Research Benchmarks

Funding University Research Operations and Infrastructure

Rhode Island Economic Policy Council

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Contents

Abstract

Funding for University of Rhode Island research operations and infrastructure is compared to funding for 133 universities. Total URI research funds from all sources increased 38% from 1980 to 1999; nationally, funds for academic research increased 139% over the same period.

Compared to other states, Rhode Island ranks 48th in State funds per capita spent on higher education operations, 50th in percentage of state higher education funds spent on academic research, and 50th in state funds per capita or state funds per $1000 personal income spent on academic research. To bring RI to the 1999 national *per capita* average of state funds for *higher education operations* would require a 43% ($61.7 million) annual increase. To bring RI to the national *per capita* average of state funds for *university research operations* would require a 412% ($21.6 million) annual increase.

URI research spending was compared to 133 universities—including all Carnegie Foundation Research I and II universities, all 1862 land grant universities, and 13 universities previously used by URI for peer analysis. URI has a higher dependency on federal funds for academic research operations (measured as percent of total research operating budget) than any of 92 public universities in the comparison group. URI spends more per capita than the national average on research operations in environmental and psychology fields, but less than average for engineering, physical science, mathematical science, computer science, life science, or social science fields.

Rhode Island per capita expenditures on buildings, laboratories, and equipment used for research are below national averages and significantly less than top 100 research universities. A minimum necessary investment in research building construction, laboratory renovation, and equipment replacement is estimated to be $11 million annually.

Several examples are presented to illustrate what URI might want to do to develop economically-oriented university research centers and university-affiliated industrial research parks. Analysis of other factors critical to growth in major research universities include commitment to attain national prominence; leadership at all organizational levels; state, federal, and industrial funding; and the ability to exploit institutional "natural advantages."

Preface

Modern research universities drive the New Economy. The 125 Carnegie Research Universities[(1)]—including most of the land grant universities[(2)]—are a small fraction of the Nation's nearly 4000 colleges, universities, and advanced technical schools, yet they produce most of the nation's academic research and most of the graduate-level training in the sciences and engineering. Of the 13 higher education institutions in Rhode Island, there are only two research universities—Brown and URI—and only URI is public. With its rich land grant traditions of applied research, practical education, and engaged extension, URI is Rhode Island's natural focal point for research investment in higher education.

Because Rhode Island must turn to knowledge and technology to prosper in the New Economy[(3)], URI needs the strongest possible research and training facilities in the sciences and engineering. URI holds the key to preparation of globally-competitive scientists and technicians. URI can be the primary source of the next generation of entrepreneurs who will help us start and grow new leading-edge businesses. The University is an important kernel around which the future economy will form.

Rhode Island, however, is failing to make the necessary investment so that URI can fulfill its vital role in the economy. This is most apparent in economically critical science and engineering fields. By failing to invest in URI research operations and infrastructure, the State hinders URI's potential entrepreneurship in business, the applied sciences, and engineering.

This document will show that total funding for URI has remained essentiall flat over the past 30 years, and that current levels of investment in research operations and infrastructure compare poorly to what other states are spending. The document includes models at other research universities for investment in research and examples for creative partnering with leading-edge businesses. The document is intended to stimulate discussion about benchmarks and targeted investments, and to ultimately promote interest in an entrepreneurial renaissance at URI.

The University as Economic Engine

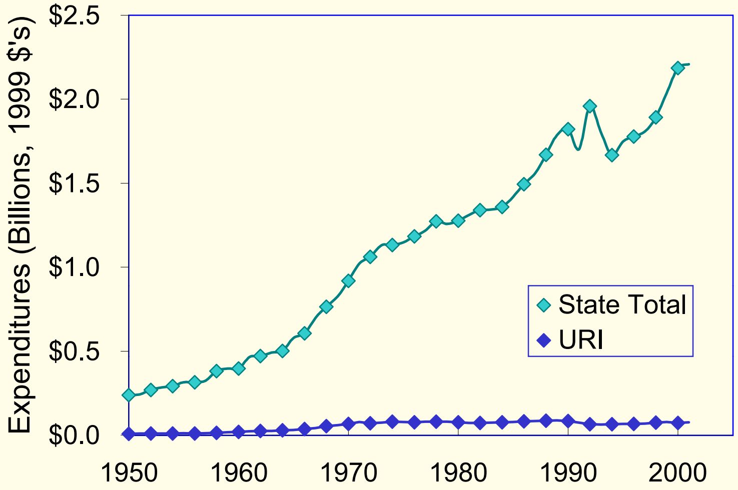
What follows assumes that the University of Rhode Island is an engine of the State's current and future economy; that the University's sciences and engineering[4]—and specifically on research and research-dependent graduate education—are key components of that economy; and that the comparative vitality of the research enterprise in Rhode Island's only public research University will be critical to how our economy fares in the future.

It is also assumed that to strengthen links between URI and the State economy, four components must be present. There must first be substantial **research operations**, well-supported continual commitments to a broad research agenda involving substantial numbers of faculty in areas relevant to the evolving state and regional economy. There must be up-to-date **research infrastructure**, including good buildings and laboratories and contemporary major items of equipment. To enhance the relevancy of both research and learning, there should also be an active extension of the university, characterized by campus support for **technology nurseries and commercialization** of intellectual properties produced by campus research. And finally—as is true in any quality organization—URI must adopt a hallmark commitment to perpetual customer **feedback**, in this case a continual evaluation of the quality of the product (the university's graduates and intellectual properties) and their relevance to the needs of the marketplace (the industries and government laboratories engaged in leading-edge technologies). These assumptions provide the framework for this document.

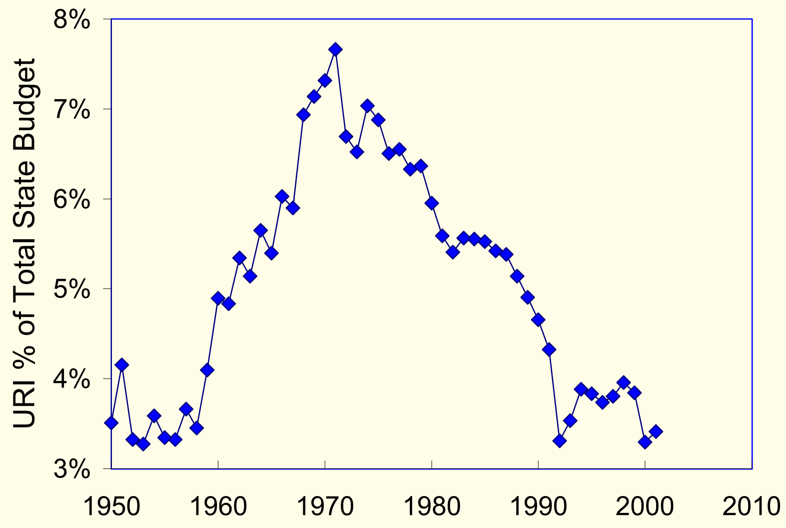
The effort to compare Rhode Island and its public research University to other states and universities—and to seek understanding from comparative "benchmarks" of how we might better support and use the University—is best preceded by an understanding of the fiscal evolution of the University as part of the State's budget over the past 30-50 years, as provided in the following brief historical overview.

What has happened to URI's research budget?

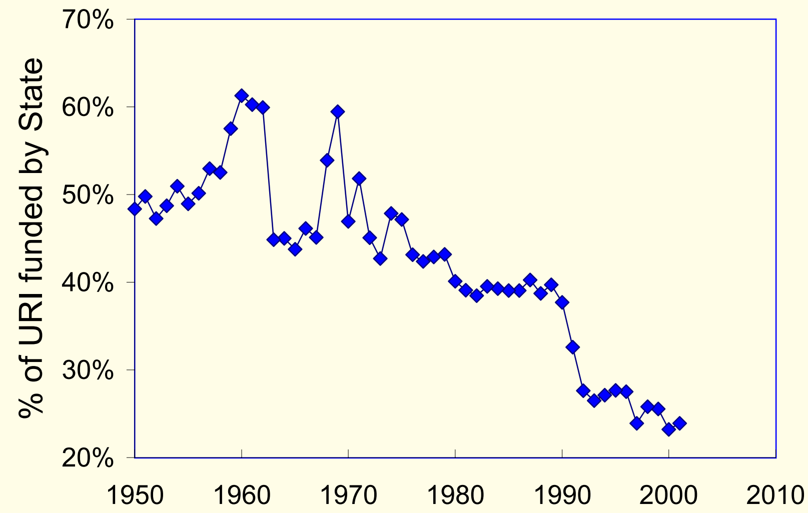
When State budgets grew, URI remained flat-funded. Inflation-adjusted, State general-revenue funding for the University grew exponentially in the 1960s: From 1960 to the early 1970s, URI's State funds nearly doubled twice. In 1971, real growth stopped. URI entered the new millennium with 3% less state support than it had in 1971: In contrast, the 2001 State budget had grown 116%[5].



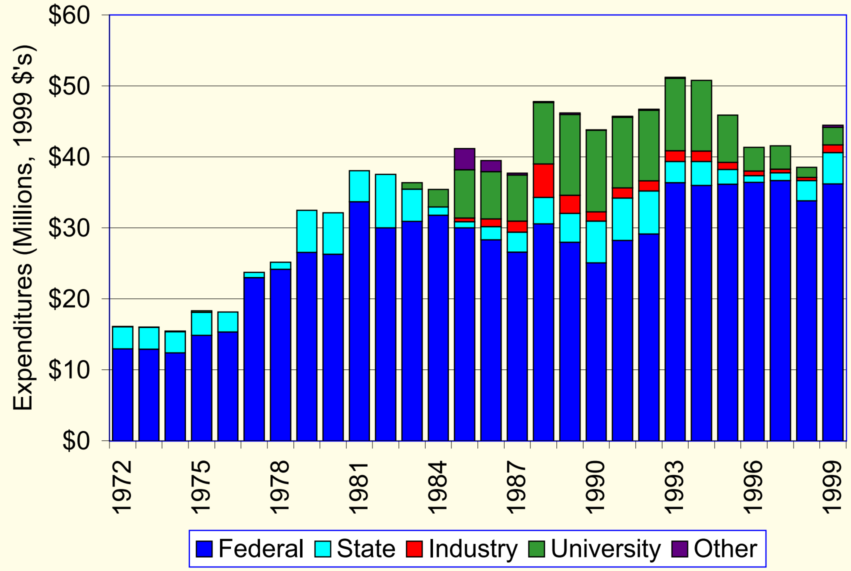
URI's State budget share has dropped since 1971.
As a result of flat funding, URI's budgetary importance has dropped steadily from its high of 7.7% of the Rhode Island total in 1971 to a low of 3.3% in 2000. Today's budget portion is similar to the 1950s, when URI was the State College, with a third of its present students and faculty[6].



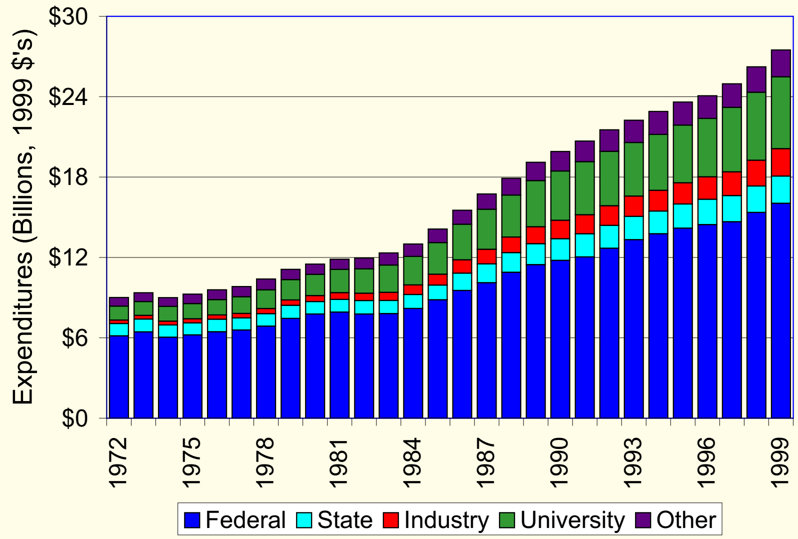
The State funded less of URI's budget every year. To keep up with inflation, the University raised tuition, competed for overhead-paying grants, and sought private donations to build its endowment[(7)]. Failure to increase state funding meant that URI has been moving from "State University" to "State-assisted University." On average, the State provided more than half of URI's funding in the 1950s and 60s, but provides less than one-quarter today[(8)].



Institutional support for research has declined. To balance its budget, URI has depended increasingly on tuition revenues. Inflation-adjusted institutional funds for research grew in the 1980s, but fell 87.5% from their 1990 peak by 1998. In 1997, URI had the highest percentage of federal sources for its research expenditures of any major research university. URI research expenditures from all funding sources have grown 38% over the past 20 years, while national averages (next page) have grown 139%[(9)].



URI's stagnant research expenditures contrast with national growth in spending. Nationally, spending on university research continues to grow, for all funding sources[9]. Adjusted for inflation, expenditures for science and engineering research conducted at U.S. universities have grown steadily for 30 years. Federal and State funds have grown less rapidly than the total, falling respectively from 68 and 10% of total in 1972 to 58 and 7% by 1999. Industry and University sources have grown from 3 and 12% of total in 1972 to 7 and 20% by 1999, while funding from private-non-profit foundations has remained at 7% of the total[10].



URI is not following national trends in funding research. Many Universities report that state budgets are lagging growth of University expenses[11]. Nevertheless, research expenditures have continued to grow as Universities compete for still-growing federal funds and use institutional funds on research, and as they collaborate with industry to fund on-campus research. URI is neither using more of its own funds nor obtaining industry funds to expand its research mission. URI has also seen little growth in federal funds in the 1990s.

Does Rhode Island differ from the nation because it is small or poor? By adjusting for population and income, we can compare our level of state and institutional investments to other states and other major universities to establish appropriate benchmarks for funding university research operations.

Benchmarks for Funding for Research Operations

How does Rhode Island compare to other states in support for university research operations?

Statewise comparisons. Rhode Island is the geographically smallest state. It is 43rd in population[12], 44th in gross state product[13], and 42nd in total personal income[14], yet Rhode Island per capita income is 18th in the nation (**Table 1**). Relatively speaking, RI is not poor!

How does Rhode Island compare in spending for Higher Education? Rhode Island ranked 48th in per capita state expenditures on higher education operations in 1999 (not including funds for buildings or major equipment, nor funds derived from tuition) (**Table 2**)[15]. 1999 RI per capita spending on higher education operations, $136.50, was 70% of the national average (of 50 states) of $195.

If Rhode Island were to have spent the national per capita average in state funds to support higher education operations—requiring an *increase* of $58.87 per capita (43.1%)—the State would spend an *additional* $61.7 million annually.

How does Rhode Island compare in spending for University research? State funds for university research include direct state contracts (i.e., grants from state agencies—to both public and private institutions) and all funds (from state appropriations, tuition, institutional foundations, etc.) spent internally for research at public institutions. The National Science Foundation provides on-line data on mean annual expenditure for all academic research in science and engineering[9]. To compare, we averaged expenditure data from 1997 to 1999 (latest available), adjusting each year to 1999 dollars.

- Rhode Island ranked 50th in percentage of higher education operating funds spent on research in 1999 (**Table 2**). RI's percentage (3.7%) is far below the national mean (of 50 states) of 13.1%.
- Rhode Island ranked 50th in per capita state support for university research (**Table 2**). RI's $5.01 was 19.5% of the national average (of 50 states) of $25.66.
- Rhode Island ranked 50th in state spending on University research aper $1000 of personal income (**Table 2**). RI's $0.18 was 18% of the national average (of 50 states) of $1.00.

If Rhode Island were to spend the national per capita average in state funds to support university research operations, an increase of 412% ($20.65 per capita), the State would spend an *additional* $21.6 million annually.
(Computing total national spending / national population produces a more conservative estimate than merely averaging the ratios for the 50 states. If the average per capita higher education operations state budget were computed as national total spending divided by national population, it would be $188 per capita, and RI would need an additional $54 million annually in state funds to become average. If the average per capita research state budget were computed as total states spending divided by U.S. population, it would be $22.15 per capita, and RI would need an additional $18 million annually in state funds for research to become average. If the average per $1000 of personal income level of support were taken as total national spending divided by total national personal income, it would be $0.80 per $1000 and RI would again need an additional $18 million annually in state funds for research to become average).

How does URI compare to other universities in support for its research operations?

Institutional comparisons. To allow broad comparison of URI without loosing tractability, we looked at 134 universities, listed in **Appendix Table 1**. This sample includes all 125 Carnegie Research I and II Universities[16], all 50 1862 Land Grant Universities[17], and 13 Universities previously used by URI for "peer group" comparisons[18]. The set includes 93 public universities and 77 universities with affiliated hospitals. We used NSF data on mean annual expenditures for academic research in science and engineering, averaged over 1997 to 1999, adjusted to 1999 dollars[9]. These institutions accounted for 84% of the national total spent on academic research from 1997 to 1999, including 84% of funds from the federal government, 82% from state governments, 81% from industry, 87% from institutional funds, and 79% from other sources.

<u>Distribution of funding sources: Public versus Private, and the influence of affiliated hospitals.</u> Public and private research institutions

Table 1. State 2000 population, 1999 Gross State Product, 1999 Personal Income and Per Capita Income, ranked. See text for sources.

State	2000 Population	Rank	1999 Gross State Product (Millions of $'s)	Rank	1999 Personal Income (Millions of $'s)	Rank	1999 Per Capita Income	Rank
Alabama	4,447,100	23	115,071	25	100,385	24	22,573	41
Alaska	626,900	48	26,353	45	17,736	47	28,291	14
Arizona	5,130,600	20	143,683	23	120,287	25	23,445	37
Arkansas	2,673,400	33	64,773	33	56,724	33	21,218	47
California	33,871,600	1	1,229,098	1	989,590	1	29,216	12
Colorado	4,301,300	24	153,728	21	127,904	22	29,736	9
Connecticut	3,405,565	29	151,779	22	129,780	21	38,108	1
Delaware	783,600	45	34,669	41	23,135	44	29,523	11
Florida	15,982,378	4	442,895	5	419,800	4	26,266	24
Georgia	8,186,453	10	275,719	10	212,806	11	25,995	26
Hawaii	1,211,537	42	40,914	39	32,641	40	26,941	19
Idaho	1,293,953	39	34,025	43	28,627	43	22,124	45
Illinois	12,419,293	5	445,666	4	377,650	5	30,408	7
Indiana	6,080,485	14	182,202	15	155,448	16	25,565	30
Iowa	2,926,324	30	85,243	30	73,453	30	25,101	33
Kansas	2,688,418	32	80,843	31	70,876	31	26,364	22
Kentucky	4,041,769	25	113,539	26	92,000	26	22,762	40
Louisiana	4,468,976	22	128,959	24	99,855	25	22,344	42
Maine	1,274,923	40	34,064	42	30,803	41	24,160	36
Maryland	5,296,486	19	174,710	16	168,168	15	31,751	5
Massachusetts	6,349,097	13	262,564	11	219,386	10	34,554	2
Michigan	9,938,444	8	308,310	9	277,214	9	27,893	17
Minnesota	4,919,479	21	172,982	17	146,810	17	29,843	8
Mississippi	2,844,658	31	64,286	34	57,272	32	20,133	50
Missouri	5,595,211	17	170,470	18	144,389	18	25,806	27
Montana	902,195	44	20,636	47	19,419	45	21,524	46
Nebraska	1,711,263	38	53,744	36	45,061	36	26,332	23
Nevada	1,998,257	35	69,864	32	56,094	34	28,071	15
New Hampshire	1,235,786	41	44,229	38	37,626	39	30,447	6
New Jersey	8,414,350	9	331,544	8	290,004	8	34,465	3
New Mexico	1,819,046	36	51,025	37	37,991	37	20,885	49
New York	18,976,457	3	754,590	2	616,878	2	32,508	4
North Carolina	8,049,313	11	258,592	12	202,109	13	25,109	32
North Dakota	642,200	47	16,991	50	14,747	49	22,964	38
Ohio	11,353,140	7	361,981	7	305,855	7	26,940	20
Oklahoma	3,450,654	27	86,382	29	77,093	29	22,342	43
Oregon	3,421,399	28	109.694	27	89.398	28	26,129	25
Pennsylvania	12,281,054	6	382,980	6	343,263	6	27,951	16
Rhode Island	1,048,319	43	32,546	44	29,066	42	27,726	18
South Carolina	4,012,012	26	106,917	28	91,463	27	22,797	39
South Dakota	754,844	46	21,631	46	18,358	46	24,321	35
Tennessee	5,689,283	16	170,085	19	140,094	20	24,624	34
Texas	20,851,820	2	687,272	3	537,857	3	25,794	28
Utah	2,233,169	34	62,641	35	49,573	35	22,199	44
Vermont	608,827	49	17,164	49	15,345	48	25,205	31
Virginia	7,078,515	12	242,221	13	204,769	12	28,928	13
Washington	5,894,121	15	209.258	14	174,877	14	29,670	10
West Virginia	1,808,344	37	40,685	40	37,802	38	20,904	48
Wisconsin	5,363,675	18	166,481	20	143,705	19	26,792	21
Wyoming	493,782	50	17,448	48	12,644	50	25,606	29
	Total: 280,849,744		Mean: 185,063		Mean: 155,277		Mean: 26,407	

Table 2. State funds for Higher Education Operating and University research, and spending per capita and per $1000 of income. See text for sources.

State	State Funds for Higher Education Operating ($1000s, 1999)	Per Capita Higher Educ. Operating (State $'s)	Rank	State Funds for Univ. Research (Mean 1997-1999, $1000s, 1999 $'s)	% of State H. Ed. Funds Spent on Research	Rank	Per Capita State Funds For University Research	Rank	State Funds For Univ. Res. $1s per $1000 Pers. Income	Rank
Alabama	1,037,680	233.34	11	90,446	8.72	42	20.34	31	0.90	27
Alaska	170,403	271.82	3	31,927	18.74	8	50.93	3	1.80	5
Arizona	836,389	163.02	39	158,136	18.91	6	30.82	14	1.31	13
Arkansas	556,659	208.22	18	55,655	10.00	38	20.82	30	0.98	25
California	7,250,661	214.06	15	785,602	10.83	31	23.19	25	0.79	31
Colorado	682,210	158.61	41	86,528	12.68	25	20.12	32	0.68	34
Connecticut	623,692	183.14	29	66,408	10.65	33	19.50	34	0.51	45
Delaware	164,115	209.44	17	24,423	14.88	15	31.17	12	1.06	19
Florida	2,501,857	156.54	42	269,287	10.76	32	16.85	39	0.64	37
Georgia	1,483,818	181.25	30	297,997	20.08	4	36.40	8	1.40	11
Hawaii	322,258	265.99	7	48,063	14.91	14	39.67	6	1.47	9
Idaho	266,522	205.98	19	36,153	13.56	20	27.94	19	1.26	15
Illinois	2,411,068	194.14	22	220,043	9.13	39	17.72	38	0.58	39
Indiana	1,147,819	188.77	27	154,227	13.44	21	25.36	23	0.99	23
Iowa	784,987	268.25	5	142,371	18.14	10	48.65	4	1.94	3
Kansas	604,704	224.93	12	106,091	17.54	11	39.46	7	1.50	7
Kentucky	888,700	219.88	13	119,169	13.41	22	29.48	16	1.30	14
Louisiana	859,036	192.22	25	145,986	16.99	12	32.67	11	1.46	10
Maine	199,149	156.20	43	14,734	7.40	47	11.56	47	0.48	46
Maryland	942,748	177.99	31	176,112	18.68	9	33.25	10	1.05	20
Massachusetts	975,360	153.62	44	69,773	7.15	48	10.99	48	0.32	48
Michigan	1,882,500	189.42	26	278,887	14.81	16	28.06	18	1.01	22
Minnesota	1,239,394	251.94	10	108,580	8.76	40	22.07	26	0.74	32
Mississippi	751,195	264.07	8	56,502	7.52	46	19.86	33	0.99	24
Missouri	919,548	164.35	37	118,009	12.83	24	21.09	28	0.82	29
Montana	129,929	144.01	47	30,371	23.38	2	33.66	9	1.56	6
Nebraska	440,095	257.18	9	102,822	23.36	3	60.09	1	2.28	1
Nevada	290,363	145.31	45	32,113	11.06	29	16.07	40	0.57	41
New Hampshire	91,156	73.76	50	17,156	18.82	7	13.88	46	0.46	47
New Jersey	1,453,937	172.79	32	162,375	11.17	28	19.30	35	0.56	42
New Mexico	517,261	284.36	1	56,635	10.95	30	31.13	13	1.49	8
New York	3,104,892	163.62	38	192,003	6.18	49	10.12	49	0.31	49
North Carolina	2,149,972	267.10	6	227,363	10.58	34	28.25	17	1.12	18
North Dakota	173,107	269.55	4	28,244	16.32	13	43.98	5	1.92	4
Ohio	1,934,587	170.40	33	203,357	10.51	35	17.91	37	0.66	35
Oklahoma	725,450	210.24	16	101,787	14.03	19	29.50	15	1.32	12
Oregon	556,412	162.63	40	71,922	12.93	23	21.02	29	0.80	30
Pennsylvania	1,773,094	144.38	46	184,243	10.39	36	15.00	43	0.54	43
Rhode Island	143,100	136.50	48	5,254	3.67	50	5.01	50	0.18	50
South Carolina	777,801	193.87	24	110,515	14.21	18	27.55	21	1.21	16
South Dakota	125,882	166.77	36	11,020	8.75	41	14.60	44	0.60	38
Tennessee	957,970	168.38	35	81,186	8.47	43	14.27	45	0.58	40
Texas	3,527,867	169.19	34	440,531	12.49	26	21.13	27	0.82	28
Utah	489,173	219.05	14	59,360	12.13	27	26.58	22	1.20	17
Vermont	59,173	97.19	49	14,648	24.75	1	24.06	24	0.95	26
Virginia	1,299,919	183.64	28	132,423	10.19	37	18.71	36	0.65	36
Washington	1,146,399	194.50	21	91,600	7.99	44	15.54	41	0.52	44
West Virginia	362,261	200.33	20	27,810	7.68	45	15.38	42	0.74	33
Wisconsin	1,040,341	193.96	23	148,607	14.28	17	27.71	20	1.03	21
Wyoming	139,711	282.94	2	26,992	19.32	5	54.66	2	2.13	2
	Total: 52,912,324	Mean: 195.38		Mean: 124,429	Mean: 13.08		Mean: 25.66		Mean: 1.00	

Public and private universities differ in how they fund research (Table 3).

- Of universities with expenditures for science and engineering research in the 1990s, 392 **public** institutions (57%) spent **68%** of total research dollars.
- **State governments** invested in research mostly within their own public institutions, which spent 91% of state agency grants.
- Public institutions also spent more **institutional** funds (derived from tuition, state appropriations, etc.) on research compared to private (24% versus 9% of institutional total).
- Private institutions depended more heavily on **federal** funds than public (72 versus 52% of institutional).
- The distribution of funding sources is affected by status as public or private more than it is by an affiliated hospital / medical school.

Table 3. University research spending in 1999 by **percentage,** from major sources.

	Federal	State	Industry	University	Other
All Universities (n=688; Total=$27.49 Billion)					
	58.4	7.4	7.4	19.5	7.3
All **Public** Universities (n=392; Total=$18.63 Billion)					
	51.9	9.9	7.3	24.3	6.6
Public, with hospital (n=32; Total=$5.10 Billion)					
	57.9	*5.0*	*7.0*	*20.6*	*9.4*
Public, without hospital (n=360; Total=$13.53 Billion)					
	49.1	*11.8*	*7.4*	*25.7*	*5.5*
All **Private** Universities (n=296; Total=$8.86 Billion)					
	72.0	2.0	7.8	9.4	8.8
Private, with hospital (n=28; Total=2.81 Billion)					
	71.0	*1.6*	*11.1*	*7.9*	*8.4*
Private, without hospital (n=268; Total=$6.05 Billion)					
	72.5	*2.2*	*6.3*	*10.2*	*8.9*
Percentage of this funding source spent in public universities:					
	60.3	91.3	66.3	84.4	61.2

differ in how they fund research. For example, in 1999 (see **Table 3** and sidebar) states spent 91% of their state agency research grants in public institutions. States also permit public institutions to spend money directly on research, creating significant differences in the relative amount of "institutional" funds spent on research. Differences in funding patterns (i.e., percentage of funds from each major source) are relatively unaffected by affiliation with a hospital.

