis in public institutions at the State level: 39,000[6] at State universities and colleges and 5,000 in the direct employ of State government agencies. The cost per scientist or engineer (S/E) man-year at State universities and colleges was approximately $45,000. This figure compares with $36,000 per S/E man-year in State government agencies. These averages include not only salaries of scientists and engineers but also all supporting costs; i.e., the salaries of technicians and other support personnel, as well as supplies and all other overhead items.

State Agency/State University Interface

To date, State universities and colleges have not been extensively used by State government agencies to assist them in solving problems related to State government administration. In 1973 only 11 percent of the research and development sponsored by State government agencies ($28.5 million) was performed by State universities and colleges. In 1964 and 1968 the amounts represented by State university work were approximately 10 percent of the total State government agency R&D effort.

State governments are now operating in an atmosphere that is increasingly conducive to R&D approaches. The cost squeeze on State budgets and the proliferating problems in environment, energy, and social services call for more technical inputs to policy-making and more efficient methods of delivering services that were previously used. An important question facing State agencies is how to coordinate their own R&D efforts with those of other performers for the most effective results.

State universities represent a rich source for problem solving that is only beginning to be tapped. In the past decade Federal grants to the States have grown many times over, and a number of them have represented the kinds of categorical programs — in areas like water resources, housing and urban development, vocational training, occupational safety, and energy conservation — that have tended to involve university faculty. As a result, better management of State agency/State

[5] See National Science Foundation, *Expenditures for Scientific Activities at Universities and Colleges, Fiscal Year 1973* appendix tables. Functional data were derived from fields of science data for this report: the health data mainly from the life sciences, excluding an estimated amount for the agricultural sciences, and the natural resources data from the agricultural and environmental sciences.

[6] This figure includes graduate students receiving compensation for part-time services as scientists and engineers.

TABLE 6. R&D EXPENDITURES OF STATE PUBLIC INSTITUTIONS, BY STATE AND FIELD OF SCIENCE: FISCAL YEAR 1973

[Dollars in thousands]