"State" versus "Institutional" funds. NSF distinguishes between "state and local" (simply "state" in what follows) and "institutional" funds. Whether "institutional" expenditures are derived from tuition or the institution's endowment (the only options in private universities) or from state legislative line items for research (i.e., in public institutions), the funds are virtually indistinguishable from state funds allocated through state agency budgets as grants to the university. For example, if a state wants research on automated systems to control highway traffic, it can elect to fund this through a state Department of Transportation grant (which NSF then lists under "State & Local") or it can fund the institution directly for an internal "Transportation Research Center" (which NSF then lists under "Institutional"). Institutional funds make up a relatively higher proportion of research expenditures in public universities (24% versus 9% in private universities, **Table 3**).

URI's dependency on federal funds for research. From 1997 to 1999, 86% of URI's research expenditures came from federal funds: Only six institutions in our sample, including none of the 92 other public universities and none of the 49 other state land grant universities, show a higher dependency on federal funds (**Appendix Table 2**). Conversely, none of the 92 public universities or 49 land grants had a smaller percentage of research funds coming from institutional sources than URI. Adding state grants (52 of the 92 public universities had a higher percentage of funds from state agencies than URI) was insufficient to lift URI or Rhode Island from the bottom rank of state research investments (**Table 2**). URI has not significantly compensated with funds from industry: 88 of the other 92 public institutions had a higher percentage of research funds coming from industry.

Funding for research, by field. **Table 4** compares the research profile of URI to the national research profile, using NSF data on total research and development expenditures by field[19], with means from 1997 to 1999, in 1999 dollars. NSF reports R&D expenditures under major fields—engineering and seven for science—with subfields for engineering, and physical, environmental, life, and social sciences. Data are for operations, and do not include funds for buildings or major items of equipment (see next section).

Every university is distinct, and there is no *a priori* best pattern of internal investment by scientific field. The Ocean State is markedly different from the Lone Star State, for example, and the research profile of URI is naturally different from that of Texas A&M. Accordingly, URI has a substantial level of research activity in oceanography, for example: URI's per capita expenditures (from all funding sources) for oceanography are nearly ten times the national average.

In general, URI's *total* per capita expenditures for research operations ($39.62 per capita, with 86% from federal sources) are only 42% of the national average of $93.25[9]. URI exceeds national per capita operational expenditures only in environmental sciences (355% of national average) and psychology (260%). URI is under national average per capita operational expenditures in all fields of engineering (24% of average over all subfields, with no expenditures for aeronautics, bioengineering/biomedical, and materials research). URI has very low relative expenditures for mathematical sciences (0.12% of national average) and computer sciences (6%). The life sciences (14% of national average) show very low relative expenditures in biological and medical sciences (7.5% and 5.2% of national, respectively).

Table 4. Total separately budgeted R&D expenditures in the sciences and engineering, by field, using means for 1997 to 1999, adjusted for inflation to 1999 $'s.

	Nation			Rhode Island			RI per capita
Field of Science / subfield	Mean ($1000s)	$'s per capita	% of Total	Mean ($1000s)	$'s per capita	% of Total	as % of National per capita
Engineering	$4,113,583	$14.62	15.68%	$3,706	$3.53	8.92%	24.18%
Aeronautical & Astronautical	*$255,990*	*$0.91*	*0.98%*	*$0*	*$0.00*	*0.00%*	*0.00%*
Bioengineering/Biomedical	*$106,480*	*$0.38*	*0.41%*	*$0*	*$0.00*	*0.00%*	*0.00%*
Chemical	*$335,696*	*$1.19*	*1.28%*	*$482*	*$0.46*	*1.16%*	*38.55%*
Civil	*$505,269*	*$1.80*	*1.93%*	*$706*	*$0.67*	*1.70%*	*37.49%*
Electrical	*$1,018,231*	*$3.62*	*3.88%*	*$646*	*$0.62*	*1.55%*	*17.02%*
Mechanical	*$577,722*	*$2.05*	*2.20%*	*$409*	*$0.39*	*0.99%*	*19.02%*
Metallurgical & Materials	*$393,882*	*$1.40*	*1.50%*	*$0*	*$0.00*	*0.00%*	*0.00%*
Other, not elsewhere classified	*$920,314*	*$3.27*	*3.51%*	*$1,463*	*$1.40*	*3.52%*	*42.67%*
Physical sciences	$2,515,571	$8.94	9.59%	$898	$0.86	2.16%	9.58%
Astronomy	*$330,481*	*$1.17*	*1.26%*	*$0*	*$0.00*	*0.00%*	*0.00%*
Chemistry	*$882,601*	*$3.14*	*3.36%*	*$523*	*$0.50*	*1.26%*	*15.90%*
Physics	*$1,105,159*	*$3.93*	*4.21%*	*$366*	*$0.35*	*0.88%*	*8.90%*
Other, not elsewhere classified	*$197,329*	*$0.70*	*0.75%*	*$9*	*$0.01*	*0.02%*	*1.24%*
Environmental sciences	$1,634,043	$5.81	6.23%	$21,613	$20.62	52.04%	355.08%
Atmospheric sciences	*$268,173*	*$0.95*	*1.02%*	*$797*	*$0.76*	*1.92%*	*79.78%*
Earth sciences	*$508,384*	*$1.81*	*1.94%*	*$85*	*$0.08*	*0.21%*	*4.50%*
Oceanography	*$569,019*	*$2.02*	*2.17%*	*$20,704*	*$19.75*	*49.85%*	*976.78%*
Other, not elsewhere classified	*$288,467*	*$1.03*	*1.10%*	*$27*	*$0.03*	*0.07%*	*2.51%*
Mathematical sciences	$308,266	$1.10	1.17%	$1	$0.00	0.00%	0.12%
Computer sciences	$781,943	$2.78	2.98%	$176	$0.17	0.42%	6.05%
Life sciences	$14,785,280	$52.54	56.34%	$7,817	$7.46	18.82%	14.19%
Agricultural sciences	*$2,025,748*	*$7.20*	*7.72%*	*$4,188*	*$3.99*	*10.08%*	*55.50%*
Biological sciences	*$4,649,573*	*$16.52*	*17.72%*	*$1,301*	*$1.24*	*3.13%*	*7.51%*
Medical sciences	*$7,555,921*	*$26.85*	*28.79%*	*$1,473*	*$1.40*	*3.55%*	*5.23%*
Other, not elsewhere classified	*$554,037*	*$1.97*	*2.11%*	*$855*	*$0.82*	*2.06%*	*41.45%*
Psychology	$441,265	$1.57	1.68%	$4,282	$4.08	10.31%	260.49%
Social sciences	$1,186,247	$4.22	4.52%	$1,056	$1.01	2.54%	23.90%
Economics	*$267,158*	*$0.95*	*1.02%*	*$804*	*$0.77*	*1.94%*	*80.79%*
Political science	*$186,532*	*$0.66*	*0.71%*	*$27*	*$0.03*	*0.07%*	*3.89%*
Sociology	*$262,394*	*$0.93*	*1.00%*	*$1*	*$0.00*	*0.00%*	*0.07%*
Other, not elsewhere classified	*$470,164*	*$1.67*	*1.79%*	*$224*	*$0.21*	*0.54%*	*12.80%*
Other sciences, n.e.c.	$475,883	$1.69	1.81%	$1,986	$1.89	4.78%	112.02%
Total	$26,242,080	$93.25	100.00%	$41,535	$39.62	100.00%	42.49%

Benchmarks for Funding University Research Operations. Academic research expenditure data reflect investment in scientists, technicians, research aides and graduate students, and the expendable supplies and equipment needed for universities to conduct science and engineering research. Rhode Island is investing less in academic research than any other state, after adjusting for state population and income. Without State investment in research operations, URI scientists are at a competitive disadvantage, which may in part explain 20 years of slow growth of federal funds (and stagnation since the early 1990s) at URI, over a span when available funds have doubled (see page 4).

To have leading edge science and engineering, URI needs a robust research agenda. Funding benchmarks for operations (based on the above, in 1999 $'s), with mean of 50 states as the goal, are these:

• Attaining an average per capita level of state support for higher education operating expenses would require a 43% increase, or $58.87 per capita annually (total increase $61.7 million).

• Attaining an average per capita level of state support for university research operations would require a 412% increase, or $20.65 per capita annually (total $21.6 of the $61.7 million increase to higher education).

Competition to attract and retain faculty and research associates—competition between URI and leading research universities and the private sector—is critically dependent upon investment of state and institutional funds. Having the lowest level of state and institutional support of any major public research university is a competitive disadvantage for both the University and the State. The comparative underinvestment in operational support for research at URI will not create a competitive URI or a sound economic future for Rhode Island.

While it may never be appropriate for URI to establish a goal of building, say, an aeronautical or astronautical research program, state economic policy makers and University leaders should reflect upon the folly of continued low research investment (leading to low research productivity) in fields that are important to maintaing a leading edge for the Rhode Island economy.

Benchmarks for Funding Research Infrastructure

Funding Buildings, Laboratories, and Fixed Equipment

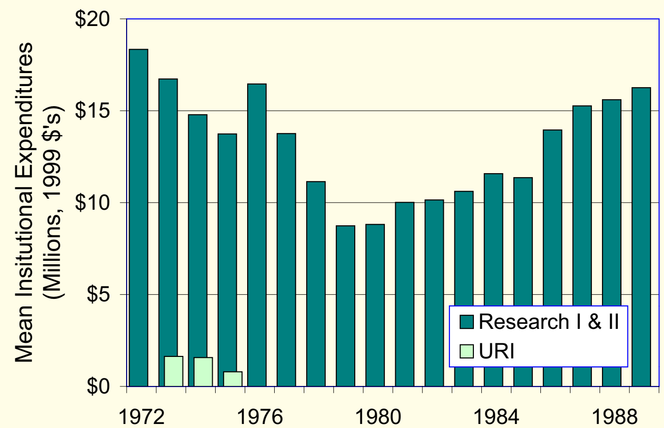
To understand Rhode Island's relative effort to build its economy through University research, we also need to compare support for construction of new research space, renovation of outmoded research buildings and laboratories, and replacement or upgrades for equipment.

Maintaining a leading edge in research and graduate education in the sciences and engineering requires constant upgrading of buildings, laboratories, and major items of equipment—collectively, "infrastructure." Major ("fixed") items of equipment—instruments over $500[20], with life expectancies of more than two years—include such things as electron microscopes, robotic gene sequencers, and major analytic machines. Even expensive and sophisticated instruments may become outdated in 3-10 years in areas of science where technology is advancing most rapidly. State-of-the-art laboratories may require renovation after 15-20 years, and even entire buildings may prove inadequate only 30 or 40 years after they are built, requiring renovation or replacement.

The research operations expenditures reported in the previous section do not include spending on infrastructure. NSF conducts separate surveys of workspace (i.e., buildings and laboratories used for scientific and engineering research) and fixed equipment. These data are gathered annually from research-performing institutions (i.e., those with more than $50,000 in research operations expenditures in the most recent NSF survey). Published survey results, on-line data, and methodology are available through the NSF web site, www.nsf.gov[21].

Buildings and Laboratories: Space for Research. NSF publishes reports on facilities every two years, summarizing the quantity and quality of research space for various fields of science and engineering. The most recent publication is "Scientific and Engineering Research Facilities at Colleges and Universities, 1998," which was published in

Prior to 1989, NSF published information on total capital expenditures—collectively, fixed or expensive movable equipment, construction costs (site work, architect fees, building, etc.), and major equipment[15]. From 1972 to 1989, URI's total reported capital expenditures ($1.3 million, 89% from federal sources) for research and development were 1.7% of the institutional average of the Carnegie Research I & II Universities.



In the 1970s and 80s, URI reported significantly lower capital expenditures than the average research university.

October 2000[22]. (Preliminary survey data from 1999 are available online.) The 1998 survey covered 660 colleges and universities. Fifty-seven percent (378) were doctorate-granting, including the "top 100" and 278 "other" institutions, based on R&D expenditures[23].

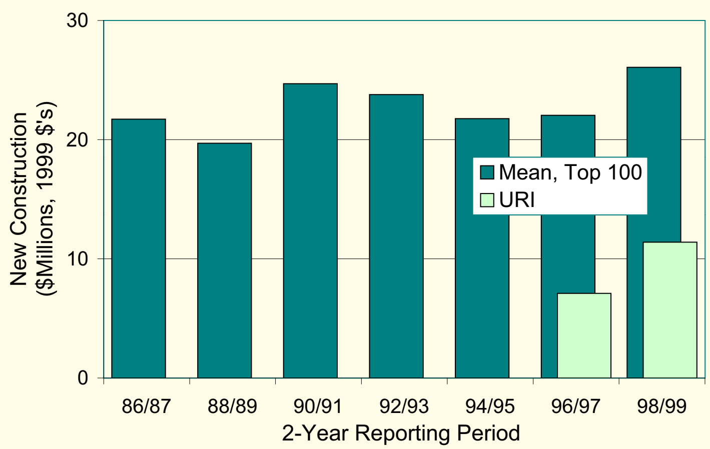
In the overview to the 1998 report, NSF outlines the critical research space issues for the nation. These translate directly into issues for Rhode Island and URI policy makers.

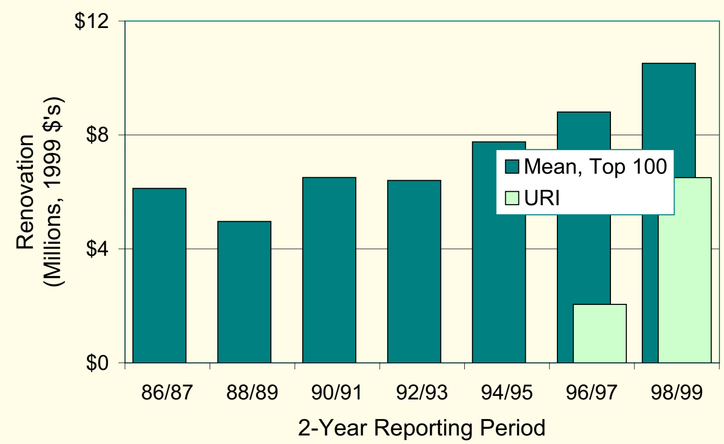
- *How much space is there for conducting S&E (science and engineering) research?*
- *Is this enough space to meet the Nation's S&E research needs?*
- *What is the condition of this space?*
- *How much new S&E space needs to be constructed? How much of the existing S&E space needs repair or renovation?*
- *How much construction and repair/renovation is taking place and what does it cost?*
- *How do colleges, universities, and biomedical institutions fund these capital projects?*
- *How has the situation changed over the past decade?*

How does the amount of research space at URI compare to other doctorate-granting universities and the top 100?

The 378 doctorate-granting colleges and universities in the 1998 survey accounted for 416 (85%) of the estimated 488 million square feet of *instructional and research* space in *all* academic fields, and 261 (91%) of the 286 million square feet of *instructional and research* space in *science and engineering* fields **(Table 5)**[24]. The top 100 accounted for 71% of research space (and 80.7% of all research expenditures).

The number of square feet of space allocated to research at URI, 237,600 (**Table 5**, last column), is 56% of the average for all doctorate-





In the late 1980s and 1990s, investment in new S&E construction continued at a steady rate and renovation of existing space increased for the top 100 research universities, which accounted for 81% of academic R&D expenditures and 71% of research space by 1999. URI data is only for 1996/97 (actual) and 1998/99 (estimated for NSF, 1998).[22]

granting institutions, and 24% of the top 100. The percentage of available instructional and research space allocated to research at URI (38%) is 67% of the average percentage of doctorate-granting institutions and 60% of the percentage of the top 100.

How does distribution of research space among science and engineering fields at URI compare to the national pattern?

Table 6 compares amounts and relative percentages of research space across major fields of science for all research universities, top 100 and other doctorate-granting research universities, non doctorate-granting research universities, and URI. Relative distribution of space allocated to environmental sciences (Earth, Atmospheric, and Ocean Sciences) is proportionally higher at URI, as are relative amounts for psychology (includes the cancer prevention research center), engineering, and other (mostly human development) sciences. Conversely, smaller proportions of research space are devoted to physical sciences, mathematics and computer sciences, biological and medical sciences, and the remaining social sciences. The difference in relative amounts of space for the biological sciences (22% nationally versus 4% at URI) stands out.

Is the amount of space in each field of science adequate to meet current needs?

NSF's 1998 facilities report[22] indicated that for all fields of science surveyed except mathematics, at least half of surveyed institutions reported inadequate amounts of space for research. Nationally, space for academic science and engineering research space increased 28% between 1988 and 1998. The same surveys indicate that across all science and engineering fields, only 39% of existing research facilities are considered "suitable for use in most scientifically sophisticated research."

The need for additional space and the assessment of the condition of space is determined by a survey distributed to University officials and to academic department chairs. As such, it is highly subjective and in

Table 5. Instructional and research (I&R) space (millions of net assignable square feet[25]) for research-performing institutions, for all academic research and for science and engineering (S&E) research, by institution type, 1998.

		—Instructional and Research—		—Research Only—		Mean Research
	Number of Institutions	Space in all Academic Fields	Space in S&E Fields	Space in S&E Fields	% of I&R Space	Sq. Ft. (1000's) per Institution
Total	660	488	286	143	50.0	217
Doctorate-granting	378	416	261	136	52.1	360
Top 100	100	252	177	101	57.1	1,010
Other	278	164	84	35	41.7	126
Nondoctorate-granting	282	72	25	7	28.0	25
URI (Sq. Ft. in 1000's):	1	n/a	620	238	38.3	238

Table 6. Amount of science and engineering research space (1000s of net assignable square feet), and percentage distribution by field of science, by institution type. National data is 1998. URI data is 1999[26].

			—Doctorate-granting—							
	Total		Top 100		Other		Nondoctorate		URI	
Field of Science	NASF	%	NASF	%	NASF	%	NASF	%	NASF	%
Engineering	22,833	15.9%	16,192	16.0%	6,312	18.2%	329	4.4%	51.8	21.8%
Physical sciences	18,191	12.7%	11,205	11.1%	5,200	15.0%	1,786	24.1%	8.4	3.5%
Environmental sciences	7,524	5.3%	5,416	5.3%	1,676	4.8%	431	5.8%	77.9	32.8%
Mathematical sciences	889	0.6%	460	0.5%	286	0.8%	144	1.9%	0.3	0.1%
Computer sciences	2,018	1.4%	1,381	1.4%	442	1.3%	195	2.6%	0.9	0.4%
Agricultural sciences	24,607	17.2%	20,141	19.9%	3,155	9.1%	1,310	17.7%	59.3	25.0%
Biological sciences	31,067	21.7%	20,797	20.5%	8,475	24.5%	1,795	24.2%	13.9	5.8%
Medical sciences	25,129	17.5%	19,339	19.1%	5,609	16.2%	180	2.4%	12.4	5.2%
Psychology	3,360	2.3%	1,841	1.8%	1,056	3.1%	463	6.2%	10.9	4.6%
Social sciences	4,620	3.2%	2,912	2.9%	1,185	3.4%	524	7.1%	1.9	0.8%
Other sciences, n.e.c.	3,050	2.1%	1,588	1.6%	1,210	3.5%	252	3.4%	0	0%
Total	143,288		101,272		34,606		7,409		237.6	
% of National Total		100.0%		70.7%		24.2%		5.2%		0.13%

need of, as NSF cautions, "careful interpretation." URI survey data is developed by the URI Research Office.

Table 7 summarizes URI space data from 1999, with comparisons from national data for all institutions with research space in the respective fields[26]. Relatively high URI space usage in agriculture includes high square footage of barns, old farm buildings, greenhouses, etc., assigned to the Agricultural Experiment Station and Plant Science and Animal Science departments): despite a large space inventory, the agricultural sciences (as well as the biological sciences in general) suffer from an inventory of buildings and laboratories that are 30-90 years old and in need of renovation or replacement before these sciences can fully engage in state-of-the-art technology-driven research.

The determination of adequacy is also affected by the condition of space. Estimating that 50-70% of existing URI space for agriculture, biological science, or medical sciences is suitable for "the most scientifically competitive research in the field" patently overstates the quality of the space inventory in these fields (see next item).

How much new S&E space needs to be constructed? How much existing S&E space needs repair or renovation?
In the 1990s four buildings with research laboratories (the Kirk Applied Engineering Lab, the Cancer Prevention Research Center, The Kingston Campus Coastal Institute Building, and the Center for Atmospheric Chemistry Studies), were constructed at URI, adding to space inventory for atmospheric sciences, agricultural sciences, social sciences, and industrial engineering. Most science fields at URI have seen no new construction nor renovation of R&D facilities in 30+ years. URI's *total* expenditures for construction and renovation of research space since 1970 (figures on pages 12 and 13) are under the ~$18 million *annual* capital expenditure average of top 100 research Universities.

1998 URI estimates of new space needed—85,000 square feet (**Table 6)**—may understate actual need. After these estimates were made, for example, the Environmental Biotechnology Initiative, a faculty-driven effort, recommended construction of new core facilities in genomics, transgenics, imaging, and informatics, with an estimate of 50-85,000 square feet needed for plant and animal biotechnology laboratories. A bond issue to finance the EBI facilities was proposed to

Table 7. Amount of URI research space (Table 6) per Expended Research Dollar (Table 4) by field, estimated additional space needed, and current condition of S&E space for URI/nationally, 1999.

Field of Science	Sq. Ft. (x1000) Needed (% incr.)	Condition* A	B	C	D
Engineering	0 (0)	20/43	50/35	30/17	/5
Physical sciences	10 (111)	20/41	30/36	30/19	20/5
Environmental sciences	10 (15)	50/39	30/34	5/21	15/6
Mathematical sciences	0 (0)	50/52	50/33	/12	/3
Computer sciences	5 (610)	50/43	5/35	/15	/7
Agricultural sciences	20 (71)	60/33	25/34	13/23	2/10
Biological sciences	10 (278)	70/41	20/30	10/22	/6
Medical sciences	10 (89)	50/31	50/43	/20	/6
Psychology	5 (85)	80/39	20/39	/19	/4
Social sciences	5 (474)	60/43	20/39	10/15	10/3
Other sciences	0 (0)	50/70	30/19	20/9	/22
Total	85 (44)				

* Condition: % of Total (Table 6) in following categories:

A Suitable for the most scientifically competitive research in the field;

B Effective for most levels of research in the field, but may need limited repair/renovation;

C Requires major renovation to be used effectively;

D Requires replacement.

the Board of Governors for inclusion on the 2002 ballot. An additional 10,000 square feet of greenhouse space for transgenic plants and 10,000 square feet to replace an agronomy farm field house are also needed.

Planned repair and renovation projects and unfunded space needs, from the 1998 URI estimates, are listed in **Table 8**[27]. These include $55 million for renovations and $0.6 million for new construction. The latter does not reflect more recent discussions of a new biotechnology building, with an approximate cost upwards of $50 million.

The space planning process at URI is driven by internal prioritization of academic needs, based on the desires of academic department chairs and college deans. Priorities reflect the University's commitment to undergraduate students. Current projects include renovation of Green Hall—to centralize the registrar and bursar—and renovation of Ballentine Hall to replace 16 classrooms plus offices for the College of Business. Renovation of Lippitt and Independence Halls also relate primarily to needs for classroom and office upgrades. The renovation of Ranger Hall, given bond approval in 1996, was intended to renovate a building used primarily for teaching: a suggestion to instead used Ranger for the Environmental Biotechnology Initiative was not proposed until 1999. Woodward Hall—a mixture of offices (50%), classrooms (10%), and laboratories (40%)—was renovated in 1996 due to asbestos abatement.

There is no clear relation of URI space planning processes to the specific enhancement of University infrastructure to better relate the University to the State's economy—for example, to build research space for computer sciences in response to economic needs for information technology. There are no plans to build on-or-near-campus centers for the development of industrial research collaborations or for commercialization of research products from such collaborations. This subject is dealt with further, below.

How are research capital projects funded? Nationally, in 1996/97 public institutions funded S&E research facility repairs and renovation from either state and local (49%) or institutional funds (27%). URI funded 1996/97 repair and renovation 98% from state funds (institutional funds made up the last 2%) (**Table 9**).

Nationally, new construction (>$100,000 per project) depended on state (47%) and institutional funds (43%, including 13% private, 13% institutional, and 13% tax-exempt bonds). URI funded 1996/97 construction with 13% federal and 79% institutional funds (including private 14%, institutional 8%, and bonds 56%). The accrual of debt service on bonds is a major financial burden on the University. The University may be able to offset some debt servicing through charges for facilities use (e.g., dormitory fees, convocation center ticket sales, etc.), but this is unlikely for capital improvements for research facilities.

How has the situation changed over the past decade? Nationally, the amount of S&E academic research space increased 28% over the past decade, but the amount of space requiring renovation or replacement has increased in all fields but mathematics, as the nation's exponential growth in science facilities in the 1960s begins to show its age. Five fields have seen an increase of over 100% in the amount of space needing major renovation or replacement, including social sciences (147% increase), medical sciences outside medical schools (125%), environmental sciences (earth, atmospheric, and ocean sciences 111%), agricultural sciences (108%) and biological sciences outside medical schools (100%)[22].

URI's buildings and laboratories are also showing their age. Expenditures in 1996/97 (**Table 7**) for repair and renovation and corrected estimates for 1998/99 (**Table 8**[23]) averaged $1 million annually. There remain ~$55.5 million in needed repairs and renovation (**Table 8**). URI's S&E R&D facilities have grown with the four projects noted above, completed between 1996 and 2001—for use in atmospheric sciences, natural resources management and natural resources economics, social sciences, and industrial engineering—with no growth in other fields.

Equipment: Tools for Research. NSF stopped reporting individual institutional capital expenditure data (e.g., figure on page 12) after 1989. Construction and repair and renovation data were replaced by the "Scientific and Engineering Research Facilities at Colleges and Universities" survey and publication series, discussed above. Individual institutional data on expenditures for fixed equipment, however, continue to be reported. Data are available on line for fiscal years 1981-99 as part of the "Survey of Scientific and Engineering Expen-

Table 8. URI 1998 estimates of planned S&E construction and repair/renovation projects over $100,000 and needed but unfunded projects, as net assignable square feet (NASF) with estimated cost ($1000s), by field.

	—Planned Projects Over $100,000—				—Cost of Needed but Unfunded Space—			
	New Construction		Repair/Renovation		In a Plan		Not in a Plan	
Field of Science	NASF	Cost	NASF	Cost	Construct	Renovate	Construct	Renovate
Engineering			5,000	$200	$200	$5,000		
Physical sciences			5,000	$200	$50	$9,000		
Environmental sciences	5,000	$3,000			$50	$2,000		
Mathematical sciences								
Computer sciences							$80	$10,000
Agricultural sciences	50,000	$7,000						
Biological sciences			n/a	$4,600	$60	$10,000	$60	$14,000
Medical sciences					$60	$3,000		
Psychology	10,000	$1,400						
Social sciences			13,000	$1,500	$13	$2,500		
Other sciences.								
Total	65,000	$11,400	23,000	$6,500	$433	$31,500	$140	$24,000

Table 9. Sources of funds for the construction and repair/renovation of scientific and engineering research facilities at **public** institutions and URI[26], for the two-year period, 1996-97[28].

	National Total			Top 100		URI		
	$Millions (1999)	per capita	% of total	$Millions (1999)	% of total	$1000's (1999)	per capita	% of total
Repair/Renovation								
Federal	**$74**	**$0.263**	**10.76%**	**$30**	**7.20%**	**$0**	**$0.000**	**0.00%**
State/local	**$337**	**$1.198**	**49.03%**	**$185**	**44.67%**	**$2,056**	**$1.962**	**97.56%**
Internal	**$276**	**$0.982**	**40.21%**	**$199**	**48.14%**	**$51**	**$0.049**	**2.44%**
Private	*$39*	*$0.139*	*5.68%*	*$35*	*8.44%*	*$0*	*$0.000*	*0.00%*
Institutional	*$185*	*$0.657*	*26.91%*	*$137*	*33.00%*	*$51*	*$0.049*	*2.44%*
Tax-exempt bonds	*$26*	*$0.091*	*3.74%*	*$12*	*2.98%*	*$0*	*$0.000*	*0.00%*
Other debt	*$0*	*$0.000*	*0.00%*	*$0*	*0.00%*	*$0*	*$0.000*	*0.00%*
Other sources	*$27*	*$0.095*	*3.89%*	*$15*	*3.72%*	*$0*	*$0.000*	*0.00%*
Total	**$688**	**$2.443**	**100.00%**	**$414.16**	**100.00%**	**$2,107**	**$2.011**	**100.00%**
New Construction > $100,000								
Federal	**$207**	**$0.734**	**10.11%**	**$133**	**9.60%**	**$925**	**$0.883**	**12.68%**
State/local	**$966**	**$3.433**	**47.28%**	**$672**	**48.66%**	**$617**	**$0.588**	**8.45%**
Internal	**$870**	**$3.093**	**42.61%**	**$577**	**41.74%**	**$5,755**	**$5.492**	**78.87%**
Private	*$274*	*$0.975*	*13.43%*	*$195*	*14.14%*	*$1,028*	*$0.981*	*14.08%*
Institutional	*$256*	*$0.909*	*12.53%*	*$219*	*15.85%*	*$617*	*$0.588*	*8.45%*
Tax-exempt bonds	*$267*	*$0.949*	*13.08%*	*$140*	*10.12%*	*$4,111*	*$3.923*	*56.34%*
Other debt	*$55*	*$0.197*	*2.72%*	*$22*	*1.56%*	*$0*	*$0.000*	*0.00%*
Other sources	*$17*	*$0.062*	*0.86%*	*$1*	*0.07%*	*$0*	*$0.000*	*0.00%*
Total	**$2,043**	**$7.260**	**100.00%**	**$1,381.23**	**100.00%**	**$7,297**	**$6.962**	**100.00%**

ditures at Universities and Colleges," under the data source "Current Fund Research Equipment Expenditures," through WebCaspar[9] and annual reports[29].

Statewise comparisons: *How does Rhode Island compare in spending for University research equipment?* Expenditure data from the Current Fund Research Equipment Expenditures survey from 1997 to 1999 (in 1999 $'s) were used for comparison. Mean and per capita total, federal, and non-federal (includes state, institutional, private, and industry) research equipment expenditures for the 133 comparison institutions and state totals are listed in **Appendix Table 3**.

Adjusting each state's *total* spending on research equipment to per capita (**Table 10**), Rhode Island ranked 20th during 1997-99. 84% of RI expenditures were from federal sources, compared to 57% nationally. Rhode Island's per capita *state* expenditures ($0.83) were 43% of the national average, ranking it 45th.

<u>Benchmarks for Funding University Research Infrastructure</u>. Academic research infrastructure provides the workplaces and tools used by scientists, technical support staff, and students. Having invested little in buildings, laboratories, or equipment for three decades, URI needs State help with new buildings, accelerated renovation of old buldings and laboratories, and the acquisition of state-of-the-art fixed equipment. Without investment, URI may not be able to remain competitive in oceanography and will remain at a competitive disadvantage in the remaining sciences and engineering.

It would be unwise to base benchmarks for state funding for infrastructure on on a goal of attaining a national average per capita level of investment. Such a goal would never allow URI to catch up:

• Attaining average per capita state support for new construction of science and engineering facilities would require a 4% increase over the level of 1996-97, or $0.13 per capita (total $0.14 million) annually.

• Attaining average per capita state support to renovate S&E research space would require 6% more than in 1996-97, an additional renovation effort of $0.06 per capita (total $0.06 million) annually.

These goals would create an annual renovation budget of $1.1 million and a construction budget of $3.3 million. *Although these figures are greater than the current projections, they would not suffice to meet needs*. The $55 million backlog of repairs and needed renovation is too great to be met with a budget of $1.1 million annually. A construction budget of $3.3 million annually would permit less than one small new science or engineering building every decade, and certainly would not permit projects such as the faculty's contemplated new biotechnology building: A budget of $3.3 million would not service debt on such a building. Clearly, benchmarks for renovation and construction based on a goal of national average will never suffice to overcome URI's backlog and failure to build over the past 30 years.

If Rhode Island desires a public university with a research capacity sufficient to help the State's economy, it needs to eliminate the research infrastructure renovation backlog and to build new state-of-the-art research laboratories. At a minimum, the **benchmark should be set at a doubling of the 1996/97 average renovation and construction figures (i.e., to $2.1 and $6.4 million annually).** This would still only approximate the annual mean figures for the top 100 institutions (i.e., $1.9 and $6.3 million of state and institutional funds annually, from **Table 9**)[30]. The benchmark might be lowered by ~10% if the State would develop an alternative to heavy reliance on debt-bearing bonds as its primary method of funding new construction (e.g., 56% of funding for 1996-97 construction, **Table 9**), or if the State would assume responsibility for debt service on those bonds (i.e., not pass it on to the University). These figures would conceivably permit a more realistic schedule for renovation (at least, one that matches the pace of deterioration) and construction of a major new facility more often than once each decade: this should be taken as a very minimum for an investment target.

• Attaining mean (of 50 states) per capita level of state support for fixed research equipment (based on **Table 10** and in 1999 dollars) would require a 145% increase, $1.20 per capita (total $1.3 million) annually[31].

The total benchmark for S&E infrastructure—comprising construction, renovation, and fixed equipment—would thus be at a minimum ~$10 million annually (60% for construction, 20% for renovation, and 20% for equipment).

Table 11 summarizes operational and infrastructure funding benchmarks. The increase for S&E research (~$23.2 million) would require

Table 10. Per capita total and state expenditures for S&E university research equipment, ranks, and % of total from state, 1997-99, in 1999 $s.

	Total	Rank	State	Rank	% State
Alabama	$4.47	29	$1.60	30	35.85%
Alaska	$9.87	3	$5.23	2	52.96%
Arizona	$4.13	30	$1.66	28	40.27%
Arkansas	$2.33	45	$1.20	38	51.55%
California	$4.62	27	$1.34	33	28.92%
Colorado	$5.02	19	$1.51	31	30.16%
Connecticut	$4.64	24	$1.81	24	38.97%
Delaware	$8.70	5	$4.99	4	57.35%
Florida	$3.31	37	$1.31	35	39.46%
Georgia	$7.89	6	$5.02	3	63.57%
Hawaii	$7.18	7	$2.51	12	34.88%
Idaho	$2.64	41	$1.18	39	44.66%
Illinois	$5.63	8	$1.90	21	33.68%
Indiana	$4.69	23	$2.12	17	45.28%
Iowa	$5.10	16	$2.87	10	56.26%
Kansas	$5.14	13	$2.95	9	57.27%
Kentucky	$2.59	43	$1.31	34	50.74%
Louisiana	$5.18	12	$3.43	7	66.29%
Maine	$1.98	46	$0.60	47	30.31%
Maryland	$11.71	1	$5.70	1	48.72%
Massachusetts	$10.67	2	$2.97	8	27.80%
Michigan	$3.61	33	$1.74	27	48.27%
Minnesota	$2.93	40	$1.12	41	38.15%
Mississippi	$3.44	36	$1.12	42	32.52%
Missouri	$4.63	26	$1.82	23	39.43%
Montana	$1.76	48	$0.42	49	23.95%
Nebraska	$5.08	17	$3.73	6	73.44%
Nevada	$1.55	50	$0.72	46	46.80%
New Hampshire	$4.78	21	$1.23	37	25.72%
New Jersey	$2.55	44	$1.01	43	39.46%
New Mexico	$9.25	4	$2.22	16	23.97%
New York	$5.23	10	$1.92	19	36.81%
North Carolina	$5.04	18	$2.32	14	46.12%
North Dakota	$4.64	25	$1.75	26	37.68%
Ohio	$3.49	34	$2.08	18	59.67%
Oklahoma	$3.65	32	$2.29	15	62.80%
Oregon	$2.59	42	$0.41	50	15.71%
Pennsylvania	$4.71	22	$1.86	22	39.56%
Rhode Island	$5.02	20	$0.83	45	16.45%
South Carolina	$3.45	35	$1.80	25	52.18%
South Dakota	$1.86	47	$0.88	44	47.47%
Tennessee	$3.02	39	$1.24	36	40.91%
Texas	$3.95	31	$1.91	20	48.45%
Utah	$5.22	11	$1.48	32	28.37%
Vermont	$4.58	28	$2.33	13	50.98%
Virginia	$3.03	38	$1.16	40	38.35%
Washington	$5.13	14	$1.66	29	32.40%
West Virginia	$1.57	49	$0.57	48	36.04%
Wisconsin	$5.60	9	$2.64	11	47.24%
Wyoming	$5.12	15	$3.74	5	73.14%
Means:	*$4.68*		*$2.02*		*42.74%*

Table 11. Summary of State (includes grants and public institutional funds) research operation and infrastructure funding benchmarks (see text for derivations). Dollars are based on mean operations or infrastructure expenditures (in 1999 $'s), derived from Tables 2, 9, and 10.

Target	**Benchmark State Funds, $s per capita**	**Benchmark State Annual Expenditure**	**Expenditure Increase (%)**
Operations	$25.66	$26.9 million	$21.6 million (412%)*
Infrastructure	$10.11	$10.6 million	$5.6 million (112%)
Construction	*$6.08*	*$6.4 million*	*$3.2 million (100%)***
Renovation	*$2.01*	*$2.1 million*	*$1.1 million (100%)***
Equipment	*$2.02*	*$2.1 million*	*$1.3 million (145%)**
Total	$35.77	$37.5 million	$27.2 million (264%)

** above mean 1997-1999 expenditures*

*** above 1996/1997 expenditures.*

Benchmarks for Targeting Research Investment

Developing a Strategy for Investing in University Research for Economic Development

In an entity as complex as a state university, myriad factors and perspectives affect an institution's view of itself and its chances of success as a research university. Important actors who will determine URI's research future—and, it is assumed, Rhode Island's economic future as well—include State Government leaders, the Board of Governors, URI's administrative officers and faculty, and multiple external supporters. These disparate individuals, with divergent perspectives, must not only come together to address the fiscal shortcomings addressed in the preceding section: They must also link with State economic leaders to develop strategies for investment in University research that can lead to success, for both the University and the State.

The general dynamics of successful leading edge American Research Universities since World War II[32] must be applied to URI if it is to emerge into the top 100 or further (*see* Strategies for Innovation and Impact, below). Important precursors to this emergence include development of a consensus on approaches to strategic planning for research and a greater awareness of the value of focused science and engineering research centers, the subjects of this section. Another precursor to success may be the development of congruent technology commercialization and industrial collaborations through research and technology parks, the subject of the following section.

Approaches to Strategic Planning

Building from natural advantages. Before the State gives URI greater support for research, it will need plans that explain benefits from the investment. There are two perspectives from which to plan. A "Build from Strengths" approach focuses on assessment of fields in which the University possesses some natural advantages[33]—which then are viewed as primary targets for investment. URI Strategic Plans[34] recognize strengths in four areas which are to be favored for growth:

- Marine and the Environment
- Health
- Children, Families, and Communities
- Enterprise and Advanced Technology

Similarly, the Rhode Island Economic Policy Council based its Samuel Slater Technology Fund investments largely on existing university research capacities. The resulting Centers of Excellence then use these natural advantages to "foster industry-university collaborations, build and strengthen relationships among academic institutions, and develop industry clusters." The Slater Centers are:

- Biomedical Technology
- Design Innovation
- Environmental Biotechnology
- Interactive Technologies
- Advanced Manufacturing
- Ocean Technology

The build-from-strengths approach is thus oriented to existing academia and to the question, "What do our colleges and universities do best *now* that we can use to build a better state economy?"

Building toward future needs. There is also a need for a second planning approach that takes a broader perspective and a longer time frame. The long-term interests of the state suggest the importance of a "Build toward Needs" approach that focuses on the questions, "What is the future economy that we want? What do we need from our colleges and universities to build that economy? How can we best support academic research and teaching to build what we will need?"

Both approaches must acknowledge the proclivity of university faculty and academic departments to form their own academic priorities and corresponding research agendas. The three strongest determiners of academic research agendas are faculty curiosity, value of the research to professional advancement, and external grant opportunities. These may not suffice to drive scientists or engineers to work on the highest priority needs of the future State economy.

Financial opportunities may be used to persuade researchers and administrators that there are sufficient academic reasons to respond to a particular request for proposals. All researchers have ongoing needs to support graduate students and technical staff, and to acquire state-of-the-art equipment. A build-toward-needs approach could help meet researcher needs through an outcome-funding program.

Programmed Research. Research to promote economic development is "programmed research," directed by funding agencies which focus funds directly on specific goals. Although some agencies continue to fund curiosity-driven research (aka "basic"), an increasing portion of federal funding and virtually all industrial funding is for programmed research, usually for targeted outcomes that link academic research outputs (i.e., papers, technologies, inventions) to specific outcomes (practices, technologies) used by target audiences[35].

While a detailed national survey or local priority-setting analysis of programmed research opportunities is beyond the present scope, examples can serve to stimulate further discussion. For applied science and engineering, some of the best examples of focused research centers are listed in **Appendix Table 4.** These were chosen from the National Science Foundation Engineering Research Centers (ERC)[36], Industry/University Cooperative Research Centers (I/UCRC)[37], and Materials Research Science and Engineering Centers (MRSEC)[38] to illustrate leading edge research activities in the nations top universities. These centers were first established in the mid 1980s. It is significant that they are NSF Centers, developed by the lead federal champion of basic science! Their explicit purpose is to promote collaboration between universities and industry on interdisciplinary research on generic topics. Industry contributes about one-third of Center budgets. A few additional examples of state-supported centers[38] are also included.

Initial Investment Targets. The search for natural advantages upon which to build economically-oriented research programs leads to some obvious current strengths as starting points.

- The strength of the Graduate School of Oceanography's research campus (average over $20 million annually in grant awards), for example, suggest investments in **ocean technology**, including devices to monitor physical aspects of the ocean and technologies to detect pollution or other biotic measures of ocean health.
- Large number of biologists on the URI faculty support a conceptual plan for centralized facilities for **Environmental Biotechnology**[39].
- Engineering research programs (e.g., **surface and sensor technologies**) may also precipitate future URI research centers.

If Rhode Island adopts the benchmarks suggested above for funding research operations and infrastructure, it will certainly place a high priority on developing a core biotechnology facility[40].

New Priority-setting Mechanisms to link University Research to State Needs. The State and URI need a way to set priorities for large-magnitude investments such as the Environmental Biotechnology Initiative (i.e., centers that require both infrastructure and operation funds) and both need a consensus plan for the state economy that is based on investment in the R&D potentials of the public research University, along the lines of the examples in **Appendix Table 4**. State planners must recognize that major development at the University needs to fit the institution's aspirations and vision. University leaders must respond to State needs for an entrepreneurial science and engineering engine for its economy. Together the University and the State must come to concur on the State's future needs and appropriate investment priorities within the University to meet those needs.

For its part, the State will want to be assured that funding used to enhance research capacity will eventually connect to the economy. This can be accomplished through enhancement of University-affiliated technology development and commercialization programs. For its part, the University needs to see an enhanced research capacity as an essential part of the intellectual growth of the institution—leading toward a mature entrepreneurial learning culture in the sciences, engineering, and business. A closing section discusses these concerns further.

The University of Nebraska's new core biotechnology facilities may someday serve as a model for URI's Environmental Biotechnology Initiative.

Benchmarks for Linking Research to the Economy

Academic research benefits the economy as a source of scientific discoveries and technological inventions, and as a vehicle for training scientists and engineers. Benefits can be enhanced when universities link their research laboratories to the economy through **technology transfer**, **commercialization**, or engagement in campus-affiliated **research and technology parks**. These should be considered as means to better tie URI to the State economy.

Nearly all research universities have offices of **technology transfer** to promote patents on inventions or "intellectual properties" from university labs, and to sell or license patented technologies to companies, transferring a legal right to use, develop, or market products.

The Bayh-Dole Act of 1980 created a uniform policy for all federal agencies that fund academic research. It transferred to the universities the rights of ownership and the right to income generated through licensing. It also encouraged the issuing of licenses to small firms capable of bringing the invention to practical application. Bayh-Dole is intended to expedite the commercial use of inventions created with federal funds(41).

The FY1999 Licensing Survey of the Association of University Technology Managers(42) covered 190 U.S. and Canadian universities, teaching hospitals, research institutes, and patent commercialization companies. The Survey showed that at least 417 new products were introduced from 98 institutions in FY1999, including licenses for health care products, software, agricultural products, and research reagents and tools used by industry and universities for research, development, or commercial purposes. The licenses generated $40.9 billion in economic activity and supported 270,900 jobs, according to AUTM. 62% of the 3,914 new licenses were to companies with fewer than 500 employees, and 344 were to new companies created to develop and commercialize results from academic research, 82% of them in the state of the university that licensed the technology.

Beyond simply marketing rights to develop and sell the products of research, many universities are actively taking inventions into the marketplace through various forms of **commercialization**. The October 1999 National Workshop on Research Centers of Excellence, hosted in Newport RI by the RI Economic Policy Council, sampled 10 invited states, which shared their approaches to technology-based economic development. One thing that was clear from the conference was that although all participants were engaged in long-term efforts involving university-industry technology development and commercialization, there was a significant array of "typologies" in the organization of centers, including broad and narrow technology foci, and various approaches to promote and develop basic research at universities and to commercialize it.

A broader survey of university affiliated business incubators and research / technology parks makes it clear that there is a wide spectrum of approaches to commercialization. **Appendix Table 5** provides examples of commercialization efforts from our sample group.

The first **university-affiliated research / technology park** was established by Stanford in 1951. By 1975, there were only ten parks, but 25 more followed within the next decade. In the early 1980s only about one in four research parks was successful in attracting industries, yet universities continued to be drawn to hopes of increased interactions with industry based on university research. Research parks were viewed as one path toward that goal.

Appendix Table 5 presents a broad spectrum, with each institution unique in many ways. At one end of the spectrum are the very top research universities, including Berkeley, Harvard, UCLA, Cornell, Johns Hopkins, Minnesota, Stanford, Yale, MIT, Caltech, and Wisconsin, and perhaps a half dozen more. For the most part, these institutions are characterized by faculty and students at the highest levels of basic science and the forefronts of technology. The entrepreneurial abilities of these faculties and graduates are reflected throughout the US economy. Curiously, precise analyses of the economic impacts of these institutions are lacking, with the recent exception of a BankBoston study, "MIT: The Impact of Innovation," which will be discussed briefly in the concluding section. Institutions like MIT affect the economy directly through myriad start-ups and mature large corporations founded by graduates or based on research spin-offs.

Some major Universities have research parks. Some parks are huge, with a mixture of large, often multinational, corporations, blended with smaller startups. The large parks of North Carolina's research triangle (**Duke, UNC Chapel Hill,** and **NCSU Raleigh)**, and the parks at the University of Arizona and Arizona State University are at once a product of research successes at those institutions, and a contributor to future strength. The involvement of collaborating research faculty, enrolled student apprentices, and graduated employees of the companies meets the goal of mutual benefits established when these parks were formed. U of A's park, established only in 1994, is particularly impressive for having full occupancy of its 1.8 million sq ft capacity, with plans for a 600,000 sq ft expansion.

Most research parks are considerably more modest, with fewer than 200 acres and often less than 100,000 sq ft of space. Many offer research and laboratory accommodations, usually with implied collaborations with the University, and usually for a limited duration, after which tenants are expected to "graduate" to more permanent company quarters. Most parks offer supportive business services, including help with legal, accounting, personnel and business planning services.


Utah Technology Park

At the lower end of the spectrum, Universities offer incubator services to support basic business functions of affiliated start-ups, increasing the odds that new companies will survive the early transition from academic research to the business world.

In considering incubators or technology / research parks to link URI research to the economy, Rhode Island is not starting totally cold. A decision to engage in technology-based economic development has already been made, and six Slater Technology Fund Centers of Excellence are already in place to serve as conduits to transport advanced research products into the marketplace. It remains to be seen, however, whether Rhode Island university research centers and university/industry collaborations can generate an adequate flow of new intellectual properties to adequately feed the Slater Centers.

The University currently feels significant real space pressures, aggravated by a large inventory of buildings now being taken off-line for renovation and repair. URI is also under severe management pressures caused by budget shortfalls and high turnover in critical upper management positions. With their focus on factors affecting undergraduate enrollments and tuition dollars, conversion of on-campus space into technology incubators is an unlikely priority for campus leaders.

To accelerate a research-based approach to building the economy, URI needs a research and development park. Substantial land holdings at the University could meet needs for future open space, natural and agricultural research areas, and athletic field expansions with sufficient land left for a modest (50-60 acre) research park. Development could take place on Plains Road, over an existing Superfund site, for example. The State and URI need to consider the mutual interests of such a project, and to seek support services to manage new infrastructure and to grow new university/industry collaborations.

Benchmark Strategies for Innovation and Impact

Conclusions: Strategic benchmarks?

Roger Geiger's **Research and Relevant Knowledge**[43] is an analysis of factors affecting American research universities since World War II. URI has a great deal to learn from the experiences of successful research Universities. Rhode Island's State University is not alone in its struggles to find adequate funding for its many missions, nor in its internal and surrounding philosophical heterogeneity about just what those missions should be and in what priority.

A fundamental understanding that can be taken from Geiger's book is that today's University of Rhode Island has yet to establish itself as a top research university. The University on Kingston Hill focuses on undergraduates and the liberal arts. It has comparatively modest (i.e., very modest relative to top 100 institutions) research presence in behavioral psychology, some fields of engineering, and environmental sciences. It also has a meaningful affiliation with a reputable oceanography research institute only a few miles away. The University thus does have a necessary set of "natural advantages" in its faculty, programs, and setting from which it can build to eventual national prominence and research excellence. Oceanography, environmental biotechnology, some aspects of electrical or materials engineering, and elements of its social sciences (particularly those concerned with family and youth development issues) provide adequate starting points for growth, and there are potentially other kernels about which significant organized research units could be formed.

What is needed to elevate URI's standing among the nation's research universities is congruent with what is needed to make it a major actor in shaping the future Rhode Island economy. All public universities that have made major advances as research universities in the second half of the 20th century had several traits in common. They all began with vigorous commitments to higher standings as research institutions. They all had characteristically strong leadership at all levels of the institution, and in particular a determined President or presidentially-supported Provost who pursued that commitment to raise the institution to a higher plane. Most had strong backing from state government (i.e., public universities), the federal government, or industry. There was also usually an element of good luck or fortunate timing.

Reinvigorating URI as a research university strategically targeted to play a major role in State economic development must begin with affirmation by faculty and administration that the University is committed to a vibrant and robust research mission. That affirmation needs to be rooted by the establishment of realistic quantitative goals for its research mission, including aspirations to have organized research units (i.e., multi-department or multidisciplinary amalgams of researchers organized to support common research programs) or academic departments recognized as being among top research units nationally. The University also needs to set a goal to gradually increase its overall standing among research universities. Certainly, a goal of, say, doubling external funding—necessary to reach the top 100 in NSF's research expenditures ranking—will require determined commitment and leadership at all levels.

In 1997, BankBoston analyzed the impact of one of the Universities that was most prominent in Geiger's book, the Massachusetts Institute of Technology. "MIT: The Impact of Innovation[44]" measured the national job creation of this single research university, and in the process developed fascinating insight into why MIT alumni were able to make major contributions to the local and national economies. The study itself can serve as an intellectual benchmark for URI, setting for a clear intellectual standard for a new culture of entrepreneurial learning.

In reading the BankBoston study, it is initially difficult not to focus on the sheer impact of the nearly 4000 companies started by MIT graduates. In total, these companies employ 1.1 million people and had annual world sales of $232 billion, equivalent to the 24th largest national economy in the world. It is also impossible not to be impressed by the roster of large companies—now employing over 10,000 people each—founded by MIT graduates. These include Hewlett-Packard, Rockwell International, Raytheon, McDonnell Douglas, Digital Equipment, Texas Instruments, Campbell Soup, Intel, and Gillette.

What is more important for URI in both the Geiger and BankBoston studies is to recognize that the essential culture of the very top research universities is itself the primary reason that they are so relevant to the development of local economies. MIT and the other great research universities have a learning culture that instill an entrepreneurial spirit in graduates. Students come to realize, through exposures to great professors and top fellow students, a sense of critical humility (vital to CEO's who must learn to listen to customers and to respect the opinions of their employees). At the same time, completion of an MIT education instills confidence that bright people working together can solve problems. Hands-on approaches, encouraging solutions to real-world problems—brought in by faculty from their real-world industrial engagements—are combined with education that instills knowledge of the state of the art in the field of study.

In its academic and research endeavors in science, engineering, and business, URI needs to expand upon its commitment to a new culture for learning by developing and expanded commitment to the scientific, technical, and entrepreneurial side of that culture. Growth of economically-focused research centers of excellence is needed to balance the curiosity-driven research of individual scholars. Greater engagement with business and technology leaders outside of the University, made possible through research collaboration and technical exchanges in a new campus-affiliated research park, is needed to develop leading edge training opportunities.

At the same time, such exchanges can provide invaluable feedback on the quality of URI graduates—and their value to the economy as inventors, high-technology employees, and entrepreneurs. University academicians in the sciences, engineering, and business could profit from immediate feedback, to adjust the technical components of their curricula, forcing constant attention on the state-of-the-art relevancy of URI's applied science and technical training. Attention to feedback would provide one of URI's most valuable hallmarks of quality, and perhaps its strongest future marketing tool.

Rhode Island and its public research university cannot afford to be complacent about the current state of research and the economic relevance of URI, nor can URI ignore the need to anticipate future State economic needs or URI's role in meeting them. At the very least, everyone concerned with URI's future needs to be mindful of the relative state of our commitments to higher education and to economically targeted research investment, and of our clear need to do better.

Appendix Table 1. Mean (1997-99) Annual Research Spending at 134 Select Universities, & State Totals, by Major Sources (in $1,000's, 1999).
See text and footnotes at end of table for explanations.