State	R&D total	Life sciences	Psychology	Physical sciences	Environmental sciences	Mathematics	Engineering	Social sciences	Other sciences
Total, all States .	$1,989,511	$1,021,986	$64,041	$196,951	$156,504	$42,072	$226,665	$213,063	$68,229
California	307,600	168,624	14,262	36,571	37,485	5,251	25,104	16,812	3,491
Texas	119,124	57,832	2,653	14,644	6,083	2,778	17,933	9,975	7,226
Michigan	118,324	52,208	6,000	7,254	3,948	2,647	22,796	20,127	3,344
New York	110,530	73,700	2,754	7,769	7,030	3,117	5,256	8,444	2,460
Wisconsin	92,645	32,932	4,728	10,730	13,369	3,349	5,045	15,040	7,452
Washington ...	78,848	47,219	1,721	5,173	9,467	663	7,475	6,366	164
Illinois	64,112	22,766	3,120	6,756	4,338	3,971	12,540	8,325	2,296
Colorado	61,346	24,707	2,705	8,177	3,974	1,089	6,139	7,065	7,490
North Carolina .	57,597	33,889	992	1,652	1,208	985	5,878	4,525	8,468
Minnesota	56,469	34,331	1,036	3,991	971	909	5,012	7,164	3,055
Indiana	53,092	24,658	1,056	6,731	448	1,473	6,899	9,580	2,247
Florida	52,355	25,632	1,846	5,901	2,170	1,437	6,275	9,033	61
Pennsylvania ..	52,277	22,689	1,345	6,236	4,314	264	7,264	7,342	2,823
Georgia.....	44,742	19,123	1,199	5,277	595	1,302	8,628	8,475	143
Ohio	43,098	18,856	1,003	4,162	2,029	588	7,744	8,030	686
Virginia	40,808	21,801	454	4,473	2,327	767	6,656	2,509	1,821
Oregon	37,770	20,628	785	2,257	5,845	383	1,727	6,077	68
Missouri	36,119	25,254	353	1,306	885	353	4,741	1,968	1,259
Utah	34,889	18,333	1,659	3,090	2,582	2,322	5,861	1,042	—
Iowa	33,439	19,811	331	4,524	266	1,288	3,658	3,432	129
Kansas	32,715	17,720	2,558	1,646	2,390	592	3,508	3,377	924
Arizona.....	32,417	11,968	1,112	8,413	4,000	201	3,538	3,142	43
New Jersey ...	31,453	13,443	1,178	3,043	2,970	950	2,239	5,213	2,417
Maryland	30,594	13,284	569	6,921	2,897	1,974	3,357	1,390	202
Hawaii	29,110	10,787	346	3,309	7,070	58	2,261	4,694	585
Alabama.....	26,164	18,719	953	686	1,346	37	2,796	1,475	152
Louisiana	23,779	15,051	481	2,380	2,133	635	1,830	921	348
Oklahoma.....	21,588	11,444	240	827	1,015	406	2,750	1,126	3,780
Kentucky	20,713	11,056	528	844	710	75	2,319	3,702	1,479
Alaska.....	20,591	7,842	67	4,984	5,247	2	676	1,760	13
Mississippi	20,156	15,111	225	962	168	92	1,486	2,111	1
Connecticut...	19,381	12,468	824	574	930	740	2,177	1,668	—
New Mexico...	18,970	4,162	474	1,107	2,030	142	7,316	2,920	819
Nebraska	18,008	13,825	48	689	1,317	128	1,169	832	—
Massachusetts	15,412	4,319	1,449	2,234	2,199	266	2,205	2,680	60
Tennessee	15,163	9,523	423	691	185	57	2,374	1,878	32
South Carolina	12,889	8,093	238	315	509	99	830	2,363	442
Arkansas	11,032	7,822	111	329	941	94	586	1,104	45
Idaho	9,790	6,524	2	317	282	3	621	677	1,364
Montana.....	9,418	5,444	88	718	946	17	1,540	640	25
West Virginia ..	9,073	5,042	203	69	302	1	2,201	1,254	1
Rhode Island ..	9,058	3,365	455	1,799	23	474	1,618	1,324	...
Vermont	8,294	6,108	415	207	135	5	98	1,201	125
Maine	8,292	4,682	102	230	1,811	—	458	1,006	3
South Dakota .	7,979	3,862	174	66	1,501	2	667	1,076	631
Wyoming	7,576	3,370	137	1,568	1,503	2	626	315	55
North Dakota ..	7,359	6,030	2	161	401	1	407	357	...
Nevada	7,343	2,706	136	3,414	572	1	120	394	...
Delaware	6,004	1,441	329	927	1,424	51	1,438	394	...
New Hampshire	4,006	1,782	172	847	213	31	823	138	...

university work arrangements is a subject of increasing interest.[7]

Nonetheless, in 1973 only 1.6 percent of the total State university R&D effort was devoted to work for State agencies. A recent report of the Council of State Governments pointed out that State university professors and State agency administrators had different operating philosophies that had worked in the past as a barrier to effective interchange between the two groups.[8] The State administrator requires specific results from a research or development project that he can use as a plan for action, and he needs to show measurable benefits from his expenditures. The academic researcher is more interested in advancing knowledge *per se* and often wishes to continue with a problem over a long period. Instances have also occurred where university professors working under State grants or contracts have arrived at politically unpalatable conclusions and have had support withdrawn.

At the present time, however, the recognition is growing in both State government and State university circles that university expertise could be further extended into the public service sphere with benefit to both groups.[9] In a number of States new institutional links are being established to make university competence available to State agencies, and efforts are being made to reduce or eliminate the obstacles to effective work between the two groups. Instances of such activities continue to grow, and the adjustments to be made by both sides are becoming increasingly apparent and attainable. Although the Federal Government will undoubtedly continue to lead as a source of State university R&D support, a few years hence a larger portion of that support may well be provided by State government agencies for the performance of research and development to implement State programs.

[7] D.C. Spriesterbach, Margery E. Hoppin, and John McCrone, "University Research and the New Federalism," *Science*, Vol. 186 (October 25, 1974).

[8] The Council of State Governments, *Power to the States: Mobilizing Public Technology*, Lexington, Ky., May 1972.

[9] *Ibid*; M. Frank Hersman, *Resident Resources for Problem-Solving in the 1970's*, speech at the North Dakota Summit Conference for State Officials, Grand Forks, N.D., March 11, 1974.