	Total	Federal	State	Industry	Institutional	Other	Public	Carnegie	Hospital
Alabama									
University of Alabama—Birmingham	$224,218	$163,075	$1,010	$14,653	$19,681	$25,799	Yes	R-I	Yes
Auburn University	$85,819	$27,784	$943	$4,313	$48,786	$3,993	Yes	R-II	No
Other Alabama	$116,591	$81,777	$5,271	$8,876	$14,803	$5,864			
Total: Alabama	**$426,627**	**$272,635**	**$7,223**	**$27,842**	**$83,271**	**$35,655**			
Alaska									
University of Alaska— Fairbanks	$79,491	$31,844	$3,907	$16,262	$27,473	$6	Yes	D-I	No
Other Alaska	$1,705	$908	$69	$139	$478	$111			
Total: Akaska	**$81,196**	**$32,751**	**$3,976**	**$16,400**	**$27,950**	**$118**			
Arizona									
Arizona State University	$94,520	$44,876	$1,789	$4,138	$40,799	$2,917	Yes	R-II	No
University of Arizona	$306,763	$166,331	$8,121	$16,225	$104,211	$11,875	Yes	R-I	Yes
Other Arizona	$11,594	$7,476	$1,521	$902	$1,695	$0			
Total: Arizona	**$412,877**	**$218,683**	**$11,431**	**$21,266**	**$146,705**	**$14,792**			
Arkansas									
University of Arkansas	$67,004	$16,153	$30,978	$5,222	$11,748	$2,904	Yes	R-II	Yes
Other Arkansas	$46,708	$26,038	$1,263	$3,640	$11,666	$4,100			
Total: Arkansas	**$113,711**	**$42,191**	**$32,241**	**$8,861**	**$23,414**	**$7,004**			
California									
California Institute of Technology	$194,291	$181,497	$620	$4,086	$6,379	$1,709	No	R-I	Yes
Stanford University	$416,424	$347,662	$2,548	$27,943	$17,864	$20,407	No	R-I	Yes
University of California—Berkeley	$422,034	$176,345	$49,775	$21,662	$137,955	$36,296	Yes	R-I	No
University of California—Davis	$291,941	$116,014	$20,117	$13,907	$118,382	$23,522	Yes	R-I	Yes
University of California—Irvine	$132,399	$69,727	$4,770	$15,275	$26,690	$15,938	Yes	R-I	Yes
University of California—Los Angeles	$447,204	$237,144	$9,454	$28,975	$107,387	$64,244	Yes	R-I	Yes
University of California—Riverside	$78,123	$22,670	$4,068	$2,603	$41,260	$7,523	Yes	R-II	No
University of California—San Diego	$424,597	$268,078	$18,946	$27,718	$67,710	$42,146	Yes	R-I	Yes
University of California—San Francisco	$385,220	$222,860	$16,513	$33,131	$66,367	$46,349	Yes	R-I	Yes
University of California—Santa Barbara	$98,570	$70,150	$1,905	$3,933	$16,455	$6,127	Yes	R-I	No
University of California—Santa Cruz	$53,693	$26,694	$1,677	$1,377	$18,655	$5,290	Yes	R-II	No
University of Southern California	$273,335	$196,715	$7,592	$23,267	$45,760	$0	No	R-I	Yes
Other California	$216,989	$130,588	$27,157	$23,667	$24,131	$11,446			
Total: California	**$3,434,821**	**$2,066,144**	**$165,142**	**$227,543**	**$694,995**	**$280,997**			
Colorado									
Colorado State University	$141,568	$85,064	$19,103	$6,444	$30,729	$228	Yes	R-I	No
University of Colorado	$303,926	$224,659	$5,492	$9,881	$28,794	$35,099	Yes	R-I	Yes
Other Colorado	$37,633	$24,081	$1,814	$9,998	$1,098	$641			
Total: Colorado	**$483,127**	**$333,805**	**$26,409**	**$26,322**	**$60,622**	**$35,969**			
Connecticut									
*University of Connecticut**	$138,731	$53,452	$11,686	$9,739	$53,263	$10,590	Yes	R-I	Yes
Yale University	$264,336	$205,296	$941	$16,133	$16,249	$25,717	No	R-I	Yes
Other Connecticut	$8,984	$4,897	$422	$500	$2,116	$1,049			
Total: Connecticut	**$412,051**	**$263,646**	**$13,049**	**$26,372**	**$71,628**	**$37,356**			
Delaware									
*University of Delaware**	$70,455	$33,913	$4,346	$3,841	$19,865	$8,490	Yes	R-II	No
Other Delaware	$2,564	$2,238	$95	$37	$117	$76			
Total: Delaware	**$73,019**	**$36,151**	**$95**	**$37**	**$117**	**$76**			

Appendix Table 1 (continued).	Total	Federal	State	Industry	Institutional	Other	Public	Carnegie	Hospital
District of Columbia									
George Washington University	$66,347	$43,607	$993	$6,591	$5,222	$9,934	No	R-II	Yes
Georgetown University	$117,400	$85,525	$424	$8,706	$15,331	$7,414	No	R-I	Yes
Howard University	$25,410	$23,361	$404	$1,468	$31	$146	No	R-I	Yes
Other District of Columbia	$19,520	$15,482	$564	$906	$1,142	$1,425			
Total: District of Columbia	**$228,677**	**$167,975**	**$2,385**	**$17,671**	**$21,726**	**$18,919**			
Florida									
Florida State University	$97,373	$53,762	$1,781	$1,115	$36,813	$3,901	Yes	R-I	No
University of Florida	$287,783	$109,115	$63,460	$25,271	$79,890	$10,047	Yes	R-I	Yes
University of Miami	$139,429	$103,075	$1,596	$13,943	$7,009	$13,807	No	R-I	Yes
University of South Florida	$110,753	$36,801	$7,952	$5,188	$51,165	$9,648	Yes	R-II	No
Other Florida	$104,854	$65,730	$13,433	$10,044	$14,870	$778			
Total: Florida	**$740,192**	**$368,483**	**$88,222**	**$55,561**	**$189,747**	**$38,180**			
Georgia									
Emory University	$177,600	$121,387	$4,907	$7,488	$20,899	$22,919	No	R-I	Yes
Georgia Institute of Technology	$257,913	$114,623	$13,284	$57,144	$72,861	$0	Yes	R-I	No
University of Georgia	$230,136	$55,828	$44,504	$10,765	$117,778	$1,262	Yes	R-I	No
Other Georgia	$152,423	$81,634	$9,421	$9,178	$45,735	$6,454			
Total: Georgia	**$818,072**	**$373,472**	**$72,116**	**$84,575**	**$257,274**	**$30,635**			
Hawaii									
University of Hawaii at Manoa	**$143,490**	**$85,345**	**$33,965**	**$10,081**	**$14,098**	**$2**	Yes	R-I	Yes
Idaho									
University of Idaho	$60,520	$20,263	$18,028	$5,076	$14,394	$2,758	Yes	R-I	No
Other Idaho	$10,573	$4,732	$1,858	$2,110	$1,872	$0			
Total: Idaho	**$71,093**	**$24,995**	**$19,886**	**$7,187**	**$16,267**	**$2,758**			
Illinois									
Northwestern Univ	$222,301	$124,589	$3,541	$12,816	$56,858	$24,496	No	R-I	Yes
Southern Illinois University-Carbondale	$31,664	$8,150	$7,416	$2,270	$10,691	$3,137	Yes	R-II	Yes
University of Chicago	$157,138	$129,548	$670	$1,670	$9,223	$16,027	No	R-I	Yes
University of Illinois at Chicago	$157,421	$78,003	$3,916	$8,796	$54,645	$12,061	Yes	R-I	Yes
University of Illinois at Urbana-Champaign	$328,952	$173,428	$35,897	$12,930	$92,484	$14,213	Yes	R-I	No
Other Illinois	$141,485	$130,347	$3,621	$9,671	-$17,230	$15,075			
Total: Illinois	**$1,039,243**	**$592,520**	**$58,308**	**$55,279**	**$252,093**	**$81,043**			
Indiana									
Indiana University	$179,631	$99,376	$1,828	$5,202	$54,216	$19,009	Yes	R-I	Yes
Purdue University	$219,483	$94,820	$23,994	$27,687	$72,687	$294	Yes	R-I	No
University of Notre Dame	$28,191	$22,239	$199	$2,335	$3,418	$0	No	R-II	No
Other Indiana	$7,993	$2,585	$227	$3,855	$1,286	$40			
Total: Indiana	**$435,298**	**$219,020**	**$26,249**	**$39,080**	**$131,608**	**$19,342**			
Iowa									
Iowa State University	$160,052	$53,516	$47,807	$12,521	$42,468	$3,741	Yes	R-I	No
University of Iowa	$199,569	$117,073	$5,691	$18,149	$45,401	$13,255	Yes	R-I	Yes
Other Iowa	$4,175	$953	$287	$151	$1,495	$1,290			
Total: Iowa	**$363,796**	**$171,542**	**$53,784**	**$30,820**	**$89,364**	**$18,286**			
Kansas									
Kansas State University	$82,353	$27,334	$33,372	$3,422	$15,574	$2,649	Yes	R-I	No
University of Kansas	$121,178	$52,208	$10,360	$10,409	$37,226	$10,975	Yes	R-I	Yes
Other Kansas	$14,544	$3,006	$4,494	$983	$5,064	$997			
Total: Kansas	**$218,075**	**82,548**	**48,226**	**14,814**	**57,865**	**14,621**			

Appendix Table 1 (continued).	Total	Federal	State	Industry	Institutional	Other	Public	Carnegie	Hospital
Kentucky									
University of Kentucky	$155,354	$63,901	$10,527	$13,518	$64,971	$2,436	Yes	R-I	Yes
University of Louisville	$43,715	$14,908	$993	$4,864	$17,014	$5,936	No	R-II	Yes
Other Kentucky	$39,402	$10,852	$16,882	$569	$8,786	$2,314			
Total: Kentucky	**$238,471**	**$89,662**	**$28,402**	**$18,950**	**$90,771**	**$10,686**			
Louisiana									
Louisiana State University	$216,334	$70,331	$70,217	$13,076	$49,102	$13,609	Yes	R-I	Yes
Tulane University	$88,440	$51,861	$2,634	$12,027	$17,643	$4,277	No	R-I	Yes
Other Louisiana	$58,684	$26,284	$6,183	$7,109	$17,850	$1,257			
Total: Louisiana	**$363,458**	**$148,476**	**$79,034**	**$32,212**	**$84,594**	**$19,142**			
Maine									
*University of Maine**	$36,372	$15,957	$1,602	$5,089	$12,705	$1,019	Yes	D-II	No
Other Maine	$2,329	$921	$196	$199	$591	$422			
Total: Maine	**$38,702**	**$16,878**	**$1,798**	**$5,289**	**$13,296**	**$1,441**			
Maryland									
Johns Hopkins University	$864,384	$759,818	$983	$14,867	$42,695	$46,022	No	R-I	Yes
University of Maryland—College Park	$235,358	$127,332	$45,427	$3,453	$48,774	$10,371	Yes	R-I	Yes
Other Maryland	$252,015	$132,951	$28,383	$21,133	$52,598	$16,950			
Total: Maryland	**$1,351,757**	**$1,020,101**	**$74,793**	**$39,453**	**$144,068**	**$73,342**			
Massachusetts									
Boston University	$132,278	$109,869	$1,340	$8,789	$0	$12,280	No	R-I	Yes
Brandeis University	$44,940	$27,958	$166	$0	$4,833	$11,983	No	R-II	No
Harvard University	$315,051	$250,150	$754	$11,405	$12,744	$39,998	No	R-I	Yes
Massachusetts Institute of Technology	$420,638	$314,782	$1,993	$65,911	$21,989	$15,963	No	R-I	No
Northeastern University*	$25,787	$20,442	$408	$3,156	$1,781	$0	No	R-II	No
Tufts University	$93,708	$60,886	$675	$6,159	$17,823	$8,164	No	R-I	Yes
*University of Massachusetts at Amherst**	$88,695	$41,927	$6,753	$6,021	$27,303	$6,690	Yes	R-I	Yes
Other Massachusetts	$245,387	$166,213	$19,817	$12,493	$22,164	$24,699			
Total: Massachusetts	**$1,366,483**	**$992,227**	**$31,905**	**$113,936**	**$108,639**	**$119,776**			
Michigan									
Michigan State University	$199,958	$85,825	$35,731	$7,391	$63,481	$7,531	Yes	R-I	Yes
University of Michigan	$503,236	$318,192	$3,996	$33,413	$105,282	$42,355	Yes	R-I	Yes
Wayne State University	$138,398	$57,105	$12,338	$11,099	$42,960	$14,896	Yes	R-I	Yes
Other Michigan	$53,266	$24,835	$3,950	$8,518	$11,739	$4,225			
Total: Michigan	**$894,858**	**$485,956**	**$56,014**	**$60,421**	**$223,461**	**$69,006**			
Minnesota									
University of Minnesota	$370,088	$207,089	$49,601	$24,418	$57,698	$31,281	Yes	R-I	Yes
Other Minnesota	$5,573	$2,666	$722	$600	$767	$818			
Total: Minnesota	**$375,661**	**$209,755**	**$50,324**	**$25,018**	**$58,465**	**$32,100**			
Mississippi									
Mississippi State University	$99,767	$41,686	$25,630	$7,032	$22,459	$2,960	Yes	R-II	No
University of Mississippi	$24,252	$14,264	$4,171	$1,488	$2,924	$1,405	Yes	R-II	Yes
Other Mississippi	$26,020	$22,739	$589	$1,330	$1,363	$0			
Total: Mississippi	**$150,039**	**$78,689**	**$30,390**	**$9,849**	**$26,745**	**$4,365**			
Missouri									
St Louis University	$27,472	$23,758	$254	$2,859	$249	$352	No	R-II	Yes
University of Missouri—Columbia	$139,611	$48,180	$16,776	$4,042	$64,947	$5,666	Yes	R-I	Yes
Washington University	$286,298	$200,250	$5,466	$20,641	$29,089	$30,852	No	R-I	Yes
Other Missouri	$53,278	$23,104	$1,861	$2,969	$22,878	$2,466			
Total: Missouri	**$506,659**	**$295,292**	**$24,357**	**$30,511**	**$117,163**	**$39,335**			

Appendix Table 1 (continued).	Total	Federal	State	Industry	Institutional	Other	Public	Carnegie	Hospital
Montana									
Montana State University - Bozeman	$53,120	$23,609	$12,833	$7,246	$9,433	$0	Yes	D-I	No
Other Montana	$26,470	$15,613	$2,145	$1,651	$5,960	$1,101			
Total: Montana	**$79,590**	**$39,221**	**$14,978**	**$8,897**	**$15,393**	**$1,101**			
Nebraska									
University of Nebraska at Lincoln	$124,010	$40,635	$27,931	$5,013	$46,966	$3,465	Yes	R-I	Yes
Other Nebraska	$68,204	$21,921	$7,535	$11,086	$23,054	$4,607			
Total: Nebraska	**$192,214**	**$62,557**	**$35,466**	**$16,099**	**$70,021**	**$8,072**			
Nevada									
University of Nevada-Reno	$49,420	$22,222	$1,407	$1,548	$22,183	$2,061	Yes	D-I	Yes
Other Nevada	$39,716	$25,350	$3,452	$3,867	$5,072	$1,975			
Total: Nevada	**$89,136**	**$47,572**	**$4,859**	**$5,416**	**$27,254**	**$4,035**			
New Hampshire									
*University of New Hampshire**	$52,638	$27,228	$5,735	$3,243	$8,624	$7,808	Yes	D-I	No
Other New Hampshire	$66,262	$45,606	$2,797	$3,509	$8,468	$5,881			
Total: New Hampshire	**$118,900**	**$72,834**	**$8,532**	**$6,752**	**$17,093**	**$13,689**			
New Jersey									
Princeton University	$119,898	$71,537	$1,382	$5,283	$28,728	$12,969	No	R-I	No
*Rutgers**	$200,652	$72,218	$24,284	$9,367	$79,324	$15,459	Yes	R-I	No
Other New Jersey	$376,290	$162,568	$39,848	$23,054	$124,151	$26,670			
Total: New Jersey	**$496,188**	**$234,105**	**$41,230**	**$28,337**	**$152,878**	**$39,638**			
New Mexico									
New Mexico State University	$80,559	$57,686	$8,879	$2,746	$9,851	$1,396	Yes	R-I	No
University of New Mexico	$121,006	$83,239	$2,724	$3,066	$27,797	$4,180	Yes	R-I	Yes
Other New Mexico	$26,632	$12,782	$1,917	$6,123	$5,467	$344			
Total: New Mexico	**$228,197**	**$153,707**	**$13,520**	**$11,934**	**$43,115**	**$5,920**			
New York									
Columbia University	$267,235	$230,461	$2,264	$2,459	$7,244	$24,807	No	R-I	Yes
Cornell University	$375,090	$217,752	$37,888	$10,639	$70,496	$38,314	No	R-I	Yes
New York University	$161,171	$103,598	$1,386	$8,252	$18,635	$29,298	No	R-I	Yes
Rensselaer Polytechnic Institute	$39,350	$22,773	$2,399	$10,274	$2,739	$1,165	No	R-II	No
Rockefeller University	$117,264	$44,903	$2,111	$2,679	$34,256	$33,315	No	R-I	No
SUNY at Albany*	$58,203	$40,992	$3,391	$1,453	$4,950	$7,418	Yes	R-II	No
SUNY at Binghamton*	$19,636	$6,150	$2,687	$2,636	$6,033	$2,130	Yes	D-I	No
SUNY at Buffalo*	$153,390	$80,974	$4,574	$7,811	$32,302	$27,728	Yes	R-I	No
SUNY at Stony Brook*	$144,428	$91,936	$2,798	$7,248	$35,718	$6,728	Yes	R-I	Yes
Syracuse University	$37,708	$28,042	$3,341	$1,624	$2,083	$2,617	No	R-I	Yes
University of Rochester	$171,325	$129,115	$8,943	$16,894	$6,090	$10,283	No	R-I	Yes
Yeshiva University	$103,919	$83,658	$0	$0	$18,606	$1,655	No	R-I	Yes
Other New York	$316,391	$180,455	$13,392	$29,572	$51,584	$41,387			
Total: New York	**$1,965,108**	**$1,260,811**	**$85,175**	**$101,541**	**$290,736**	**$226,845**			
North Carolina									
Duke University	$297,800	$174,030	$6,033	$79,078	$15,365	$23,295	No	R-I	Yes
North Carolina State University at Raleigh	$254,777	$72,811	$88,938	$30,319	$60,470	$2,239	Yes	R-I	No
University of North Carolina at Chapel Hill	$239,702	$171,754	$25,541	$4,741	$37,666	$0	Yes	R-I	Yes
Other North Carolina	$131,333	$95,525	$4,577	$20,454	$4,566	$6,211			
Total: North Carolina	**$923,612**	**$514,120**	**$125,090**	**$134,591**	**$118,067**	**$31,745**			

Appendix Table 1 (continued).	Total	Federal	State	Industry	Institutional	Other	Public	Carnegie	Hospital
North Dakota									
North Dakota State University	$40,492	$9,617	$1,354	$1,360	$26,382	$1,779	Yes	D-I	No
Other North Dakota	$18,556	$15,162	$48	$2,309	$460	$577			
Total: North Dakota	**$59,048**	**$24,780**	**$1,401**	**$3,668**	**$26,842**	**$2,356**			
Ohio									
Case Western Reserve University	$175,872	$132,927	$4,648	$6,355	$16,636	$15,306	No	R-I	Yes
Kent State University	$11,906	$8,125	$829	$823	$2,130	$0	Yes	R-II	No
Ohio State University	$308,653	$129,078	$51,105	$43,581	$60,673	$24,216	Yes	R-I	Yes
Ohio University	$21,606	$10,361	$1,831	$2,337	$6,283	$794	Yes	R-II	No
University of Cincinnati	$153,540	$90,816	$3,625	$18,095	$33,396	$7,608	Yes	R-I	Yes
Other Ohio	$142,574	$82,128	$10,065	$14,037	$31,275	$5,069			
Total: Ohio	**$814,151**	**$453,433**	**$72,104**	**$85,228**	**$150,393**	**$52,992**			
Oklahoma									
Oklahoma State University	$73,286	$22,932	$23,055	$3,240	$23,344	$714	Yes	R-II	No
University of Oklahoma	$129,468	$53,293	$14,729	$7,531	$39,579	$14,335	Yes	R-II	Yes
Other Oklahoma	$12,166	$6,739	$989	$3,478	$646	$313			
Total: Oklahoma	**$214,920**	**$82,965**	**$38,774**	**$14,249**	**$63,569**	**$15,363**			
Oregon									
Oregon State University	$138,236	$82,551	$28,519	$531	$18,071	$8,564	Yes	R-I	No
University of Oregon	$32,956	$27,174	$308	$168	$3,480	$1,825	Yes	R-II	No
Other Oregon	$140,396	$96,468	$4,742	$9,560	$19,846	$9,780			
Total: Oregon	**$311,588**	**$206,193**	**$33,570**	**$10,259**	**$41,397**	**$20,169**			
Pennsylvania									
Carnegie Mellon University	$140,126	$93,647	$12,680	$18,566	$7,383	$7,850	No	R-I	No
Lehigh University	$27,197	$13,890	$3,703	$6,604	$2,711	$290	No	R-II	No
Pennsylvania State University	$365,619	$192,836	$13,936	$62,734	$96,112	$0	Yes	R-I	Yes
Temple University	$62,252	$28,688	$483	$5,031	$22,048	$6,003	Yes	R-I	Yes
University of Pennsylvania	$342,131	$251,262	$3,070	$25,245	$28,943	$33,611	No	R-I	Yes
University of Pittsburgh	$224,890	$176,982	$1,013	$11,202	$19,289	$16,404	Yes	R-I	Yes
Other Pennsylvania	$188,146	$119,694	$11,775	$23,266	$21,400	$12,011			
Total: Pennsylvania	**$1,350,361**	**$876,998**	**$46,660**	**$152,648**	**$197,887**	**$76,168**			
Rhode Island									
Brown University	$74,935	$45,076	$77	$1,657	$25,005	$3,121	No	R-I	Yes
University of Rhode Island	$41,535	$35,579	$2,782	$679	$2,394	$100	Yes	R-II	No
Other Rhode Island (Providence College)	$65	$22	$0	$17	$26	$0			
Total: Rhode Island	**$116,535**	**$80,677**	**$2,859**	**$2,352**	**$27,425**	**$3,221**			
South Carolina									
Clemson University	$92,402	$28,185	$19,549	$6,861	$32,971	$4,835	Yes	R-II	No
University of South Carolina	$93,341	$43,248	$4,313	$2,114	$40,769	$2,896	Yes	R-II	Yes
Other South Carolina	$64,961	$40,936	$1,395	$2,177	$11,891	$8,561			
Total: South Carolina	**$250,703**	**$112,370**	**$25,257**	**$11,153**	**$85,631**	**$16,292**			
South Dakota									
South Dakota State University	$15,857	$5,931	$7,097	$488	$1,344	$997	Yes	C-I	No
Other South Dakota	$9,569	$6,008	$1,186	$59	$1,393	$922			
Total: South Dakota	**$25,426**	**$11,939**	**$8,283**	**$547**	**$2,737**	**$1,919**			
Tennessee									
University of Tennessee	$156,796	$72,376	$28,551	$13,619	$29,542	$12,708	Yes	R-I	No
Vanderbilt University	$137,637	$108,762	$132	$3,494	$13,393	$11,856	No	R-I	Yes
Other Tennessee	$60,360	$30,618	$9,708	$2,801	$13,351	$3,883			
Total: Tennessee	**$354,793**	**$211,756**	**$38,390**	**$19,915**	**$56,286**	**$28,447**			

Appendix Table 1 (continued).	Total	Federal	State	Industry	Institutional	Other	Public	Carnegie	Hospital
Texas									
Rice University	$42,520	$36,430	$1,870	$1,643	$0	$2,576	No	R-II	No
Texas A&M University	$392,929	$148,449	$90,919	$33,866	$112,883	$6,811	Yes	R-I	Yes
Texas Tech University	$53,449	$17,766	$15,304	$5,707	$11,667	$3,005	Yes	R-II	Yes
University of Houston	$44,496	$21,696	$10,793	$1,787	$6,395	$3,826	Yes	R-II	No
University of Texas at Austin	$250,760	$162,878	$17,207	$34,080	$31,726	$4,869	Yes	R-I	No
Other Texas	$959,361	$546,358	$45,983	$69,715	$130,194	$167,111			
Total: Texas	**$1,743,516**	**$933,578**	**$182,077**	**$146,798**	**$292,865**	**$188,199**			
Utah									
Brigham Young University	$15,983	$10,244	$611	$1,462	$2,959	$707	No	R-II	No
University of Utah	$146,206	$105,341	$1,186	$9,923	$22,498	$7,258	Yes	R-I	Yes
Utah State University	$94,942	$53,709	$16,884	$3,411	$18,181	$2,757	Yes	R-I	No
Total: Utah	**$257,131**	**$169,294**	**$18,681**	**$14,796**	**$43,638**	**$10,723**			
Vermont									
*University of Vermont**	$61,308	$34,334	$2,721	$6,085	$11,926	$6,242	Yes	R-II	Yes
Other Vermont	$762	$674	$1	$0	$29	$58			
Total: Vermont	**$62,070**	**$35,008**	**$2,722**	**$6,085**	**$11,955**	**$6,299**			
Virginia									
University of Virginia	$138,651	$97,976	$5,014	$11,147	$12,562	$11,952	Yes	R-I	Yes
Virginia Commonwealth University	$80,889	$47,764	$2,961	$8,698	$16,553	$4,913	Yes	R-I	Yes
Virginia Polytechnic Institute and State Univ	$171,129	$83,149	$34,844	$12,434	$36,837	$3,865	Yes	R-I	No
Other Virginia	$113,014	$66,330	$8,505	$13,815	$15,843	$8,521			
Total: Virginia	**$503,683**	**$295,219**	**$51,324**	**$46,094**	**$81,796**	**$29,251**			
Washington									
University of Washington—Seattle	$449,579	$348,402	$10,963	$43,018	$39,177	$8,019	Yes	R-I	Yes
Washington State University	$98,068	$45,355	$3,509	$3,196	$35,583	$10,425	Yes	R-II	Yes
Other Washington	$8,302	$4,110	$984	$869	$1,705	$633			
Total: Washington	**$555,949**	**$397,867**	**$15,455**	**$47,084**	**$76,466**	**$19,077**			
West Virginia									
West Virginia University	$63,918	$27,294	$2,876	$4,656	$24,742	$4,350	Yes	R-I	Yes
Other West Virginia	$883	$345	$55	$0	$427	$56			
Total: West Virginia	**$64,802**	**$27,640**	**$2,931**	**$4,656**	**$25,169**	**$4,406**			
Wisconsin									
University of Wisconsin—Madison	$448,171	$244,772	$38,687	$14,667	$97,142	$52,903	Yes	R-I	Yes
University of Wisconsin—Milwaukee	$21,292	$8,954	$4,330	$494	$6,237	$1,277	Yes	R-II	No
Other Wisconsin	$71,789	$50,490	$1,201	$5,359	$6,794	$7,945			
Total: Wisconsin	**$541,252**	**$304,216**	**$44,218**	**$20,520**	**$110,173**	**$62,125**			
Wyoming									
*University of Wyoming**	$48,500	$17,534	$4,777	$2,885	$22,214	$1,090	Yes	R-II	No

Land Grant Universities in *italics*. URI "peer group" = *. Carnegie: Research Universities I & II = R-I & R-II; Doctoral Universities I & II = D-I & D-II; Comprehensive Universities I = C-I.

Appendix Table 2. Per capita mean (1997-1999) annual research operating funds (% of institutional total) at 134 Universities by major sources.

	Federal	State & Local	Industry	Institutional	Other
Alabama					
University of Alabama—Birmingham	$36.67 (72.7)	$0.23 (0.5)	$3.29 (6.5)	$4.43 (8.8)	$5.80 (11.5)
Auburn University	$6.25 (32.4)	$0.21 (1.1)	$0.97 (5.0)	$10.97 (56.8)	$0.90 (4.7)
Alaska					
University of Alaska— Fairbanks	$50.80 (40.1)	$6.23 (4.9)	$25.94 (20.5)	$43.82 (34.6)	$0.01 (0.0)
Arizona					
Arizona State University	$8.75 (47.5)	$0.35 (1.9)	$0.81 (4.4)	$7.95 (43.2)	$0.57 (3.1)
University of Arizona	$32.42 (54.2)	$1.58 (2.6)	$3.16 (5.3)	$20.31 (34.0)	$2.31 (3.9)
Arkansas					
University of Arkansas	$6.04 (24.1)	$11.59 (46.2)	$1.95 (7.8)	$4.39 (17.5)	$1.09 (4.3)
California					
California Institute of Technology	$5.36 (93.4)	$0.02 (0.3)	$0.12 (2.1)	$0.19 (3.3)	$0.05 (0.9)
Stanford University	$10.26 (83.5)	$0.08 (0.6)	$0.82 6.7)	$0.53 (4.3)	$0.60 (4.9)
University of California—Berkeley	$5.21 (41.8)	$1.47 (11.8)	$0.64 (5.1)	$4.07 (32.7)	$1.07 (8.6)
University of California—Davis	$3.43 (39.7)	$0.59 (6.9)	$0.41 (4.8)	$3.50 (40.5)	$0.69 (8.1)
University of California—Irvine	$2.06 (52.7)	$0.14 (3.6)	$0.45 (11.5)	$0.79 (20.2)	$0.47 (12.0)
University of California—Los Angeles	$7.00 (53.0)	$0.28 (2.1)	$0.86 (6.5)	$3.17 (24.0)	$1.90 (14.4)
University of California—Riverside	$0.67 (29.0)	$0.12 (5.2)	$0.08 (3.3)	$1.22 (52.8)	$0.22 (9.6)
University of California—San Diego	$7.91 (63.1)	$0.56 (4.5)	$0.82 (6.5)	$2.00 (15.9)	$1.24 (9.9)
University of California—San Francisco	$6.58 (57.9)	$0.49 (4.3)	$0.98 (8.6)	$1.96 (17.2)	$1.37 (12.0)
University of California—Santa Barbara	$2.07 (71.2)	$0.06 (1.9)	$0.12 (4.0)	$0.49 (16.7)	$0.18 (6.2)
University of California—Santa Cruz	$0.79 (49.7)	$0.05 (3.1)	$0.04 (2.5)	$0.55 (34.7)	$0.16 (9.9)
University of Southern California	$5.81 (72.0)	$0.22 (2.8)	$0.69 (8.5)	$1.35 (16.7)	$0.00 (0.0)
Colorado					
Colorado State University	$19.78 (60.1)	$4.44 (13.5)	$1.50 (4.6)	$7.14 (21.7)	$0.05 (0.2)
University of Colorado, All Campuses	$52.23 (73.9)	$1.28 (1.8)	$2.30 (3.3)	$6.69 (9.5)	$8.16 (11.5)
Connecticut					
University of Connecticut	$15.70 (38.5)	$3.43 (8.4)	$2.86 (7.0)	$15.64 (38.4)	$3.11 (7.6)
Yale University	$60.28 (77.7)	$0.28 (0.4)	$4.74 (6.1)	$4.77 (6.1)	$7.55 (9.7)
Delaware					
University of Delaware	$43.28 (48.1)	$5.55 (6.2)	$4.90 (5.5)	$25.35 (28.2)	$10.83 (12.0)
District of Columbia					
George Washington University	$76.23 (65.7)	$1.74 (1.5)	$11.52 (9.9)	$9.13 (7.9)	$17.37 (15.0)
Georgetown University	$149.50 (72.8)	$0.74 (0.4)	$15.22 (7.4)	$26.80 (13.1)	$12.96 (6.3)
Howard University	$40.84 (91.9)	$0.71 (1.6)	$2.57 (5.8)	$0.05 (0.1)	$0.26 (0.6)
Florida					
Florida State University	$3.36 (55.2)	$0.11 (1.8)	$0.07 (1.1)	$2.30 (37.8)	$0.24 (4.0)
University of Florida	$6.83 (37.9)	$3.97 (22.1)	$1.58 (8.8)	$5.00 (27.8)	$0.63 (3.5)
University of Miami	$6.45 (73.9)	$0.10 (1.1)	$0.87 (10.0)	$0.44 (5.0)	$0.86 (9.9)
University of South Florida	$2.30 (33.2)	$0.50 (7.2)	$0.32 (4.7)	$3.20 (46.2)	$0.60 (8.7)
Georgia					
Emory University	$14.83 (68.3)	$0.60 (2.8)	$0.91 (4.2)	$2.55 (11.8)	$2.80 (12.9)
Georgia Institute of Technology	$14.00 (44,4)	$1.62 (5.2)	$6.98 (22.2)	$8.90 (28.3)	$0.00 (0.0)
University of Georgia	$6.82 (24.3)	$5.44 (19.3)	$1.31 (4.7)	$14.39 (51.2)	$0.15 (0.5)
Hawaii					
University of Hawaii at Manoa	$70.44 (59.5)	$28.03 (23.7)	$8.32 (7.0)	$11.64 (9.8)	$0.00 (0.0)

Appendix Table 2 (continued).	Federal	State & Local	Industry	Institutional	Other
Idaho					
University of Idaho	$15.66 (33.5)	$13.93 (29.8)	$3.92 (8.4)	$11.12 (23.8)	$2.13 (4.6)
Illinois					
Northwestern Univ	$10.03 (56.0)	$0.29 (1.6)	$1.03 (5.8)	$4.58 (25.6)	$1.97 (11.0)
Southern Illinois University-Carbondale	$0.66 (25.7)	$0.60 (23.4)	$0.18 (7.2)	$0.86 (33.8)	$0.25 (9.9)
University of Chicago	$10.43 (82.4)	$0.05 (0.4)	$0.13 (1.1)	$0.74 (5.9)	$1.29 (10.2)
University of Illinois at Chicago	$6.28 (49.6)	$0.32 (2.5)	$0.71 (5.6)	$4.40 (34.7)	$0.97 (7.7)
University of Illinois at Urbana-Champaign	$13.96 (52.7)	$2.89 (10.9)	$1.04 (3.9)	$7.45 (28.1)	$1.14 (4.3)
Indiana					
Indiana University	$16.34 (55.3)	$0.30 (1.0)	$0.86 (2.9)	$8.92 (30.2)	$3.13 (10.6)
Purdue University	$15.59 (43.2)	$3.95 (10.9)	$4.55 (12.6)	$11.95 (33.1)	$0.05 (0.1)
University of Notre Dame	$3.66 (78.9)	$0.03 (0.7)	$0.38 (8.3)	$0.56 (12.1)	$0.00 (0.0)
Iowa					
Iowa State University	$18.29 (33.4)	$16.34 (29.9)	$4.28 (7.8)	$14.51 (26.5)	$1.28 (2.3)
University of Iowa	$40.01 (58.7)	$1.94 (2.9)	$6.20 (9.1)	$15.51 (22.7)	$4.53 (6.6)
Kansas					
Kansas State University	$10.17 (33.2)	$12.41 (40.5)	$1.27 (4.2)	$5.79 (18.9)	$0.99 (3.2)
University of Kansas	$19.42 (43.1)	$3.85 (8.5)	$3.87 (8.6)	$13.85 (30.7)	$4.08 (9.1)
Kentucky					
University of Kentucky	$15.81 (41.1)	$2.60 (6.8)	$3.34 (8.7)	$16.07 (41.8)	$0.60 (1.6)
University of Louisville	$3.69 (34.1)	$0.25 (2.3)	$1.20 (11.1)	$4.21 (38.9)	$1.47 (13.6)
Louisiana					
Louisiana State University	$15.74 (32.5)	$15.71 (32.5)	$2.93 (6.0)	$10.99 (22.7)	$3.05 (6.3)
Tulane University	$11.60 (58.6)	$0.59 (3.0)	$2.69 (13.6)	$3.95 (19.9)	$0.96 (4.8)
Maine					
University of Maine	$12.52 (43.9)	$1.26 (4.4)	$3.99 (14.0)	$9.97 (34.9)	$0.80 (2.8)
Maryland					
Johns Hopkins University	$143.46 (87.9)	$0.19 (0.1)	$2.81 (1.7)	$8.06 (4.9)	$8.69 (5.3)
University of Maryland—College Park	$24.04 (54.1)	$8.58 (19.3)	$0.65 (1.5)	$9.21 (20.7)	$1.96 (4.4)
Massachusetts					
Boston University	$17.30 (83.1)	$0.21 (1.0)	$1.38 (6.6)	$0.00 (0.0)	$1.93 (9.3)
Brandeis University	$4.40 (62.2)	$0.03 (0.4)	$0.00 (0.0)	$0.76 (10.8)	$1.89 (26.7)
Harvard University	$39.40 (79.4)	$0.12 (0.2)	$1.80 (3.6)	$2.01 (4.0)	$6.30 (12.7)
Massachusetts Institute of Technology	$49.58 (74.8)	$0.31 (0.5)	$10.38 (15.7)	$3.46 (5.2)	$2.51 (3.8)
Northeastern University	$3.22 (79.3)	$0.06 (1.6)	$0.50 (12.2)	$0.28 (6.9)	$0.00 (0.0)
Tufts University	$9.59 (65.0)	$0.11 (0.7)	$0.97 (6.6)	$2.81 (19.0)	$1.29 (8.7)
University of Massachusetts at Amherst	$6.60 (47.3)	$1.06 (7.6)	$0.95 (6.8)	$4.30 (30.8)	$1.05 (7.5)
Michigan					
Michigan State University	$8.64 (42.9)	$3.60 (17.9)	$0.74 (3.7)	$6.39 (31.7)	$0.76 (3.8)
University of Michigan, All Campuses	$32.02 (63.2)	$0.40 (0.8)	$3.36 (6.6)	$10.59 (20.9)	$4.26 (8.4)
Wayne State University	$5.75 (41.3)	$1.24 (8.9)	$1.12 (8.0)	$4.32 (31.0)	$1.50 (10.8)
Minnesota					
University of Minnesota	$42.10 (56.0)	$10.08 (13.4)	$4.96 (6.6)	$11.73 (15.6)	$6.36 (8.5)
Mississippi					
Mississippi State University	$14.65 (41.8)	$9.01 (25.7)	$2.47 (7.0)	$7.90 (22.5)	$1.04 (3.0)
University of Mississippi	$5.01 (58.8)	$1.47 (17.2)	$0.52 (6.1)	$1.03 (12.1)	$0.49 (5.9)

Appendix Table 2 (continued).	Federal	State & Local	Industry	Institutional	Other
Missouri					
St Louis University	$4.25 (86.5)	$0.05 (0.9)	$0.51 (10.4)	$0.04 (0.9)	$0.06 (1.3)
University of Missouri—Columbia	$8.61 (34.5)	$3.00 (12.0)	$0.72 (2.9)	$11.61 (46.5)	$1.01 (4.1)
Washington University	$35.79 (69.9)	$0.98 (1.9)	$3.69 (7.2)	$5.20 (10.2)	$5.51 (10.8)
Montana					
Montana State University - Bozeman	$26.17 (44.4)	$14.22 (24.2)	$8.03 (13.6)	$10.46 (17.8)	$0.00 (0.0)
Nebraska					
University of Nebraska at Lincoln	$23.75 (32.8)	$16.32 (22.5)	$2.93 (4.0)	$27.45 (37.9)	$2.02 (2.8)
Nevada					
University of Nevada-Reno	$11.12 (45.0)	$0.70 (2.8)	$0.77 (3.1)	$11.10 (44.9)	$1.03 (4.2)
New Hampshire					
University of New Hampshire	$22.03 (51.7)	$4.64 (10.9)	$2.62 (6.2)	$6.98 (16.4)	$6.32 (14.8)
New Jersey					
Princeton University	$8.50 (59.7)	$0.16 (1.2)	$0.63 (4.4)	$3.41 (24.0)	$1.54 (10.8)
Rutgers	$8.58 (36.0)	$2.89 (12.1)	$1.11 (4.7)	$9.43 (39.5)	$1.84 (7.7)
New Mexico					
New Mexico State University	$31.71 (59.7)	$4.88 (11.0)	$1.51 (3.4)	$5.42 (12.2)	$0.77 (1.7)
University of New Mexico	$45.76 (36.0)	$1.50 (2.3)	$1.69 (2.5)	$15.28 (23.0)	$2.30 (3.5)
New York					
Columbia University	$12.14 (86.2)	$0.12 (0.8)	$0.13 (0.9)	$0.38 (2.7)	$1.31 (9.3)
Cornell University	$11.47 (58.1)	$2.00 (10.1)	$0.56 (2.8)	$3.71 (18.8)	$2.02 (10.2)
New York University	$5.46 (64.3)	$0.07 (0.9)	$0.43 (5.1)	$0.98 (11.6)	$1.54 (18.2)
Rensselaer Polytechnic Institute	$1.20 (57.9)	$0.13 (6.1)	$0.54 (26.1)	$0.14 (7.0)	$0.06 (3.0)
Rockefeller University	$2.37 (38.3)	$0.11 (1.8)	$0.14 (2.3)	$1.81 (29.2)	$1.76 (28.4)
SUNY at Albany	$2.16 (70.4)	$0.18 (5.8)	$0.08 (2.5)	$0.26 (8.5)	$0.39 (12.7)
SUNY at Binghamton	$0.32 (31.3)	$0.14 (13.7)	$0.14 (13.4)	$0.32 (30.7)	$0.11 (10.8)
SUNY at Buffalo	$4.27 (52.8)	$0.24 (3.0)	$0.41 (5.1)	$1.70 (21.1)	$1.46 (18.1)
SUNY at Stony Brook	$4.84 (63.7)	$0.15 (1.9)	$0.38 (5.0)	$1.88 (24.7)	$0.35 (4.7)
Syracuse University	$1.48 (74.4)	$0.18 (8.9)	$0.09 (4.3)	$0.11 (5.5)	$0.14 (6.9)
University of Rochester	$6.80 (75.4)	$0.47 (5.2)	$0.89 (9.9)	$0.32 (3.6)	$0.54 (6.0)
Yeshiva University	$4.41 (80.5)	$0.00 (0.0)	$0.00 (0.0)	$0.98 (17.9)	$0.09 (1.6)
North Carolina					
Duke University	$21.62 (58.4)	$0.75 (2.0)	$9.82 (26.6)	$1.91 (5.2)	$2.89 (7.8)
North Carolina State University at Raleigh	$9.05 (28.6)	$11.05 (34.9)	$3.77 (11.9)	$7.51 (23.7)	$0.28 (0.9)
University of North Carolina at Chapel Hill	$21.34 (71.7)	$3.17 (10.7)	$0.59 (2.0)	$4.68 (15.7)	$0.00 (0.0)
North Dakota					
North Dakota State University	$14.98 (23.8)	$2.11 (3.3)	$2.12 (3.4)	$41.08 (65.2)	$2.77 (4.4)
Ohio					
Case Western Reserve University	$11.71 (75.6)	$0.41 (2.6)	$0.56 (3.6)	$1.47 (9.5)	$1.35 (8.7)
Kent State University	$0.72 (68.2)	$0.07 (7.0)	$0.07 (6.9)	$0.19 (17.9)	$0.00 (0.0)
Ohio State University	$11.37 (41.8)	$4.50 (16.6)	$3.84 (14.1)	$5.34 (19.7)	$2.13 (7.8)
Ohio University	$0.91 (48.0)	$0.16 (8.5)	$0.21 (10.8)	$0.55 (29.1)	$0.07 (3.7)
University of Cincinnati	$8.00 (59.1)	$0.32 (2.4)	$1.59 (11.8)	$2.94 (21.8)	$0.67 (5.0)
Oklahoma					
Oklahoma State University	$6.65 (31.3)	$6.68 (31.5)	$0.94 (4.4)	$6.77 (31.9)	$0.21 (1.0)
University of Oklahoma	$15.44 (41.2)	$4.27 (11.4)	$2.18 (5.8)	$11.47 (30.6)	$4.15 (11.1)

Appendix Table 2 (continued).	Federal	State & Local	Industry	Institutional	Other
Oregon					
Oregon State University	$24.13 (59.7)	$8.34 (20.6)	$0.16 (0.4)	$5.28 (13.1)	$2.50 (6.2)
University of Oregon	$7.94 (82.5)	$0.09 (0.9)	$0.05 (0.5)	$1.02 (10.6)	$0.53 (5.5)
Pennsylvania					
Carnegie Mellon University	$7.63 (66.8)	$1.03 (9.0)	$1.51 (13.2)	$0.60 (5.3)	$0.64 (5.6)
Lehigh University	$1.13 (51.1)	$0.30 (13.6)	$0.54 (24.3)	$0.22 (10.0)	$0.02 (1.1)
Pennsylvania State University	$15.70 (52.7)	$1.13 (3.8)	$5.11 (17.2)	$7.83 (26.3)	$0.00 (0.0)
Temple University	$2.34 (46.1)	$0.04 (0.8)	$0.41 (8.1)	$1.80 (35.4)	$0.49 (9.6)
University of Pennsylvania	$20.46 (73.4)	$0.25 (0.9)	$2.06 (7.4)	$2.36 (8.5)	$2.74 (9.8)
University of Pittsburgh	$14.41 (78.7)	$0.08 (0.5)	$0.91 (5.0)	$1.57 (8.6)	$1.34 (7.3)
Rhode Island					
Brown University	$43.00 (60.2)	$0.07 (0.1)	$1.58 (2.2)	$23.85 (33.4)	$2.98 (4.2)
University of Rhode Island	$33.94 (85.7)	$2.65 (6.7)	$0.65 (1.6)	$2.28 (5.8)	$0.10 (0.2)
South Carolina					
Clemson University	$7.03 (30.5)	$4.87 (21.2)	$1.71 (7.4)	$8.22 (35.7)	$1.21 (5.2)
University of South Carolina, All Campuses	$10.78 (46.3)	$1.07 (4.6)	$0.53 (2.3)	$10.16 (43.7)	$0.72 (3.1)
South Dakota					
South Dakota State University	$7.86 (37.4)	$9.40 (44.8)	$0.65 (3.1)	$1.78 (8.5)	$1.32 (6.3)
Tennessee					
University of Tennessee	$12.72 (46.2)	$5.02 (18.2)	$2.39 (8.7)	$5.19 (18.8)	$2.23 (8.1)
Vanderbilt University	$19.12 (79.0)	$0.02 (0.1)	$0.61 (2.5)	$2.35 (9.7)	$2.08 (8.6)
Texas					
Rice University	$1.75 (85.7)	$0.09 (4.4)	$0.08 (3.9)	$0.00 (0.0)	$0.12 (6.1)
Texas A&M University	$7.12 (37.8)	$4.36 (23.1)	$1.62 (8.6)	$5.41 (28.7)	$0.33 (1.7)
Texas Tech University	$0.85 (33.2)	$0.73 (28.6)	$0.27 (10.7)	$0.56 (21.8)	$0.14 (5.6)
University of Houston	$1.04 (48.8)	$0.52 (24.3)	$0.09 (4.0)	$0.31 (14.4)	$0.18 (8.6)
University of Texas at Austin	$7.81 (65.0)	$0.83 (6.9)	$1.63 (13.6)	$1.52 (12.7)	$0.23 (1.9)
Utah					
Brigham Young University	$4.59 (64.1)	$0.27 (3.8)	$0.65 (9.1)	$1.33 (18.5)	$0.32 (4.4)
University of Utah	$47.17 (72.0)	$0.53 (0.8)	$4.44 (6.8)	$10.07 (15.4)	$3.25 (5.0)
Utah State University	$24.05 (56.6)	$7.56 (17.8)	$1.53 (3.6)	$8.14 (19.1)	$1.23 (2.9)
Vermont					
University of Vermont	$56.39 (56.0)	$4.47 (4.4)	$10.00 (9.9)	$19.59 (19.5)	$10.25 (10.2)
Virginia					
University of Virginia	$13.84 (70.7)	$0.71 (3.6)	$1.57 (8.0)	$1.77 (9.1)	$1.69 (8.6)
Virginia Commonwealth University	$6.75 (59.0)	$0.42 (3.7)	$1.23 (10.8)	$2.34 (20.5)	$0.69 (6.1)
Virginia Polytechnic Institute and State Univ	$11.75 (48.6)	$4.92 (20.4)	$1.76 (7.3)	$5.20 (21.5)	$0.55 (2.3)
Washington					
University of Washington—Seattle	$59.11 (77.5)	$1.86 (2.4)	$7.30 (9.6)	$6.65 (8.7)	$1.36 (1.8)
Washington State University	$7.69 (46.2)	$0.60 (3.6)	$0.54 (3.3)	$6.04 (36.3)	$1.77 (10.6)
West Virginia					
West Virginia University	$15.09 (42.7)	$1.59 (4.5)	$2.57 (7.3)	$13.68 (38.7)	$2.41 (6.8)
Wisconsin					
University of Wisconsin—Madison	$45.64 (54.6)	$7.21 (8.6)	$2.73 (3.3)	$18.11 (21.7)	$9.86 (11.8)
University of Wisconsin—Milwaukee	$1.67 (39.1)	$0.81 (20.3)	$0.09 (2.3)	$1.16 (29.3)	$0.24 (6.0)
Wyoming					
University of Wyoming	$35.51 (36.2)	$9.68 (9.9)	$5.84 (5.9)	$44.99 (45.8)	$2.21 (2.2)

Appendix Table 3. Mean (1997-1999, in $1000's, 1999) and per capita annual research equipment funds at 134 Universities by major sources.

	Mean 97-99 Expenditures		Per Capita			
	Total	Federal	Total	Federal	Non-Federal	% Non-Federal
Alabama						
University of Alabama—Birmingham	$9,503	$6,796	$2.14	$1.53	$0.61	28.48%
Auburn University	$3,376	$1,441	$0.76	$0.32	$0.44	57.32%
Other Alabama	$6,990	$4,508	$1.57	$1.01	$0.56	35.50%
Total: Alabama	**$19,870**	**$12,746**	**$4.47**	**$2.87**	**$1.60**	**35.85%**
Alaska						
University of Alaska— Fairbanks	$6,182	$2,910	$9.86	$4.64	$5.22	52.93%
Other Alaska	$4	$0	$0.01	$0.00	$0.01	100.00%
Total: Akaska	**$6,186**	**$2,910**	**$9.87**	**$4.64**	**$5.23**	**52.96%**
Arizona						
Arizona State University	$6,403	$2,726	$1.25	$0.53	$0.72	57.42%
University of Arizona	$14,298	$9,650	$2.79	$1.88	$0.91	32.51%
Other Arizona	$503	$289	$0.10	$0.06	$0.04	42.53%
Total: Arizona	**$21,205**	**$12,665**	**$4.13**	**$2.47**	**$1.66**	**40.27%**
Arkansas						
University of Arkansas	$3,591	$1,319	$1.34	$0.49	$0.85	63.26%
Other Arkansas	$2,646	$1,702	$0.99	$0.64	$0.35	35.66%
Total: Arkansas	**$6,237**	**$3,022**	**$2.33**	**$1.13**	**$1.20**	**51.55%**
California						
California Institute of Technology	$26,687	$23,682	$0.79	$0.70	$0.09	11.26%
Stanford University	$26,311	$23,449	$0.78	$0.69	$0.08	10.88%
University of California—Berkeley	$9,340	$5,909	$0.28	$0.17	$0.10	36.74%
University of California—Davis	$11,655	$5,999	$0.34	$0.18	$0.17	48.53%
University of California—Irvine	$5,522	$3,168	$0.16	$0.09	$0.07	42.63%
University of California—Los Angeles	$11,950	$6,839	$0.35	$0.20	$0.15	42.77%
University of California—Riverside	$2,492	$1,191	$0.07	$0.04	$0.04	52.23%
University of California—San Diego	$13,493	$7,139	$0.40	$0.21	$0.19	47.09%
University of California—San Francisco	$9,389	$5,361	$0.28	$0.16	$0.12	42.90%
University of California—Santa Barbara	$5,681	$4,505	$0.17	$0.13	$0.03	20.70%
University of California—Santa Cruz	$1,485	$916	$0.04	$0.03	$0.02	38.32%
University of Southern California	$10,808	$7,596	$0.32	$0.22	$0.09	29.72%
Other California	$21,806	$15,577	$0.64	$0.46	$0.18	28.57%
Total: California	**$156,620**	**$111,330**	**$4.62**	**$3.29**	**$1.34**	**28.92%**
Colorado						
Colorado State University	$7,988	$4,874	$1.86	$1.13	$0.72	38.98%
University of Colorado	$9,837	$7,520	$2.29	$1.75	$0.54	23.55%
Other Colorado	$3,766	$2,685	$0.88	$0.62	$0.25	28.71%
Total: Colorado	**$21,591**	**$15,079**	**$5.02**	**$3.51**	**$1.51**	**30.16%**
Connecticut						
University of Connecticut	$5,612	$1,457	$1.65	$0.43	$1.22	74.03%
Yale University	$8,889	$7,746	$2.61	$2.27	$0.34	12.85%
Other Connecticut	$1,317	$450	$0.39	$0.13	$0.25	65.79%
Total: Connecticut	**$15,817**	**$9,654**	**$4.64**	**$2.83**	**$1.81**	**38.97%**
Delaware						
University of Delaware	$6,513	$2,690	$8.31	$3.43	$4.88	58.69%
Other Delaware (Delaware State Univ.)	$306	$218	$0.39	$0.28	$0.11	28.88%
Total: Delaware	**$6,819**	**$2,908**	**$8.70**	**$3.71**	**$4.99**	**57.35%**

Appendix Table 3 (continued)	Mean 97-99 Expenditures Total	Federal	Per Capita Total	Federal	Non-Federal	% Non-Federal
District of Columbia						
George Washington University	$1,700	$1,116	$2.97	$1.95	$1.02	34.36%
Georgetown University	$2,826	$2,472	$4.94	$4.32	$0.62	12.54%
Howard University	$2,498	$2,348	$4.37	$4.11	$0.26	5.98%
Other District of Columbia	$629	$539	$1.10	$0.94	$0.16	14.40%
Total: District of Columbia	**$7,653**	**$6,475**	**$13.38**	**$11.32**	**$2.06**	**15.40%**
Florida						
Florida State University	$8,579	$5,924	$0.54	$0.37	$0.17	30.95%
University of Florida	$16,750	$8,321	$1.05	$0.52	$0.53	50.32%
University of Miami	$8,783	$6,813	$0.55	$0.43	$0.12	22.43%
University of South Florida	$7,456	$2,933	$0.47	$0.18	$0.28	60.67%
Other Florida	$11,372	$8,061	$0.71	$0.50	$0.21	29.11%
Total: Florida	**$52,939**	**$32,051**	**$3.31**	**$2.01**	**$1.31**	**39.46%**
Georgia						
Emory University	$5,551	$2,917	$0.68	$0.36	$0.32	47.45%
Georgia Institute of Technology	$25,012	$11,162	$3.06	$1.36	$1.69	55.37%
University of Georgia	$20,731	$3,149	$2.53	$0.38	$2.15	84.81%
Other Georgia	$13,324	$6,313	$1.63	$0.77	$0.86	52.62%
Total: Georgia	**$64,618**	**$23,541**	**$7.89**	**$2.88**	**$5.02**	**63.57%**
Hawaii						
University of Hawaii at Manoa	**$8,702**	**$5,666**	**$7.18**	**$4.68**	**$2.51**	**34.88%**
Idaho						
University of Idaho	$2,498	$1,410	$1.93	$1.09	$0.84	43.57%
Other Idaho	$913	$478	$0.71	$0.37	$0.34	47.66%
Total: Idaho	**$3,411**	**$1,888**	**$2.64**	**$1.46**	**$1.18**	**44.66%**
Illinois						
Northwestern Univ	$10,518	$5,404	$0.85	$0.44	$0.41	48.63%
Southern Illinois University-Carbondale	$1,635	$278	$0.13	$0.02	$0.11	82.99%
University of Chicago	$13,041	$11,398	$1.05	$0.92	$0.13	12.60%
University of Illinois at Chicago	$9,062	$3,928	$0.73	$0.32	$0.41	56.66%
University of Illinois at Urbana-Champaign	$29,416	$22,187	$2.37	$1.79	$0.58	24.58%
Other Illinois	$6,235	$3,171	$0.50	$0.26	$0.25	49.14%
Total: Illinois	**$69,907**	**$46,365**	**$5.63**	**$3.73**	**$1.90**	**33.68%**
Indiana						
Indiana University	$8,613	$4,294	$1.42	$0.71	$0.71	50.14%
Purdue University	$15,020	$8,699	$2.47	$1.43	$1.04	42.08%
University of Notre Dame	$4,574	$2,505	$0.75	$0.41	$0.34	45.24%
Other Indiana	$328	$117	$0.05	$0.02	$0.03	64.45%
Total: Indiana	**$28,535**	**$15,615**	**$4.69**	**$2.57**	**$2.12**	**45.28%**
Iowa						
Iowa State University	$5,764	$1,846	$1.97	$0.63	$1.34	67.98%
University of Iowa	$8,891	$4,608	$3.04	$1.57	$1.46	48.17%
Other Iowa	$257	$69	$0.09	$0.02	$0.06	73.27%
Total: Iowa	**$14,912**	**$6,523**	**$5.10**	**$2.23**	**$2.87**	**56.26%**
Kansas						
Kansas State University	$7,406	$3,430	$2.75	$1.28	$1.48	53.68%
University of Kansas	$4,997	$2,208	$1.86	$0.82	$1.04	55.82%
Other Kansas	$1,425	$271	$0.53	$0.10	$0.43	80.97%
Total: Kansas	**$13,828**	**$5,909**	**$5.14**	**$2.20**	**$2.95**	**57.27%**

Appendix Table 3 (continued)	Mean 97-99 Expenditures Total	Federal	——Per Capita—— Total	Federal	Non-Federal	% Non-Federal
Kentucky						
University of Kentucky	$6,566	$3,489	$1.62	$0.86	$0.76	46.86%
University of Louisville	$2,260	$810	$0.56	$0.20	$0.36	64.16%
Other Kentucky	$1,636	$854	$0.40	$0.21	$0.19	47.78%
Total: Kentucky	**$10,462**	**$5,153**	**$2.59**	**$1.27**	**$1.31**	**50.74%**
Louisiana						
Louisiana State University	$15,142	$3,150	$3.39	$0.70	$2.68	79.20%
Tulane University	$2,848	$1,622	$0.64	$0.36	$0.27	43.04%
Other Louisiana	$5,138	$3,025	$1.15	$0.68	$0.47	41.12%
Total: Louisiana	**$23,127**	**$7,797**	**$5.18**	**$1.74**	**$3.43**	**66.29%**
Maine						
University of Maine	$2,014	$1,582	$1.58	$1.24	$0.34	21.43%
Other Maine	$507	$174	$0.40	$0.14	$0.26	65.59%
Total: Maine	**$2,521**	**$1,757**	**$1.98**	**$1.38**	**$0.60**	**30.31%**
Maryland						
Johns Hopkins University	$36,375	$18,239	$6.87	$3.44	$3.42	49.86%
University of Maryland—College Park	$14,343	$8,740	$2.71	$1.65	$1.06	39.06%
Other Maryland	$11,294	$4,818	$2.13	$0.91	$1.22	57.34%
Total: Maryland	**$62,011**	**$31,797**	**$11.71**	**$6.00**	**$5.70**	**48.72%**
Massachusetts						
Boston University	$4,926	$4,432	$0.78	$0.70	$0.08	10.02%
Brandeis University	$1,983	$1,487	$0.31	$0.23	$0.08	25.00%
Harvard University	$11,270	$9,187	$1.78	$1.45	$0.33	18.48%
Massachusetts Institute of Technology	$27,546	$19,416	$4.34	$3.06	$1.28	29.51%
Northeastern University	$1,934	$1,622	$0.30	$0.26	$0.05	16.14%
Tufts University	$3,056	$1,955	$0.48	$0.31	$0.17	36.04%
University of Massachusetts at Amherst	$6,346	$3,921	$1.00	$0.62	$0.38	38.22%
Other Massachusetts	$10,681	$6,889	$1.68	$1.09	$0.60	35.50%
Total: Massachusetts	**$67,741**	**$48,909**	**$10.67**	**$7.70**	**$2.97**	**27.80%**
Michigan						
Michigan State University	$8,318	$4,472	$0.84	$0.45	$0.39	46.24%
University of Michigan	$15,940	$9,937	$1.60	$1.00	$0.60	37.66%
Wayne State University	$6,187	$1,609	$0.62	$0.16	$0.46	74.00%
Other Michigan	$5,416	$2,533	$0.54	$0.25	$0.29	53.23%
Total: Michigan	**$35,861**	**$18,551**	**$3.61**	**$1.87**	**$1.74**	**48.27%**
Minnesota						
University of Minnesota	$13,782	$8,686	$2.80	$1.77	$1.04	36.97%
Other Minnesota	$634	$231	$0.13	$0.05	$0.08	63.59%
Total: Minnesota	**$14,416**	**$8,917**	**$2.93**	**$1.81**	**$1.12**	**38.15%**
Mississippi						
Mississippi State University	$6,096	$3,791	$2.14	$1.33	$0.81	37.81%
University of Mississippi	$1,980	$1,267	$0.70	$0.45	$0.25	36.02%
Other Mississippi	$1,700	$1,539	$0.60	$0.54	$0.06	9.45%
Total: Mississippi	**$9,776**	**$6,597**	**$3.44**	**$2.32**	**$1.12**	**32.52%**

Appendix Table 3 (continued)	Mean 97-99 Expenditures Total	Federal	——Per Capita—— Total	Federal	Non-Federal	% Non-Federal
Missouri						
St Louis University	$546	$385	$0.10	$0.07	$0.03	29.46%
University of Missouri—Columbia	$6,066	$2,113	$1.08	$0.38	$0.71	65.16%
Washington University	$14,776	$11,727	$2.64	$2.10	$0.54	20.63%
Other Missouri	$4,491	$1,450	$0.80	$0.26	$0.54	67.73%
Total: Missouri	**$25,879**	**$15,675**	**$4.63**	**$2.80**	**$1.82**	**39.43%**
Montana						
Montana State University - Bozeman	$997	$717	$1.10	$0.79	$0.31	28.12%
Other Montana	$594	$494	$0.66	$0.55	$0.11	16.96%
Total: Montana	**$1,591**	**$1,210**	**$1.76**	**$1.34**	**$0.42**	**23.95%**
Nebraska						
University of Nebraska at Lincoln	$5,653	$1,710	$3.30	$1.00	$2.30	69.75%
Other Nebraska	$3,049	$602	$1.78	$0.35	$1.43	80.26%
Total: Nebraska	**$8,702**	**$2,311**	**$5.08**	**$1.35**	**$3.73**	**73.44%**
Nevada						
University of Nevada-Reno	$1,532	$910	$0.77	$0.46	$0.31	40.60%
Other Nevada	$1,556	$733	$0.78	$0.37	$0.41	52.91%
Total: Nevada	**$3,088**	**$1,643**	**$1.55**	**$0.82**	**$0.72**	**46.80%**
New Hampshire						
University of New Hampshire	$4,020	$2,879	$3.25	$2.33	$0.92	28.38%
Other New Hampshire (Dartmouth College)	$1,889	$1,510	$1.53	$1.22	$0.31	20.05%
Total: New Hampshire	**$5,909**	**$4,389**	**$4.78**	**$3.55**	**$1.23**	**25.72%**
New Jersey						
Princeton University	$8,095	$6,962	$0.96	$0.83	$0.13	13.99%
Rutgers	$9,078	$3,574	$1.08	$0.42	$0.65	60.63%
Other New Jersey	$4,286	$2,454	$0.51	$0.29	$0.22	42.75%
Total: New Jersey	**$21,458**	**$12,990**	**$2.55**	**$1.54**	**$1.01**	**39.46%**
New Mexico						
New Mexico State University	$4,629	$3,982	$2.54	$2.19	$0.36	13.99%
University of New Mexico	$10,245	$7,645	$5.63	$4.20	$1.43	25.37%
Other New Mexico	$1,950	$1,165	$1.07	$0.64	$0.43	40.28%
Total: New Mexico	**$16,824**	**$12,792**	**$9.25**	**$7.03**	**$2.22**	**23.97%**
New York						
Columbia University	$14,738	$11,938	$0.78	$0.63	$0.15	19.00%
Cornell University	$27,963	$15,718	$1.47	$0.83	$0.65	43.79%
New York University	$5,346	$3,527	$0.28	$0.19	$0.10	34.02%
Rensselaer Polytechnic Institute	$1,482	$1,170	$0.08	$0.06	$0.02	21.08%
Rockefeller University	$4,497	$1,292	$0.24	$0.07	$0.17	71.26%
SUNY at Albany	$1,641	$591	$0.09	$0.03	$0.06	63.95%
SUNY at Binghamton	$1,415	$538	$0.07	$0.03	$0.05	62.01%
SUNY at Buffalo	$2,116	$1,689	$0.11	$0.09	$0.02	20.20%
SUNY at Stony Brook	$6,303	$3,884	$0.33	$0.20	$0.13	38.38%
Syracuse University	$2,943	$776	$0.16	$0.04	$0.11	73.63%
University of Rochester	$14,053	$12,049	$0.74	$0.63	$0.11	14.26%
Yeshiva University	$5,818	$3,336	$0.31	$0.18	$0.13	42.66%
Other New York	$10,866	$6,167	$0.57	$0.32	$0.25	43.24%
Total: New York	**$99,180**	**$62,676**	**$5.23**	**$3.30**	**$1.92**	**36.81%**

Appendix Table 3 (continued)	Mean 97-99 Expenditures Total	Federal	Per Capita Total	Federal	Non-Federal	% Non-Federal
North Carolina						
Duke University	$11,865	$7,608	$1.47	$0.95	$0.53	35.88%
North Carolina State University at Raleigh	$15,183	$6,147	$1.89	$0.76	$1.12	59.51%
University of North Carolina at Chapel Hill	$7,450	$3,690	$0.93	$0.46	$0.47	50.48%
Other North Carolina	$6,030	$4,391	$0.75	$0.55	$0.20	27.18%
Total: North Carolina	**$40,529**	**$21,836**	**$5.04**	**$2.71**	**$2.32**	**46.12%**
North Dakota						
North Dakota State University	$1,733	$1,143	$2.70	$1.78	$0.92	34.05%
Other North Dakota (U.of North Dakota)	$1,244	$712	$1.94	$1.11	$0.83	42.75%
Total: North Dakota	**$2,977**	**$1,855**	**$4.64**	**$2.89**	**$1.75**	**37.68%**
Ohio						
Case Western Reserve University	$9,114	$4,742	$0.80	$0.42	$0.39	47.97%
Kent State University	$182	$113	$0.02	$0.01	$0.01	38.06%
Ohio State University	$14,931	$3,997	$1.32	$0.35	$0.96	73.23%
Ohio University	$1,368	$984	$0.12	$0.09	$0.03	28.07%
University of Cincinnati	$3,980	$1,278	$0.35	$0.11	$0.24	67.88%
Other Ohio	$10,009	$4,850	$0.88	$0.43	$0.45	51.55%
Total: Ohio	**$39,584**	**$15,963**	**$3.49**	**$1.41**	**$2.08**	**59.67%**
Oklahoma						
Oklahoma State University	$4,905	$1,547	$1.42	$0.45	$0.97	68.46%
University of Oklahoma	$6,724	$2,732	$1.95	$0.79	$1.16	59.36%
Other Oklahoma	$958	$403	$0.28	$0.12	$0.16	57.91%
Total: Oklahoma	**$12,588**	**$4,683**	**$3.65**	**$1.36**	**$2.29**	**62.80%**
Oregon						
Oregon State University	$4,084	$3,504	$1.19	$1.02	$0.17	14.18%
University of Oregon	$1,750	$1,636	$0.51	$0.48	$0.03	6.54%
Other Oregon	$3,044	$2,342	$0.89	$0.68	$0.21	23.05%
Total: Oregon	**$8,878**	**$7,483**	**$2.59**	**$2.19**	**$0.41**	**15.71%**
Pennsylvania						
Carnegie Mellon University	$11,561	$7,953	$0.94	$0.65	$0.29	31.21%
Lehigh University	$1,918	$1,172	$0.16	$0.10	$0.06	38.86%
Pennsylvania State University	$18,710	$8,751	$1.52	$0.71	$0.81	53.23%
Temple University	$1,973	$586	$0.16	$0.05	$0.11	70.30%
University of Pennsylvania	$10,635	$8,246	$0.87	$0.67	$0.19	22.46%
University of Pittsburgh	$5,355	$4,213	$0.44	$0.34	$0.09	21.33%
Other Pennsylvania	$7,728	$4,062	$0.63	$0.33	$0.30	47.44%
Total: Pennsylvania	**$57,880**	**$34,985**	**$4.71**	**$2.85**	**$1.86**	**39.56%**
Rhode Island						
Brown University	$3,021	$2,476	$2.88	$2.36	$0.52	18.03%
University of Rhode Island	$2,229	$1,913	$2.13	$1.83	$0.30	14.18%
Other Rhode Island (Providence College)	$12	$7	$0.01	$0.01	$0.00	41.49%
Total: Rhode Island	**$5,262**	**$4,396**	**$5.02**	**$4.19**	**$0.83**	**16.45%**
South Carolina						
Clemson University	$5,919	$1,820	$1.48	$0.45	$1.02	69.25%
University of South Carolina	$4,447	$3,020	$1.11	$0.75	$0.36	32.08%
Other South Carolina	$3,485	$1,783	$0.87	$0.44	$0.42	48.84%
Total: South Carolina	**$13,850**	**$6,623**	**$3.45**	**$1.65**	**$1.80**	**52.18%**

Appendix Table 3 (continued)	Mean 97-99 Expenditures Total	Federal	Per Capita Total	Federal	Non-Federal	% Non-Federal
South Dakota						
South Dakota State University	$653	$364	$0.87	$0.48	$0.38	44.26%
Other South Dakota	$753	$375	$1.00	$0.50	$0.50	50.25%
Total: South Dakota	**$1,407**	**$739**	**$1.86**	**$0.98**	**$0.88**	**47.47%**
Tennessee						
University of Tennessee	$8,483	$3,540	$1.49	$0.62	$0.87	58.27%
Vanderbilt University	$5,276	$4,373	$0.93	$0.77	$0.16	17.12%
Other Tennessee	$3,449	$2,255	$0.61	$0.40	$0.21	34.61%
Total: Tennessee	**$17,209**	**$10,168**	**$3.02**	**$1.79**	**$1.24**	**40.91%**
Texas						
Rice University	$2,990	$2,349	$0.14	$0.11	$0.03	21.42%
Texas A&M University	$19,335	$8,520	$0.93	$0.41	$0.52	55.94%
Texas Tech University	$3,750	$1,574	$0.18	$0.08	$0.10	58.03%
University of Houston	$3,920	$1,558	$0.19	$0.07	$0.11	60.26%
University of Texas at Austin	$13,933	$8,806	$0.67	$0.42	$0.25	36.79%
Other Texas	$38,445	$19,655	$1.84	$0.94	$0.90	48.87%
Total: Texas	**$82,373**	**$42,462**	**$3.95**	**$2.04**	**$1.91**	**48.45%**
Utah						
Brigham Young University	$788	$535	$0.35	$0.24	$0.11	32.12%
University of Utah	$9,319	$7,337	$4.17	$3.29	$0.89	21.28%
Utah State University	$1,553	$481	$0.70	$0.22	$0.48	69.00%
Total: Utah	**$11,661**	**$8,353**	**$5.22**	**$3.74**	**$1.48**	**28.37%**
Vermont						
University of Vermont	$2,695	$1,310	$4.43	$2.15	$2.27	51.40%
Other Vermont	$93	$57	$0.15	$0.09	$0.06	38.86%
Total: Vermont	**$2,788**	**$1,367**	**$4.58**	**$2.24**	**$2.33**	**50.98%**
Virginia						
University of Virginia	$7,840	$5,645	$1.11	$0.80	$0.31	28.00%
Virginia Commonwealth University	$2,206	$1,457	$0.31	$0.21	$0.11	33.92%
Virginia Polytechnic Institute and State Univ	$6,386	$2,683	$0.90	$0.38	$0.52	57.98%
Other Virginia	$5,011	$3,433	$0.71	$0.49	$0.22	31.48%
Total: Virginia	**$21,442**	**$13,219**	**$3.03**	**$1.87**	**$1.16**	**38.35%**
Washington						
University of Washington—Seattle	$28,925	$20,055	$4.91	$3.40	$1.50	30.67%
Washington State University	$539	$0	$0.09	$0.00	$0.09	100.00%
Other Washington	$755	$374	$0.13	$0.06	$0.06	50.47%
Total: Washington	**$30,220**	**$20,429**	**$5.13**	**$3.47**	**$1.66**	**32.40%**
West Virginia						
West Virginia University	$2,740	$1,756	$1.52	$0.97	$0.54	35.91%
Other West Virginia	$106	$64	$0.06	$0.04	$0.02	39.48%
Total: West Virginia	**$2,846**	**$1,820**	**$1.57**	**$1.01**	**$0.57**	**36.04%**
Wisconsin						
University of Wisconsin—Madison	$26,722	$14,112	$4.98	$2.63	$2.35	47.19%
University of Wisconsin—Milwaukee	$889	$374	$0.17	$0.07	$0.10	57.91%
Other Wisconsin	$2,415	$1,356	$0.45	$0.25	$0.20	43.86%
Total: Wisconsin	**$30,026**	**$15,841**	**$5.60**	**$2.95**	**$2.64**	**47.24%**

Appendix Table 3 (continued)	Mean 97-99 Expenditures Total	Federal	Per Capita Total	Federal	Non-Federal	% Non-Federal
Wyoming						
University of Wyoming	**$2,527**	**$679**	**$5.12**	**$1.37**	**$3.74**	**73.14%**
Total of All Academic Institutions	$1,316,226	$773,642	$4.68	$2.75	$1.93	41.22%

Appendix Table 4. What are some of the investments being made in university research centers in other states?

The following compilation is intended to serve as a set of example developments in other states for the purpose of stimulating the imagination. It is not a comprehensive listing, nor is it complete, nor necessarily the best possible collection of examples. It is, however, reflective of the stirring taking place nationally as states attempt to take command of their futures through targeted investments in their research universities.
The listing includes no entries for Alaska, Idaho, Kansas, Louisiana, Maine, Montana, Nebraska, North Dakota, South Dakota, Vermont, or Wyoming, simply because they are not related to the sample universe arbitrarily selected here (see page 25 for explanation of sampling).

Alabama

Auburn University *Center for Advanced Vehicle Electronics.* Collaboration with industry to develop and implement new technologies for packaging and manufacturing electronics, with special emphasis on the cost, harsh environment, and reliability requirements of the vehicle industry. (NSF/I-UCRC) (http://www.eng.auburn.edu/department/ee/cave/).

University of Alabama *Center for Materials for Information Technology.* Research on magnetic thin film and magnetic nanoparticle materials for ultra-high density information storage. (NSF/MRSEC) (http://bama.ua.edu/%7Emint/).

Arizona

Arizona State University *Center for High Pressure Materials*. Synthesize and characterize new materials in bulk and thin film form. (NSF/MRSEC) (http://mrsec.la.asu.edu).

University of Arizona and **Arizona State University** *Engineering Research Center for Environmentally Benign Semiconductor Manufacturing.* Develop science, technology, and educational methods for environmentally benign manufacturing of semiconductors. U of A is the lead institution, collaborating with Arizona State University, University of California at Berkeley, Cornell University, Massachusetts Institute of Technology (Lincoln laboratory), and Stanford University. (NSF/ERC) (http://www.nsf.gov/pubs/2000/nsf00137/nsf00137h.htm).

U of A *Center for the Management of Information.* Develop, test, and implement tools and methods to improve group outcomes, to enable private and public sector work groups to conduct teamwork around the clock, around the globe. (NSF/I-UCRC) (http://www.cmi.arizona.edu).

U of A (see **University of Oklahoma** *Center for Semiconductor Physics in Nanostructures*).

U of A *Center for Optoelectronic Devices, Interconnects, and Packaging.* Research design, fabrication, integration, and packaging of optoelectronic devices and optical interconnects. With the University of Maryland (NSF/I-UCRC) (http://www.ee.umd.edu/photonics/COEDIP.htm).

Arkansas

University of Arkansas *Center for Engineering Logistics and Distribution.* Provide integrated solutions to logistics problems, using modeling, analysis, and intelligent-systems technologies. (NSF/I-UCRC) (http://celdi.ineg.uark.edu).

U of A. (see **GIT** *Logistics Institute*).

California

California Institute of Technology *Center for Neuromorphic Systems Engineering.* Advance human-machine interfaces, smart products, and autonomous machines using neuromorphic technology, including neurobiology, biomimetics, optoelectronics, integrated micromechanical sensors and actuators, reconfigurable circuits, artificial neural network learning algorithms and architectures, event-driven communication, sensor-based feedback control theory, autonomous planning, and integration of learning and adaptation into algorithms and hardware. Facilities include 40,000 sq ft of the Gordon and Betty Moore Laboratory of Engineering, a $21 million state-of-the-art engineering facility; and two laboratories—a VSLI design lab and a vision processing lab—specifically intended for industrial collaborative projects. (NSF/ERC) (http://www.nsf.gov/pubs/2000/nsf00137/nsf00137p.htm).

CIT *Center for the Science and Engineering of Materials. Interdisciplinary research and education on advanced materials.* (NSF/MRSEC) (http://www.csem.caltech.edu).

Stanford University and **University of California-Davis** *Center for Polymer Interfaces and Macromolecular Assemblies.* University/industry partnership on organic thin films with applications in optical and electro-optical devices, lubrication, and adhesion. (NSF/MRSEC) (http://www.stanford.edu/group/CPIMA/).

Stanford University (see **U. Arizona** and **Arizona State U.** *Engineering Research Center for Environmentally Benign Semiconductor Manufacturing*). Develop science, technology, and educational methods for environmentally benign manufacturing of semiconductors. (NSF/ERC) (http://www.nsf.gov/pubs/2000/nsf00137/nsf00137h.htm).

University of California at Berkeley and **University of California at Davis** *Berkeley Sensor and Actuator Center.* Develop science, technology, and educational methods for environmentally benign manufacturing of semiconductors. (NSF/I-UCRC) (http://www-bsac.eecs.berkeley.edu/).

UCal Berkeley *Center for the Built Environment.* Technology of buildings, including new technologies to reduce energy use, improve environmental quality, enhance occupant comfort, and increase productivity, sensor technology for operating buildings. (NSF/I-UCRC) (http://www.cbe.berkeley.edu).

UCal Berkeley (see **U. Hawaii** MarBEC).

UCal Berkeley (see **North Carolina State University** *Silicon Wafer Engineering and Defect Science Center*).

UCal Berkeley (see **U. Arizona** and **Arizona State U.** *Engineering Research Center for Environmentally Benign Semiconductor Manufacturing*).

University of California at Davis (see **NCSU** *Center for Advanced Processing and Packaging Studies*).

University of California at Irvine *Center for Research on Information Technology and Organizations.* Theoretical and empirical research on use, impact, and management of information technology in organizations. Focus on improving ability of organizations to use information technology effectively, emphasizing E-Commerce; User Environments and Product Design; IT Enabled Enterprises; Management of IT; and Globalization of IT. (NSF/I-UCRC) (http://www.crito.uci.edu).

University of California at Santa Barbara *Center for the Science and Engineering of Materials.* To investigate chemically and structurally complex materials, with emphasis on interfaces between organic and inorganic materials, and on deformation, failure, and structural reorganization of complex materials. (NSF/MRSEC) (http://www.mrl.ucsb.edu).

University of Southern California (see **U. of Buffalo** and **Cornell** *Multidisciplinary Center for Earthquake Engineering Research*).

University of Southern California *Integrated Media Systems Center.* Integrate digital video, audio, text, animation and graphics. Facilities include >100 computers and servers in distributed clusters connected by high-speed asynchronous transfer mode links, sophisticated audio facilities, computing and electronic research facilities. (NSF/ERC) (http://www.nsf.gov/pubs/2000/nsf00137/nsf00137t.htm).

Colorado

University of Colorado at Boulder *Center for Advanced Manufacturing and Packaging of Microwave, Optical and Digital Electronics.* Research and education on CAD methodologies and tools, packaging, and manufacturing technologies to integrate microwave/millimeter-wave, high-speed digital, optical electronics, and MEMS. (NSF/I-UCRC) (http://mems.colorado.edu).

UC Boulder *Membrane Applied Science and Technology Center.* Research and development of membrane technology in separation processes. With University of Colorado. (NSF/I-UCRC) (http://www.colorado.edu/che/mast and http://www.mastcenter.org).

UC Boulder *Ferroelectric Liquid Crystal Materials Research Center.* Basic and applied research on the phases, structures, and electro-optics of liquid crystals focusing on the roles of chirality and polarization in liquid crystal behavior. (NSF/MRSEC) (http://flcmrc.colorado.edu).

University of Colorado at Denver (see **The University of Iowa** *Photopolymerizations Center*).

Connecticut

University of Connecticut (see **Purdue University** *Center for Pharmaceutical Processing Research*).

Delaware

University of Delaware (see **U. of Buffalo** and **Cornell** *Multidisciplinary Center for Earthquake Engineering Research*).

Florida

University of Florida *Engineering Research Center for Particle Science and Technology.* Develop innovative particulate-based systems for next-generation processes and devices using particulate processes. (NSF/ERC) (http://www.nsf.gov/pubs/2000/nsf00137/nsf00137h.htm).

(See also, App. Table 5, U of F, *Interdisciplinary Center for Biotechnology Research (ICBR)*)

University of Miami (see **SUNY Buffalo** *Center for Biosurfaces*).

Georgia

Georgia Institute of Technology *Packaging Research Center.* Next-generation microsystem packaging needs for computers, telecommunications, automotive, and consumer electronics. (NSF/ERC) (http://www.nsf.gov/pubs/2000/nsf00137/nsf00137q.htm).

GIT *Logistics Institute*. Logistics research, education, and practice, emphasizing supply chain design, transportation planning, and e-commerce logistics). (NSF/I-UCRC) (http://tli.isye.gatech.edu/).

GIT (see **Northwestern University** *Center for Surface Engineering and Tribology*).

GIT and **Emory University** *Center for the Engineering of Living Tissues.* Develop technology for organ transplants and tissue-engineering. New facility includes the $30 million 150,000 sq ft Parker H. Petit Institute for Bioengineering and Bioscience building at Georgia Tech, and a 7000 sq ft vivarium. (NSF/ERC) (http://www.gtec.gatech.edu/).

Hawaii

University of Hawaii and **University of California at Berkeley** *Marine Bioproducts Engineering Center (MarBEC).* Integrate marine bioproduct discovery and technology development for large-scale cultivation of marine microorganisms and processing of these products. (NSF/ERC) (http://www.nsf.gov/pubs/2000/nsf00137/nsf00137c.htm).

Illinois

Illinois Institute of Technology *Thermal Processing Technology Center.* Thermal processing technology in materials processing and manufacturing. (NSF/I-UCRC) (http://mmae.iit.edu/~tptc).

Northwestern University (see **Vanderbilt University** *ERC in Bioengineering Ed. Tech.*). Northwestern facilities include 16,000 sq ft including 1700 for instruction and fully equipped labs for biomedical engineering research.

Northwestern University *Materials Research Center.* Interdisciplinary research on materials, emphasizing the nanoscale (NSF/MRSEC) (http://mrcemis.ms.nwu.edu).

Northwestern University and the **Georgia Institute of Technology** *Center for Surface Engineering and Tribology.* Research on basic phenomena of contacting surfaces in relative motion, with applications in heavy machinery, automotive products, railroad, lubricants, agricultural and earth moving equipment, metal processing, electronic and data processing, aerospace, chemicals, and coatings. (NSF/I-UCRC) (http://cset.tech.nwu.edu/).

University of Chicago *Materials Center.* Address fundamental issues of materials and condensed matter science, to links industrial firms with science and business students to solve specific problems presented by new products or processes. (NSF/MRSEC) (http://MRSEC.uchicago.edu/MRSEC/).

University of Illinois at Urbana-Champaign *Center for Machine-Tool Systems Research.* Develop innovative machine-tool concepts and systems and improve use of existing machine tools through increased understanding and modeling of machining processes, with a goal of marked improvement of national manufacturing competitiveness through the deployment of advanced machine-tool systems. (NSF/I-UCRC) (http://mtamri.me.uiuc.edu/cmtsr.home.html).

U of Ill at Urbana-Champaign *Air Conditioning and Refrigeration Center*. Develop energy-efficient equipment that uses ozone-safe refrigerants. (NSF/I-UCRC) (http://acrc.me.uiuc.edu).

Indiana

Purdue University and **University of Connecticut** *Center for Pharmaceutical Processing Research.* Improve manufacture of pharmaceutical dosage forms to influence quality of pharmaceutical products, explore technology to improve product quality or decrease cost, develop and implement improved process monitoring methods, foster interdisciplinary pharmaceutical processing research, and catalyze scientific interaction between scientists and the pharmaceutical industry. (NSF/I-UCRC) (http://www.pharmacy.purdue.edu).

Iowa

Iowa State University *Center for Nondestructive Evaluation.* Non-invasively determine the integrity of a material component or structure, develop nondestructive evaluation as an engineering tool applicable throughout the life cycle of a structural component, with application in aviation, transportation, energy, manufacturing—to solve agricultural, biomedical, and food processing problems. (NSF/I-UCRC) (http://www.cnde.iastate.edu).

The University of Iowa and **University of Colorado** *Photopolymerizations Center.* Research on kinetics and mechanisms of photopolymerizations. (NSF/I-UCRC) (http://css.engineering.uiowa.edu/~cfap/).

The University of Iowa and **University of Texas at Austin** *Center for Virtual Proving Ground Simulation: Mechanical and Electromechanical Systems.* Virtual proving grounds for vehicle and equipment product development. (NSF/I-UCRC) (http://wash.nads-sc.uiowa.edu/).

Kentucky

University of Kentucky *Advanced Carbon Materials Center.* Research on synthesis and characterization of carbon nanotubes, fullerines, carbon fibers, pitches and their applications as polymers and composites in devices, structural materials, adsorbents and catalysts. (NSF/MRSEC) (http://www.mrsec.uky.edu).

Maryland

University of Maryland, College Park and **Rutgers University.** *Center for Oxide Thin Films, Probes and Surfaces.* Research on the dynamics of ferroelectric thin films and surface nanostructures, and with the properties of highly spin-polarized magnetic oxides. (NSF/MRSEC) (http://mrsec.umd.edu/).

University of Maryland (see **U of Arizona** *Center for Optoelectronic Devices, Interconnects, and Packaging*).

The Johns Hopkins University, Carnegie Mellon University, and **the Massachusetts Institute of Technology** *Computer-Integrated Surgical Systems and Technology Engineering Research Center.* A novel partnership between human surgeons and machines to overcome many of the limitations of traditional surgery. (NSF/ERC) (http://www.nsf.gov/pubs/2000/nsf00137/nsf00137d.htm).

The Johns Hopkins University *Center on Nanostructured Materials.* Fundamental research on magnetic nanostructures, featuring materials synthesis with nanometer structural control, advanced characterization techniques, and theoretical studies. (NSF/MRSEC) (http://www.pha.jhu.edu/groups/mrsec/main.html).

Massachusetts

Boston University (see **Northeastern University** *Center for Subsurface Sensing and Imaging Systems*).

Harvard University / MIT (see **Vanderbilt University** *ERC in Bioengineering Ed. Tech.*). Harvard facilities include "an exceptionally broad array of research and instructional facilities at both MIT and Harvard."

Harvard University *Materials Research Center.* Research on interfaces between synthetic and biological systems, electronic microsystems, and micromechanical systems. (NSF/MRSEC) (http://www.mrsec.harvard.edu/).

Massachusetts Institute of Technology *Biotechnology Process Engineering Center.* Research on advanced biological technologies—focused on protein and nucleic acid therapeutics—through interdisciplinary integration of molecular and cell biology with process engineering. (NSF/ERC) (http://www.nsf.gov/pubs/2000/nsf00137/nsf00137e.htm).

MIT and the **Brigham and Women's Hospital (see Johns Hopkins Univ.** *Computer-Integrated Surgical Systems &Technology Engineering Research Center*).

MIT (see **U. Arizona** and **Arizona State U.** *Engineering Research Center for Environmentally Benign Semiconductor Manufacturing*).

MIT *Center for Materials Science and Engineering.* Interdisciplinary fundamental materials research with broad potential for technological applications. (NSF/MRSEC) (http://web.mit.edu/cmse/www).

MIT *Center for Innovation in Product Development.* Research on product development infrastructure to succeed in a global marketplace; interdisciplinary between MIT's School of Engineering and the Sloan School of Management. (NSF/ERC) (http://www.nsf.gov/pubs/2000/nsf00137/nsf00137k.htm).

Northeastern University, Rensselaer Polytechnic Institute and **Boston University** *Center for Subsurface Sensing and Imaging Systems.* Research to detect and image biomedical and environmental-civil objects or conditions that are underground, underwater, or embedded within cells or inside the human body. Facilities on four partner campuses and affiliates. (NSF/ERC) (http://www.nsf.gov/pubs/2000/nsf00137/nsf00137s.htm).

University of Massachusetts, Amherst *Center for Polymer Science and Engineering.* Research on polymer science and engineering, emphasizing controlled interfacial interactions, polymers in supercritical fluids, polymer architecture, and synthesis. (NSF/MRSEC) (http://www.pse.umass.edu/mrsec/).

Michigan

Eastern Michigan University (see **The University of Southern Mississippi** *Cooperative Research Center in Coatings*).

The University of Michigan *Engineering Research Center for Reconfigurable Machining Systems*. Research to design systems, machines, and controls for cost-effective, rapid response to changes in market demand and products. (NSF/ERC) (http://www.nsf.gov/pubs/2000/nsf00137/nsf00137l.htm).

The University of Michigan (see **University of Wisconsin at Milwaukee** *Center for Intelligent Maintenance Systems*).

The University of Michigan, Michigan State University, and **Michigan Technological University** *Center for Wireless Integrated MicroSystems.* Develop low-cost integrated microsystems to measure or controll physical parameters, interpreting data and communicating with a host system over a bi-directional wireless link. With Michigan State University and Michigan Technological University. Facilities include state-of-the-art facility for fabrication of microsystems and devices, a Class 10/100 solid-state fabrication facility at U of M, facilities for new materials (e.g., diamond) at MSU, and capabilities for non-lithographic material processing and high-resolution micromilling at MT (NSF/ERC) (http://www.nsf.gov/pubs/2000/nsf00137/nsf00137r.htm).

Michigan State University *Center for Sensor Materials for Control and Diagnostics.* Research on sensor materials and sensing technology, with the automotive industry. (NSF/MRSEC) (http://www.pa.msu.edu:80/csm).

Minnesota

University of Minnesota *Materials Research Science and Engineering Center.* Develop hybrid materials—produced by arranging multiple components into composite structures to achieve applications that are otherwise unattainable—including microstructured polymers, artificial tissue, magnetic heterostructures, and porous materials. (NSF/MRSEC) (http://www.mrsec.umn.edu).

Mississippi

The University of Southern Mississippi *Cooperative Research Center in Coatings.* Research on technology of polymeric coatings and paints (NSF/I-UCRC) (http://www.psrc.usm.edu/NSFIUCRC).

Missouri

Life Science Research. In June Governor Holden signed an executive order committing $21.5 million of thestate's tobacco settlement funds for biotech research during fiscal year 2002. The order directs the State Office of Administration to administer the funds through the Life Sciences Research Committee, composed of the commissioner of administration, and seven members appointed by the governor. Funds can support development and clinical research including aging, endocrine, cardiovascular and neurological work, nerve regeneration, pulmonary, diagnostic disease and infectious disease, and nutrition and food safety (SSTI 7/13/01).

Biomed Research. James Stower Jr., founder of American Century mutual funds, and his wife are donating $1.114 billion to the Stowers Institute of Medical Research in Kansas City. The donation is one of the five largest philanthropic gifts in history. The Institute, opened last November after completion of the $200 million campus, is engaged in basic research toward long-term solutions for gene-based diseases such as cancer and diabetes (SSTI, 5/18/01).

Nevada

University of Nevada (see **U. of Buffalo** and **Cornell** *Multidisciplinary Center for Earthquake Engineering Research*).

New Hampshire

University of New Hampshire *Biomolecular Interaction Technologies Center.* Research to develop advanced technologies for characterizing protein molecular interactions. (NSF/I-UCRC) (http://BITC.unh.edu).

New Jersey

New Jersey Institute of Technology *Hazardous Substance Management Research Center*. Research on management of hazardous substances. Cooperators include **Princeton University, Rutgers University, Stevens Institute of Technology,** and **the University of Medicine and Dentistry of New Jersey** (NSF/I-UCRC) (http://www.hsmrc.org).

NJ Institute of Technology (see **Rensselaer Polytechnic Institute** *Center for Next Generation Video*).

Princeton University *Center for Complex Materials.* Research to synthesize and characterize mesoscopically structured, complex materials, emphasizing low-dimensional electronic materials, macromolecular soft materials, organic thin films and photonic devices, and bioinspired composites. (NSF/MRSEC) (http://www.princeton.edu/%7Epccm/).

Rutgers *Center for Quality and Reliability Engineering.* Research and development models and prototypes for evaluating system performance and for improving the quality and reliability of components, products, and systems. (NSF/I-UCRC) (http://coewww.rutgers.edu/ie/qre).

Rutgers (see **University of Maryland, College Park** *Center for Oxide Thin Films, Probes and Surfaces*).

Rutgers (see **University of New Mexico** *Ceramic and Composite Materials Center*).

New Mexico

University of New Mexico and **Rutgers University** *Ceramic and Composite Materials Center.* Interdisciplinary technologies in ceramic science and engineering, emphasizing polymer/ceramic composite materials for advanced, high-performance systems. (NSF/I-UCRC) (http://www.unm.edu/~ccmc/).

New York

Columbia University *Center for Advanced Studies in Novel Surfactants,* Research to establish structure-property relationships of surface-active molecules—including oligomeric and polymeric surfactants as well as bio-molecules—and to develop and characterize novel surfactants for industrial applications such as coatings, dispersions, deposition, gas hydrate control, personal care products, soil decontamination, waste treatment, corrosion prevention, flotation, and controlled chemical reactions. (NSF/I-UCRC) (http://www.columbia.edu/cu/iucrc/).

Columbia University *Mixed Organic/Inorganic Materials.* To address the science and technology of heterogeneous thin films formed by arrays of inorganic nanocrystals within polymeric or organic media. (NSF/MRSEC) (http://research.radlab.columbia.edu/mrsec/).

Cornell University *Power Systems Engineering Research Center.* Research on design of a high-performance electric-power system that will be more efficient, more responsive, and more environmentally acceptable than today. Project involves **Arizona State University, University of California at Berkeley, Carnegie-Mellon University, Colorado School of Mines, Georgia Institute of Technology, University of Illinois at Urbana/Champaign, Iowa State University, Texas A&M University,** and **Washington State University** (NSF/I-UCRC) (http://www.pserc.wisc.edu).

Cornell University (see **U. Arizona** and **Arizona State U.** *Engineering Research Center for Environmentally Benign Semiconductor Manufacturing*). Cornell facilities include the Cornell Nanofabrication Facility (clean room facilities for lithographic processing); the Cornell Center for Materials Research (Ion Beam Facility for Rutherford Backscattering Spectrometry studies); and the Advanced Electronic Packaging Facility (houses supercritical fluid chamber for CO_2 development).

Cornell University *Center for Materials Research.* Research on ordered and disordered materials at the nanoscale in order to achieve control at these length scales for a variety of applications. (NSF/MRSEC) (http://www.msc.cornell.edu/).

Polytechnic University (Brooklyn) *Center for Biocatalysis and Bioprocessing of Macromolecules.* Research on enzyme transformations related to polymer technology, biocatalysis and bioprocessing and their impact on business strategies (NSF/I-UCRC) (http://chem.poly.edu/gross/)

Rensselaer Polytechnic Institute *Center for Next Generation Video.* Research in the communication, transmission, storage, retrieval, and processing of digital video and multimedia including digital image processing, compression, transmission and reception, networked video and high-speed switching, multimedia storage, retrieval, and security. (NSF/I-UCRC) (http://www.rpi.edu/web/CDVMR).

Rensselaer Polytechnic Institute (see **Northeastern University** *Center for Subsurface Sensing and Imaging Systems*).

Rensselaer Polytechnic Institute (see **Virginia Polytechnic Institute and State University** *Center for Power Electronics Systems*).

SUNY Buffalo *Center for Biosurfaces*. Research to understand, predict, and control the interactions of living cells and biological matter with other materials. (NSF/I-UCRC) (http://wings.buffalo.edu/faculty/research/iucb/).

SUNY Stony Brook *Center for Novel Materials by Thermal Spray* Research on thermal spray coatings, emphasizing theoretical and experimental processing and characterization of functional deposits with coupled mechanical/electrical and mechanical/magnetic properties. (NSF/MRSEC) (http://doL1.eng.sunysb.edu/tsl/ctsr/).

SUNY Stony Brook (with **CUNY** and **Polytechnic University** *Center for Polymers at Engineered Interfaces* is a collaboration between SUNY Stony Brook, the City University of New York, Polytechnic University and several other academic and industrial partners. The focus is on the design of polymer properties on macroscopic and microscopic length scales through precise control of interfacial structure (NSF/MRSEC) (http://polymer.matscieng.sunysb.edu).

SUNY Stony Brook (see **Washington State University** *Center for Design of Analog-Digital Integrated Circuits*).

University of Buffalo and **Cornell University** *Multidisciplinary Center for Earthquake Engineering Research.* Research to reduce earthquake losses and help communities to be prepared and resilient when faced with earthquakes. (NSF/ERC) (http://www.nsf.gov/pubs/2000/nsf00137/nsf00137m.htm).

Other New York:

Photonics Center. In what could be the largest private sector commitment yet to a single industry/university research center, Corning, Kodak ,and Xerox have combined to pledge $45 million toward establishing a **Center of Excellence in Photonics and Optoelectronics** in Rochester, N.Y. and they have committed to help raise another $30 million from other private sector companies for the new partnership involving New York State, higher education, and private enterprise. University partners include the **University of Rochester, the Rochester Institute of Technology, SUNY Albany, Rensselaer Polytechnic Institute, Alfred University,** and **Cornell University**. The partners hope to position New York as a national leader in optoelectronics-related R&D and job growth, emulating Silicon Valley's emergence as a hub for the semiconductor industry. More than 91,000 New York residents already are employed in the optoelectronics and imaging industry fields, about 13 percent of the national total. The center will focus on creating technology transfer and pilot fabrication facilities for high resolution imaging and ultra-fast communications devices that can be shared by Center partners to accelerate product development. The use of light to transfer energy and information is making ever-faster and smaller devices possible, with wide applicability from medicine to telecommunications.

As part of his 2001-02 Executive Budget, Governor Pataki proposed $283 million over five years to provide state support and matching funds to critical private sector and federal investments in emerging high technology fields such as photonics. The state funds are expected to leverage approximately three times their value in federal and private funds (SSTI, 2/16/01).

North Carolina

North Carolina State University and **University of California—Berkeley** *Silicon Wafer Engineering and Defect Science Center.* Research on critical non-competitive science and technology issues the international silicon materials industry requires to meet the future needs of advanced integrated circuit manufacturing. (NSF/I-UCRC) (http://www.mse.ncsu.edu/siweds).

NCSU and **Duke University** *Center for Advanced Computing and Communication.* Research on leading-edge complex, fault-tolerant, and distributed computing systems using photonics, pervasive computing, and wired and wireless elements. (NSF/I-UCRC) (http://www.cacc.ncsu.edu).

NCSU *Center for Integrated Pest Management*. Development of pest management programs based on pest biology, monitoring tools, and control technology. (NSF/I-UCRC) (http://ipmwww.ncsu.edu/cipm/).

NCSU, Ohio State University and **University of California—Davis** *Center for Advanced Processing and Packaging Studies.* Research on safe production of marketable, high-quality aseptic and refrigerated extended shelf-life products. (NSF/I-UCRC) (http://www.ncsu.edu/ncsu/CIL/CAPPS/capps.html).

North Carolina A&T State University (see **Virginia Polytechnic Institute and State University** *Center for Power Electronics Systems*).

University of North Carolina at Charlotte *Center for Precision Metrology*. Research on precision methods of inspection in manufacturing, the metrology of both inspection and production machines, measurement algorithms and tolerance representation, and the integration of metrology into factory quality systems (NSF/I-UCRC) (http://www.uncc.edu/cpm).

Ohio

The Ohio State University *Center for Advanced Polymer and Composite Engineering*. Research on polymer and composite manufacturing and design technologies. (NSF/I-UCRC) (http://www.capce.ohio-state.edu/).

OSU (see **NCSU** *Center for Advanced Processing and Packaging Studies*).

University of Cincinnati (see **UC Boulder** *Membrane Applied Science and Technology Center*).

Oklahoma

Oklahoma State University (see **University of Tennessee** *Measurement and Control Engineering Center*).

University of Oklahoma *Center for Semiconductor Physics in Nanostructures.* Research on semiconductor nanostructure science and applications (NSF/MRSEC) (No URL).

University of Oklahoma *Center for the Study of Wireless Electromagnetic Compatibility.* Research in the use of cellular phones, personal communication devices, pagers, and other wireless products and their compatibility with other electronic devices. (NSF/I-UCRC) (http://www.ou.edu/engineering/emc/).

University of Oklahoma (see **University of Arkansas** *Center for Engineering Logistics and Distribution*).

Oregon

Oregon State University *Tree Genetic Engineering Research Cooperative.* Develop genetic technologies with application to forest industries. (NSF/I-UCRC) (http://www.fsl.orst.edu/tgerc/).

OSU (see **Washington State University** *Center for Design of Analog-Digital Integrated Circuits*).

Pennsylvania

Carnegie Mellon University *Center for Building Performance and Diagnostics*. Research, development, and demonstrations to increase the quality of and user satisfaction with commercial buildings and integrated building systems, while improving cost, time, and energy-efficiency. (NSF/I-UCRC) (http://www.arc.cmu.edu/cbpd/).

Carnegie Mellon University *Materials Research Science and Engineering Center*. Research on science and engineering of grain boundaries in polycrystalline solids, to predict how networks of intergranular interfaces evolve and determine device properties. (NSF/MRSEC) (http://mimp.mems.cmu.edu/).

Carnegie Mellon University (see Johns Hopkins Univ. *Computer-Integrated Surgical Systems & Technology Engineering Research Center*).

The Pennsylvania State University *Center for Porous Hosts.* Research on molecular, photonic and electronic effects that emerge in nanometer-scale porous systems of 1-, 1- and 3-dimensional connectivity. (NSF/MRSEC) (http://www.mrsec.psu.edu).

The Pennsylvania State University *Particulate Materials Center*. tResearch on production of powders and manufacturing with particulate materials, emphasis on colloidal and interfacial chemistry, electrophoretic deposition, nanomaterials, powder mechanics, sinter systems, solution synthesis, and spray formation. (NSF/I-UCRC) (http://www.mrl.psu.edu/sitepages/research/centers/pmc.html).

Villanova University *Center for Advanced Communications.* Focus on wireless, mobile, and broadband communications (NSF/I-UCRC) (www.cac.villanova.edu).

University of Pennsylvania *Laboratory for Research on the Structure of Matter* supports a broad interdisciplinary research program on complex nanostructures and materials (NSF/MRSEC) (http://www.lrsm.upenn.edu/).

Other Pennsylvania

Life Sciences Research. Pennsylvania's plan for its $11 billion share of the national tobacco settlement includes $160 million in one-time outlays for research and commercialization of life science technologies and a formula ensuring research gets nearly one-fifth of the total money received over the 25-year span of the settlement agreement. The plan includes a one-time payment of $100 million for three Life Science Greenhouses, modeled on the Pittsburgh Digital Greenhouse initiative launched two years ago. The Life Science Greenhouses will be a network of innovation centers based at research universities in Philadelphia, Pittsburgh and Central Pennsylvania. Nineteen percent of the money each year – more than $65 million in the first year – will support innovative health-related university and medical institute research (SSTI, 6/29/01).

Rhode Island

Brown University *Micro-and Nanomechanics of Electronic and Structural Materials.* Research to overcome mechanics of materials limitations to the development of the next generation of electronic and structural materials.(NSF/MRSEC)(http://www.brown.edu/Departments/Advanced_Materials_Research/MRSEC).

South Carolina

Clemson University *Center for Advanced Engineering Fibers and Films*, Develop technologies and specialists in control of structure in polymeric fibers and films by developing a science base, computational models that integrate molecular information with continuum or microscopic-level models, and advanced visualization tools. (NSF/ERC) (http://www.nsf.gov/pubs/2000/nsf00137/nsf00137i.htm).

Tennessee

University of Louisville (see **University of Arkansas** *Center for Engineering Logistics and Distribution*).

University of Tennessee and **Oklahoma State University**. *Measurement and Control Engineering Center*, Research on measurement and control technology, serving as a national center for research and teaching in these technologies. (NSF/I-UCRC) (http://mcec.engr.utk.edu/).

Vanderbilt University and **Arizona State University**, **Harvard University**, and **Northwestern University** *Engineering Research Center in Bioengineering Educational Technologies*. Develop integrated, time-tested educational materials on bioengineering for a diverse student population, merging physics, mathematics, and engineering science with biology. (NSF/ERC) (http://www.nsf.gov/pubs/2000/nsf00137/nsf00137f.htm).

Texas

Texas A&M University *Center in Ergonomics.* To determine causes of work-related musculoskeletal disorders, to identify effective interventions, and to identify emerging technologies and issues related to these disorders. (NSF/I-UCRC) (http://ergo-center.tamu.edu).

University of Houston *Center for Advanced Oxides and Related Materials* Research on new materials for fuel cells, catalytic reactors, and membrane reactors. Emphasis is on the bulk properties, surface structure and reactivity of oxides (NSF/MRSEC) (http://www.uh.edu/mrsec).

University of Texas at Austin (see **Vanderbilt University** *ERC in Bioengineering Ed. Tech.*).

U of T at Austin (see **The University of Iowa** *Center for Virtual Proving Ground Simulation: Mechanical and Electromechanical Systems*).

Utah

Centers of Excellence. Since 1986 the Utah Centers of Excellence Program (COEP) has awarded $30.7 million in state funding to Utah universities and colleges for applied R&D focused on the development of technologies which have the potential for economic development in the state. That funding has generated cumulative matching funds from private and federal sources of $332.7 million, resulting in a matching fund ratio of 10.8 to 1.

Faculty at the Centers have filed for 101 patents and issued 175 licensing agreements with businesses; 985 companies have been assisted through the centers; 132 technology companies created through the program today employ >1,300; 75 Centers of Excellence have been created: 44 of these have graduated; 7 are Distinguished Centers for their impact. (SSTI, 1/20/00).

Virginia

Old Dominion University *Center for Lasers and Plasmas for Advanced Manufacturing,* Research onlaser and plasma processing of materials, devices, and systems. (NSF/I-UCRC) (http://www.arc.odu.edu).

University of Virginia *Center for Nanoscopic Materials Design.* Research on guided growth processes of semiconductor surfaces to assemble highly perfected nanoscale structures for applications in quantum dot electronics, biological templating, and nanoscale control of electrochemical reactions. (NSF/MRSEC) (http://www.mrsec.virginia.edu).

Virginia Polytechnic Institute and State University *Center for Power Electronics Systems*. An integrated systems approach to engineering equipment to convert electrical power from one form to another. (NSF/ERC) (http://www.nsf.gov/pubs/2000/nsf00137/nsf00137u.htm).

Washington

University of Washington *Engineered Biomaterials Engineering Research Center.* Research to develop a new generation of biomaterials that exploit specific biological recognition mechanisms, designed so that upon implantation they will heal in the body in a facile, normal manner. (NSF/ERC)(http://www.nsf.gov/pubs/2000/nsf00137/nsf00137g.htm).

University of Washington *Center for Health Management Research.* Research on health care costs, lack of health insurance, and health care delivery. Project involves 15 universities, including **Arizona State University, University of California at Berkeley, University of California at Los Angeles, University of Colorado at Denver, University of Southern California, University of Washington, San Diego State University, Northwestern University, Ohio State University, University of Michigan, University of Missouri, University of North Carolina, The University of Penn-**

sylvania, University of Toronto, and **Virginia Commonwealth University** (NSF/I-UCRC) (no URL).

Washington State University *Center for Design of Analog-Digital Integrated Circuits.* Research on analog-digital integrated circuits and systems. The Center is a consortium of four universities (**WSU, University of Washington, Oregon State University,** and **State University of New York at Stony Brook**) and approximately 30 industry partners (NSF/I-UCRC) (http://www.eecs.wsu.edu/CDADIC).

West Virginia

West Virginia University *Center for Identification Technology Research.,* Research and development on use of automated biometric systems for human identification. (NSF/I-UCRC) (http://www.csee.wvu.edu/citer).

Wisconsin

University of Wisconsin at Madison *MRSEC on Nanostructured Materials and Interfaces.* Research on the detailed formation, characterization, and exploitation of nanoscale materials. (NSF/MRSEC) (http://mrsec.wisc.edu/).

University of Wisconsin at Madison (see **Virginia Polytechnic Institute and State University** *Center for Power Electronics Systems*).

University of Wisconsin at Milwaukee and **University of Michigan** *Center for Intelligent Maintenance Systems*. Research to reduce breakdowns of product and system through advancements in internet-based intelligent performance-degradation monitoring and proactive maintenance technologies, including innovations in machine performance degradation and reliability assessment, prognostics & diagnostics, smart service NetWare and agent, and self-maintenance intelligence. (NSF/I-UCRC) (http://www.uwm.edu/CEAS/IMS/).

...and nearby

Quebec has committed $250 Million for a new biotech-opolis in Quebec to serve as one of the best organized business centers for biotech, biopharmaceutical, and biocomputer companies in the world, government leaders hope. The Quebec government, Investissement Quebec, the City of Laval, *Laval Technopole* and *Institut national de la recherche re scientifique* (INRS), are investing $250 million over five years in cash, in-kind donations, and forgone tax revenues to support the project. The City of Biotechnology and Human Health of Metropolitan Montreal, or Biotech City for short, will function as a business and science center, with more than $100 million alone coming from INRS to equip the city with major scientific facilities and to restructure the INRS's Armand-Frappier campus. Biotech City's ~11 million sq. ft. in the Laval Science and High Technology Park will house numerous centers for research, learning, commercial and new business development, and will accommodate biotech and biopharmaceutical companies.

Appendix Table 5. What are some of the investments being made in university-affiliated business incubators, or science and technology parks in other states?

Alabama

University of Alabama—Birmingham *Office for the Advancement of Developing Industries.* Professional services, including business plans, marketing strategy, and to proprietary rights, with links to accounting, insurance, payroll and legal firms offering discounted rates to start-up companies within the incubator. The Office runs a 100 acre Oxmoor Research Parkand a Technology Center, a 67,000 sq ft facility with 20,000 sq ft of offices and 20,000 sq ft of laboratories. (www.uab.edu/oadi/).

Auburn University: —

Alaska

University of Alaska—Fairbanks: —

Arizona

Arizona State University *Research Park.* Collaborative educational opportunities, use of university equipment by research park corporations, joint research projects for new product development. Exchanges of products and lecture time to the university from research park corporations and the hiring of ASU graduates and interns. Formed in the mid 1980s. It features several large corporations with high square footage on large acreage (e.g., Motorola Labs (275,000 sq ft, 38 acres); Philips (140,000 sq ft, 14 acreage); Edward Jones (128,000 sq ft, 18.4 acres), with over 1.5 million total square feet and over 170 acres. (http://researchpark.asu.edu/).

University of Arizona *Science and Technology Park.* A premier research and development facilities, to foster technology development from laboratory to marketplace. Started in 1994, the Park is now the 6th-largest U.S. university-related research park in occupancy and jobs (>6,000 employees on site). Facility has 1,345 acres, >30 businesses, and 1.8 million sq ft of fully occupied leased space, with plans for a 600,000 sq ft expansion ~ 90% of tenants employ U of A graduates, >half use U of A students as interns, and >half have research partnerships with the University. (See also www.uatechpark.org). (www.enet-tucson.com/ResearchPark/index.htm/).

Arkansas

University of Arkansas *Genesis.* Started in 1986; houses 10 small startups and 3 "member firms;" lists 13 graduated firms. New facilities are located in the Engineering Research Center.

California

California Institute of Technology: — Note: Caltech is a small, private, coeducational university dedicated to exceptional instruction and research in engineering and science. The student body is composed of 900 undergraduate and 1,100 graduate students who maintain a high standard of scholarship and intellectual achievement. With an outstanding faculty — including several Nobel laureates — and such off-campus facilities as the Jet Propulsion Laboratory (which CalTech manages for NASA), Palomar Observatory, and the W. M. Keck Observatory, Caltech is one of the world's major research centers.

Stanford University *Research Park.* Opened in 1951, the first of its kind in the U.S.. 700 acres; 10 million sq. ft in 162 buildings; 162 companies with 23,000 employees. Predominantly scientific, technical and research oriented industries with major representation in electronics, space, biotechnology, computer hardware and software. (www.stanford.edu/dept/SMC/researchpark/).

University of California—Berkeley: —UCal—Davis *Technology Campus* (under development) (www.davistech.com)

UCAL—Irvine *University Research Park.* Project (under development) with 180 acres adjacent to campus, 40 buildings at buildout containing 2.4 million sq. feet of Research, Technology and Business space, flexible building design, build-to-suit and leasing opportunities, flexible leasing options. Access to UCI equipment and facilities available for sharing. (http://www.uadv.uci.edu/urp/).

UCal—Los Angeles: —

UCal—Riverside *Research Park.* Project (under development) with 39-acres for product development and research activities; core of designated 856-acre Riverside Regional Technology Park, which includes more than 500 acres of ready-to-develop industrial property. (http://nied.ucr.edu/research_park/).

UCal—San Diego: —

UCal—San Francisco *Mission Bay.* New campus, started in 1999, to contain 2.65 million sq ft at buildout (~15-20 years), with ~half of program space for research, emphasis on basic sciences. UCSF was co-discoverer of DNA splicing; UCSF researchers and discoveries have spawned at least 57 life science and pharmaceutical companies, including giants Genentech and Chiron. UCSF inventions produced ~70% of the $88.5 million in patent licensing revenues generated in 1998 from the nine UC campuses. Surrounding UCSF Mission Bay will be land zoned for 5 million square feet of research space for private industry.

UCal—Santa Barbara:—

UCal—Santa Cruz *Monterrey Bay Education, Science, and Technology Center* Project (under development) on 1,100 acres (former Fort Ord), with ~484 acres for a research and technology center. Roadway and utilities were completed in 2000, opening 67 acres for development. New buildings, including the UC MBEST Center Headquarters and the City of Marina Business Incubator, were completed in the spring 2001.

University of Southern California:—

Colorado

Colorado State University *Center for Advanced Technology* (no information available via www).

University of Colorado—Boulder *Research Park.* 97 acres, 11 tenants, including USWest (Internet-based data, voice, image and multimedia communications), under development. (fm.colorado.edu/researchpark/).

Connecticut

University of Connecticut. Recommended in 1996 Strategic Plan and as part of the UConn 2000 process, but a search of the web shows no indication of subsequent development.

Yale University. The Yale Office of Cooperative Research has been instrumental in attracting several major biotechnology firms and startups into the New Haven area. For related press articles, see the OCR site, (http://www.yale.edu/ocr/ocr.html).

Delaware

University of Delaware *Biotechnology Institute.* A partnership—state government, higher education (University of Delaware, Delaware State University, Delaware Technical and Community College) and industry—centered on life sciences. Includes Center for Poultry Disease (C. C. Allen Jr. Biotechnology Laboratory, UDel), Center for Applied Optics (DSU), and Center for Marine Environmental Genomics (College of Marine Sciences in Lewes).
Incubator space at the Institute at Delaware Technology Park, 40 acres at Udel.; ~25 tenants, including large corporations (Dupont).s (http://www.deltechpark.org/about.htm).

Florida

Florida State University *Innovation Park.* In Tallahassee, adjacent to Florida A&M University and FSU College of Engineering (electrical, mechanical, civil, industrial and chemical engineering); 115 acres, 650,000 sq ft of building space; ~35 tenants, including the FSU Office of Research. (http://www.innovation-park.com/tenants.htm).

University of Florida *Interdisciplinary Center for Biotechnology Research (ICBR)* Started in 1987. Features Core Laboratories with expertise, instrumentation, and technologies for faculty, staff, graduate students, and research partners. Core technologies include DNA and protein synthesis and sequencing, protein expression, hybridoma, histology, glycobiology, flow cytometry, electron microscopy, biological computing, molecular biomarkers, and genetic, reproductive and immunological analysis.(http://www.biotech.ufl.edu/).

University of Miami:—

University of South Florida *University Technology Center Research and Development Park.* Collaborative research and technology transfer between Park occupants and USF faculty and students; 87 acre Park accommodates freestanding R&D buildings of large companies, and multi-tenant buildings for smaller ones; currently four buildings; two (of 12) lots proposed for Incubator and USF Research Laboratories.

Georgia

Emory University:—

Georgia Institute of Technology *Advanced Technology Development Center* (To form and grow technology-based companies in Georgia; provides entrepreneurs market assistance; Started 1992; 79 successful startups. Assistance in three key areas: 1)customers, markets, channels and stakeholders; 2) funding, partnership opportunities, business expertise and university resources; and 3) physical settings, intellectual stimulation, and business relationships.With Clark Atlanta University, Emory University, Georgia State University, Medical College of Georgia, and the University of Georgia. (http://www.atdc.org/index.html).

University of Georgia:—

Hawaii

University of Hawaii—Manoa *Innovation Center.* A high-tech business incubator, linking ventures to university R&D. 3 acres, 46,000 sq ft. (http://www.htdc.org/mic/mic.html).

Idaho

University of Idaho *Research Park.* Links technology companies to the University of Idaho and other Northwest universities. ~25 large and many smaller technology companies, University satellite programs, and some related service and commercial businesses; 120 acres (under development). (http://www.uirp.com/).

Illinois

Northwestern University/Evanston *Research Park.* Emphasis on materials and manufacturing technology; biotechnology (pharmaceutical); and software development (artificial intelligence, robotics, and internet applications). Joint venture with Evanston; 24 acres. (http://researchpark.com/).

Southern Illinois University—Carbondale *Dunn-Richmond Economic Development Center* Emphasis on light manufacturing, R&D, and service; flexible work areas, affordable production space; shared office and meeting rooms, business counseling; 55,000 sq ft. (http://www.siu.edu/~econdev).

University of Chicago:—
University of Illinois—Chicago *Chicago Technology Park*. Emphasis on medical, biological, chemical, engineering, computer, and other technological R&D; space for purchase or lease (build to suit); access to University facilities and Rush-Presbyterian-St. Luke's Medical Center. 56 acres; Park Research Center has 56,000 sq ft incubator. (http://www.uic.edu/depts/ovcr/ctp/).

University of Illinois—Urbana-Champaign *Technology Commercialization Laboratory.* Emphasis on technology commercialization; linked to agriculture College and others (under development). (http://www.tech.com/).

Indiana

Indiana University *Advanced Research and Technology Institute* (under development?) (http://arti.indiana.edu/).

Purdue University *Purdue Research Park.* Supports faculty for technology commercialization; opened 1961; >90 companies, 2,500 employees; incubator started 1993; shared offices; flexible, low rents; equipment, services and resources at minimal cost; video-conferencing, internet access; access to Purdue libraries, laboratories and staff; mentoring (markets, prototypes, financing). Innovation Center for older companies (48,000 sq ft, at higher rents); 650 acres. (http://www.adpc.purdue.edu/PRF/prp-home.html.)
Notre Dame University:—

Iowa

Iowa State University *Research Park.* Technology incubator, started in late 1980s; 38 companies, 1,100 employees; 270,000 sq ft, 230 acres. (http://www.isupark.org/).
University of Iowa *Technology Innovation Center.* Incubator offering low rent offices, conference rooms, and standard lab spaces to ventures and established companies. 20,000 sq ft. (http://www.vpr.uiowa.edu/techtransfer/tic_main.htm).

Kansas

Kansas State University *Mid-America Commercialization Corporation*. Emphasis on technology commercialization; joint venture with State and Manhattan. Building dedicated May 1998. (http://www.ksu.edu/tech.transfer/macc/macc.htm).

University of Kansas:—

Kentucky

University of Kentucky *Advanced Science and Technology Commercialization Center.* Research and commercialization for faculty- or UK-connected start-ups; $17 million building opened in 1994; focus on biopolymers, computational sciences, materials sciences, molecular biology, and pharmaceutical engineering; 11 start-ups; 10 graduated businesses; 80,000 sq ft. (http://www.rgs.uky.edu/astecc/).
University of Louisville:—

Louisiana

Louisiana State University *Louisiana Business and Technology Center* . Department of the College of Business Administration; on-campus business incubator; technology focus; Started 1988; collaboration with Baton Rouge and Louisiana Public Facilities Authority; past dealings with >1,850 businesses and entrepreneurs, starting ~100 businesses, with >500 jobs; 48,000 sq ft. (http://www.bus.lsu.edu/lbtc/index.html).

Tulane University:—

Maine

University of Maine:—

Maryland

Johns Hopkins University:—
University of Maryland—College Park *Technology Advancement Program.* Engineering Research incubator offering space and support services for technology startups. (http://www.erc.umd.edu/TAP/index.html). The *Maryland Industrial Partnerships Program* offers matching funding for faculty engaging in collaborative research with Maryland companies, up to $100,000 per year for a project (http://www.erc.umd.edu/MIPS).

Massachusetts

Boston University:—
Brandeis University:—
Harvard University:—Harvard has an enrollment of more than 18,000 degree candidates, including undergraduates and students in 10 graduate and professional schools. An additional 13,000 students are enrolled in one or more courses in the Harvard Extension School. Over 14,000 people work at Harvard, including more than 2,000 faculty. There are also 7,000 faculty appointments in affiliated teaching hospitals. Seven presidents of the United States – John Adams, John Quincy Adams, Theodore and Franklin Delano Roosevelt, Rutherford B. Hayes, John Fitzgerald Kennedy and George W. Bush – were graduates of Harvard. Its faculty have produced nearly 40 Nobel laureates. Harvard *is* research and technology.

Massachusetts Institute of Technology:—MIT is a coeducational, privately endowed research university dedicated to advancing knowledge and educating students in science, technology, and other areas of scholarship that will best serve the nation and the world in the 21st century. The Institute has more than 900 faculty and nearly 10,000 undergraduate and graduate students, and is organized into five Schools -- Architecture and Planning, Engineering, Humanities, Arts, and Social Sciences, Management, and Science -- and the

Whitaker College of Health Sciences and Technology. Within these are twenty-seven degree-granting departments, programs, and divisions. In addition, a great deal of research and teaching takes place in interdisciplinary programs, laboratories, and centers whose work extends beyond traditional departmental boundaries. The University's recent successful capital campaign raised $2.6 billion.

For an analysis of the economic relevance of MIT, see "MIT: The Impact of Innovation," prepared by the BankBoston Economics Department, which presents the results of a major new study on the national economic impact of companies founded by MIT alumni and alumnae. Among other findings, the study reveals that MIT graduates have founded 4,000 companies, creating 1.1 million jobs worldwide and generating annual sales of $232 billion. This is the first national study demonstrating the key role that higher education and research play in the economic vitality of this nation (http://web.mit.edu/newsoffice/founders/).

Northeastern University:—
Tufts University:—
University of Massachusetts—Amherst:—

Michigan

Michigan State University:—
University of Michigan:—
Wayne State University:—Planned park on 75 acres north of will feature business incubation, offices and residential development. Completed park expects 60 new businesses to create 1,800 jobs.

Minnesota

University of Minnesota:—

Mississippi

Mississippi State University:—
University of Mississippi:—

Missouri

St Louis University:—
University of Missouri—Columbia:—
Washington University:—

Montana

Montana State University—Bozeman *Advanced Technology Park.* Space and building sites for research, light manufacturing, high-technology and knowledge/information-based industries with alliances with the University scientists; owned and managed by subsidiary of the Montana State University Foundation; 90 acres.

Nebraska

University of Nebraska—Lincoln *Technology Park*. 130-acre high-amenity, master-planned development near campus, with technology oriented incubator with 23,000 sq ft (~14,000 sq ft of lab, production, and office space); to expand to 60,000 sq ft. 30,800 sq ft multi-Tech Building I provides customized space for maturing companies and established firms. (http://www.unebtechpark.com/default.asp).

Nevada

University of Nevada—Reno:—

New Hampshire

University of New Hampshire:—

New Jersey

Princeton University:—
Rutgers:—

New Mexico

New Mexico State University:—
University of New Mexico *Science & Technology Park.* Business technology park with 360,000 sq ft office and research space; focus on microelectronics, photonics, optoelectronics, advanced materials, manufacturing, internet; and medical devices; 153 acres. (http://stc.unm.edu/scitechpark/techparkhome.cfm).

New York

Columbia University:—
Cornell University *Business and Technology Park.* Technology based (67%) companies working with Office of Technology Access and Business Assistance; help for faculty, staff, and student startups (business plans, legal, financing, logistics; assists in placing MBA interns. (http://corporate.cornell.edu/ecodev.html).

New York University *Center for Advanced Technology.* Fosters media industry growth through new technologies and business assistance to new companies; founded 1993; One of 13 New York State Centers for Advanced Technology; help with finance, education, entertainment, communications, publishing, and other fields; develops multimedia technologies, tools, services, and products; includes Film and Television, Photography, Interactive Telecommunications, Journalism, Computer Science, Biology, Music Technology. (http://www.cat.nyu.edu/).

Rensselaer Polytechnic Institute *Rensselaer Incubator Program.* Founded in 1980 as the first U.S. wholly university-based incubator. Objectives include enrichment of the academic environment; technology transfer and commercialization; and regional economic development. (http://www.rpi.edu/dept/

incubator/homepage/index.html)
Rockefeller University:—
SUNY—Albany *Center for Environmental Sciences and Technology Management.* High-technology business incubator provides office and laboratory space for start-ups; includes microelectronics; telecommunications; atmospherics; analytical instrumentation; computers; thin films and material; semiconductors; and photonics; access to University's nuclear accelerator; electron microscopes; gas chromatographs; mass spectrometer; NMR spectrometer; peptide synthesizer; libraries; computing; and the transgenic facility. (http://www.albany.edu/pr/CESTMINCU.html).

SUNY—Binghamton:—
SUNY—Buffalo:—
SUNY—Stony Brook *Long Island High Technology Incubator* (description not usable)(http://www.lihti.org).

Syracuse University *Center for Advanced Technology in Computer Applications and Software Engineering.* Research with industry; focus on computer-based products and processes, solutions to technical problems, and general infusion of new technology. (http://www.cat.syr.edu/).

University of Rochester *High Technology of Rochester.* Technology-based training and consulting. (http://www.htr.org/).
Yeshiva University:—

North Carolina

Duke University *Research Triangle Park* is recognized internationally as an international center for cutting-edge R & D. It is owned by the private, not-for-profit Research Triangle Foundation, named for the Triangle formed by the three cities and universities: **Duke University in Durham, the University of North Carolina at Chapel Hill,** and **North Carolina State University in Raleigh**. 140 private, governmental and non-profit companies share the Parks 7,000 acres. 106 of them are involved in research. These companies employ over 45,000 people and have in excess of 17 million square feet under roof. Companies like Glaxo, SmithKline Inc., IBM, Covance, Cisco Systems, Inc., Ericsson, Eisai Inc. and Nortel Networks thrive and grow in a campus-like setting that lends itself to interactive research. Approximately 50% of the employees in the Park work for multinational corporations. Park research includes Biotechnology/Biopharmaceutical; Computer Hardware and Software; Chemicals; Environmental Sciences; Information Technology; Instrumentation; Materials Science; Microelectronics; Pharmaceuticals; Public Health; Telecommunications; and Statistics. Almost 40% of Park employers have less than 10 employees. The average salary of an RTP employee is $54,145. Capital investment exceeds $2 billion and the total payroll is estimated at $2.7 billion (http://www.rtp.org/home.html).

North Carolina State University at Raleigh (see above).
University of North Carolina at Chapel Hill:—

North Dakota

North Dakota State University *Research and Technology Park* (currently under construction on campus). First building, dedicated in May 2001, has >300 technicians and staff in Phoenix International (a John Deere company); second building, scheduled for completion in Fall 2001, will house NDSU research administration; includes wet labs and Net-wired, technology-related areas. Business incubator planned. (http://www.ndsu.nodak.edu/wwwdev/vprct/research-techpark.shtml)

Ohio

Case Western Reserve University *Cleveland Biotechnology Park* (initial planning stages) (http://www.cwru.edu/pubaff/univcomm/biopark-inc.htm).

Kent State University:—
Ohio State University:—
Ohio University *Innovation Center* is a business incubator offering space and support services for new or emerging technology, service or light manufacturing businesses (http://www.ictto.ohiou.edu/ic/whoWeAre.html).

University of Cincinnati:—

Oklahoma

Oklahoma State University *Oklahoma Center for the Advancement of Science and Technology.* Technology development, transfer, and commercialization. Services include technology assessments and technical concept analysis; engineering, testing and prototype development; market research and analysis; economic feasibility studies: development of strategic marketing plans; development of strategic business plans; and access to early stage risk capital. (http://www.ocast.state.ok.us/INFOotcc.HTM).
University of Oklahoma:—

Oregon

Oregon State University:—
University of Oregon:—

Pennsylvania

Carnegie Mellon University:—
Lehigh University:—
Pennsylvania State University *Innovation Park* Technology transfer and economic development; includes incubator; material research institute class 10 clean room and materials characterization lab; the Penn Stater Conference Center Hotel; Daybridge Child Care; Penn State's technology transfer organiza-

tion; multi tenant and single tenant office, lab and manufacturing space; sevices include technical consultation; access to public and private funding; research collaborations between university and industry; technology commercialization; intellectual property services; marketing consultation; business and strategic planning assistance; 118 acres. (http://www.innovationpark.psu.edu/).

Temple University *Small Business Development Center* offers consulting and business incubator services (http://www.sbm.temple.edu/~sbdc/incubator.html).

University of Pennsylvania:—
University of Pittsburgh:—

Rhode Island

Brown University:—
University of Rhode Island:—

South Carolina

Clemson University *Research Park* has 265 acres overlooking the shores of Lake Hartwell in the foothills of the Blue Ridge Mountains. The Park has 9 tenants on 59 acres, with the rest available (http://rpg.scra.org/clemson.html).

University of South Carolina:—

South Dakota

South Dakota State University:—

Tennessee

University of Tennessee:—
Vanderbilt University:—

Texas

Rice University:—
Texas A&M University *Research Park* Long term site leases; building options. (http://researchpark.tamu.edu/index.html).

Texas Tech University:—
University of Houston:—
University of Texas at Austin:—

Utah

Brigham Young University:—
University of Utah *Research Park.* High-technology research and development. Tenants occupy 32 new buildings and employ ~ 5,100 persons; ~300 acres. (http://www.research.utah.edu/research_park.shtml).

Utah State University *Research and Technology Park.* Research and technology-oriented collaborations with University; 38-acres + ~100 acres for future development; landscaping features central, common pond and fountain. Shuttle service and direct telecommunication links to University. Opened 1986. 12 buildings with 264,260 sq ft. (http://www.usu.edu/~rschpark/).

Vermont

University of Vermont:—

Virginia

University of Virginia:—
Virginia Commonwealth University *Biotechnology Research Park.* Life sciences research; in Richmond adjacent to the medical sciences campus of Virginia Commonwealth University and the Medical College of Virginia Hospitals; 34 biotechnology/bioscience companies and research institutions. (http://www.vabiotech.com/about/).

Virginia Polytechnic Institute and State University *Corporate Research Center. E*stablished 1985; supports technologies in agriculture, biotechnology, design automation, diagnostics,
electronics, engineering, environmental engineering, enformation eechnology, library science, materials and chemistry, and transportation. 16 single and multi-tenant buildings with >100 companies; 120 acres. (http://www.g3.net/crc/).

Washington

University of Washington—Seattle:—
Washington State University *Research & Technology Park.* Technology transfer; One 50,000 sq ft building has 12 companies and a 5,000 sq ft incubator for start-ups. A second building, completed in 1998, has 7 companies in 6,000 sq ft, some of which graduated from the incubator. ~100 acres of undeveloped land. (http://www.wsu.edu/~rtp/Default.htm) (see also http://www.wabio.com/Default.asp).

West Virginia

West Virginia University Research park planned for the Morgantown campus. (www.wvu.edu/~research).

Wisconsin

University of Wisconsin—Madison *Research Park* Opened 1984; 136 acres (27 available); 88 companies, 2500 employees in 31 buildings, 1,283,000 sq ft. Offers specialized technology incubator, the Madison Gas & Electric (MGE) Innovation Center. Park pays property taxes to Madison ($1.7million), and returns all profits to UW-Madison.(http://www.universityresearchpark.org/index.html).
University of Wisconsin—Milwaukee

Wyoming

University of Wyoming:—

Footnotes

(1/preface) Used here in the sense of NSF and the 1994 Carnegie Classification. See (16).

(2/preface) Public universities founded in each state by the Morrill Land Grant Act of July 2, 1862. See http://gnv2.ifas.ufl.edu/WWW/LS_GRANT/, for more.

(3/preface) Rhode Island Economic Policy Council. 1997. Meeting the Challenge of the New Economy: Keys to Building Hope. Annual Review 1997. 343 p.

(4/p. 1) In all that follows, we use the NSF convention of focusing on science and engineering, following NSF's defined fields (see http://www.nsf.gov/sbe/srs/sgss/method99/xwalk.pdf for crosswalk of fields with Nat. Ctr. for Educ. Stats. classification). NSF does not collect data for anthropology, linguistics, and history of science, nor do they include research expenditures in the fields of education, law, humanities, music, the arts, physical education, library science, or any other non-science and engineering fields. All NSF expenditure data are taken to be "the same as 'organized research' as defined in Section B.1.b of OMB Circular A-21, including all Research and Development activities of an institution that are *separately budgeted and accounted for* (ital. from NSF)." That is, the figures reported to NSF are from auditable university records and are assumed to be accurate.

(5/p. 2) State of Rhode Island. Annual Budget.

(6/p. 2) ibid.

(7/p. 3) URI's endowment, $65 million in 2000, ranked 359th in the nation (Nat. Assoc. Col. & Univ. Bus. Off., 2000, www.nacubo.org).

(8/p. 3) RI Annual Budget. URI's 2000 state appropriation was 23.2% of its budget. The term "state-assisted university" has been used widely and in many states, generally referring to public universities with less than 25% of their funding coming from the state.

(9/pp. 3, 4, 5, 9, 20) National Science Foundation, WebCaspar (www.nsf.gov)

(10/p. 4) National Science Foundation. 2000. Science and Engineering Indicators 2000. (www.nsf.gov/sbe/srs/stats.htm.)

(11/p. 4) see, for example, Hovey, H. A. July 1999. "State Spending for Higher Education in the Next Decade: The Battle to Sustain Current Support." (www.highereducation.org/)

(12/p. 5) U.S. Dept. of Commerce, Census Bureau. 2000 Census. (www.census.gov)

(13/p. 5) U.S. Dept. of Commerce, Bureau of Economic Analysis. (www.bea.doc.gov)

(14/p. 5) ibid.

(15/p. 5) Illinois State University College of Education. Center for Higher Education and Educational Finance. Grapevine. (www.coe.ilstu.edu/grapevine) Appropriations of state tax funds for operating expenses of higher education, fiscal year 2000 (Revised). This material appears in the annual Almanac Issue of the Chronicle of Higher Education, published each September. Numbers reported were revised *after* the Chronicle issue of Sept. 1, 2000.

(16/p. 5) The Carnegie Foundation for the Advancement of Teaching erected the categories Research I and Research II in 1994. The distinction was based in part on total expenditures for science and engineering research, with cutoffs of >$40million annually (inflation adjusted to 1992 $'s) for Research I and >$15million annually for Research II. NSF retains these distinctions in its WebCaspar database. In 2000, Carnegie began using an interim classification based on numbers of doctoral degrees awarded annually, replacing Research I & II with two new definitions:

Doctoral/Research Universities—Extensive: These institutions typically offer a wide range of baccalaureate programs, and they are committed to graduate education through the doctorate. During the period studied, they awarded 50 or more doctoral degrees per year across at least 15 disciplines.

Doctoral/Research Universities—Intensive: These institutions typically offer a wide range of baccalaureate programs, and they are committed to graduate education through the doctorate. During the period studied, they awarded at least ten doctoral degrees per year across three or more disciplines, or at least 20 doctoral degrees per year overall.

Carnegie speaks of a further overhaul in the classification system in 2005. In the interim, we follow NSF and the 1994 system here, emphasizing relative amounts of research. (www.carnegiefoundation.org)

(17/p. 5) See www.nasulgc.org for listing. See the University of Florida's Institute of Food and Agricultural Sciences excellent site, gnv2.ifas.ufl.edu/WWW/LS_GRANT/, for more information on land grants, sea grants, legislation, and history.

(18/p. 5) See, for example, URI Marine and the Environment Focus Group: Library Committee. Nov. 9, 1999. Report on Marine & the Environment Focus Group (MEF) Library Issues (www.gso.uri.edu/pell/mefj11999.pdf)

(19/ p. 9) NSF. "Federally financed separately budgeted R&D expenditures in the sciences and engineering, by field: selected years." For an individual institutional profile, see http://www.nsf.gov/sbe/srs/profiles/toc.htm, which allows you to select any research university. For a profile of URI, for example, see http://www.nsf.gov/sbe/srs/profiles/data/ip003414.htm.

(20/p. 12) The $500 cutoff may be old. URI currently uses a $2500 limit on individual items of equipment to differentiate between expendable equipment (e.g., a $2000 personal computer) and capital equipment (e.g. a $20,000 scintillation counter).

(21/p. 12) See http://www.nsf.gov/sbe/srs/pubdata.htm. Additional useful information can be obtained from within the WebCaspar online data system through online help, describing variables, data source, description, availability, estimation/imputation methods, data limitations, and quality control. See http://caspar.nsf.gov/webcaspar: use the "institutional data" tab, log in as an anonymous user, select "search," enter the name of any university, select any data source, then click on the help icon for data description, etc.

(22/p. 13, 14, 17) National Science Foundation, Division of Science Resources Studies, "Scientific and Engineering Research Facilities at Colleges and Universities, 1998, NSF 01-301. (published October 2000. See http://www.nsf.gov/sbe/srs/nsf01301/start.htm). Also published in part in "Indicators" (see 10).

(23/p. 13) For a current ranking based on expenditure data, see http://www.nsf.gov/sbe/srs/profiles/data/erank.htm. For a current ranking based on obligations (i.e., grants awarded in the most recent fiscal year) see .../data/crank.htm. URI currently ranks 136 (out of 615) in total R&D expenditures (1999) and 122 (out of 1531) in S&E obligations (i.e., 1999 grants). If URI doubled its research expenditures, it would enter the Top 100, displacing the University of Alaska for 97th place. Without Oceanography, the rest of URI would rank 178, just ahead of the Desert Research Institute of Nevada.

(24/p. 13) URI figures here were imputed by NSF based on URI 1999 data submitted 8/15/00: Source NSF/SRS, L. Christorch, pers. comm. 8/9/01 via URI Research Office. (see also, 22)

Planned URI construction projects for 1998/99 included expansion of the psychology cancer prevention research center (completed 2000) and the Coastal Institute Building (completed 2000). Planned URI renovation projects for 1998/99 included renovation of Ranger Hall ($4.5 million), which has not begun as of this writing: the figure as presented thus overstates actual renovation by $4.5 million.

(25/p. 14) Net assignable square feet is determined every two years by each research institution, based on the relative amount of activity for major functions (teaching, research, etc.) in each space (office, laboratory, common rooms, etc.) of the university. The use determination is used to calculate allowable indirect costs for the university, and it is auditable.

(26/p. 15, 16) Source of URI data is NSF/SRS, pers. comm. 8/9/01 via URI Research Office. Source of national data is Scientific and Engineering Research Facilities: 1999, NSF 01-330, Table 6, "Quality of academic science and engineering research space, by field: 1999.

(27/p. 17) The $10 million total new construction in environmental plus agricultural sciences was the approximate total cost of the Coastal Institute Building, completed in December 2000, which includes at least half office and instructional space (i.e., the space assignable to research may be overstated in **Table 8**). The $4.6 million for renovations in biological sciences was the original total cost of renovating Ranger Hall, which also overstates the space assignable to research (Ranger is exclusively used for teaching and nonsponsored research and its use after renovation is still undetermined): this project was approved by a state bond in 1996 but a required $1million match (part of the $4.6 million), to be raised by the University: fund raising has not started and the voter-approved project remains on hold five years after approval. The 2002 bond issue has not been set and it is possible that the biotechnology building may be postponed to 2004.

(28/p. 19) Latest available data include expenditures for 1996-97 and anticipated expenditures for 1998-99 (i.e., estimates before the fact). (See 22, tables 5-2 (Construction at public institutions) and 5-5 (Renovation at public institutions)).

(29/p. 20) National Science Foundation, Division of Science Resources Studies, Academic Research and Development Expenditures: Fiscal Year 1999. NSF 01-329. (See also http://www.nsf.gov/sbe/srs/stats.htm).

(30/p. 20) Note, however, that the top 100 include at least one-third private institutions, which traditionally draw little state money for either renovations or construction.

(31/p. 20) The important issue of mandatory match requirements for federal equipment funds needs further study. Most agencies expect a large portion of the funding to come from state or institutional sources, typically 30 - 50% of total costs. This has clearly inhibited some URI faculty from applying to major NSF or other agency equipment programs, because they believe that they will be unable to secure required match from the institution.

(32/p. 22) Geiger, R. L. 1993. **Research and Relevant Knowledge: American Research Universities Since World War II**. Oxford U. Press, 411 p.

(33/p. 22) ibid. See Gieger's account of the rise of the University of Arizona, which began by building on the unique opportunities to study climate and astronomy afforded by AU's geography (cpt. 9).

(34/p. 22) For examples, see the 1998 URI Academic Plan (http://www.uri.edu:80/Academic_Plan/index_98.html) or the 2001 Three-Year Strategic Plan, "Balancing Mission with Resources' (http://www.uri.edu:80/spir/@planning/strategic_plan/index.html).

Compare these to the Michigan Economic Development Corporation (MEDC) Michigan Life Sciences Strategy, which outlines a plan to develop its universities, industries, and infrastructure to nurture biotechnology entrepreneurship over the next decade. In developing the strategy, MEDC conducted three studies: a Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis; a comparative analysis of competitor states and best practices in public biotech programs; and a situational analysis of Michigan's current portfolio of programs and activities related to life sciences. The best practices and comparison analysis are drawn from Maryland and North Carolina. (See http://medc.michigan.org/ and click on "Michigan Life Sciences Corridor.")

(35/p. 23) **Outcome Funding**, A New Approach to Targeted Grantmaking by Harold S. Williams, Arthur Y. Webb and William J. Phillips (©The Rensselaerville Institute, 250 pages, paperback) (see http://www.tricampus.org/index.html)

See, for example USDA's current Plan of Work process, under the 1998 Farm Bill (http://www.reeusda.gov/part/areera/amain.htm). Each state is to identify stakeholder input processes, to identify target audiences for all programs, to specify outcomes of each program, etc. Failure to include outcomes as a part of the planning process can result in withheld funds for USDA's Agricultural Experiment Station and Cooperative Extension at each land grant university. See also, NSF's strategic plan, again based on outcomes (http://www.nsf.gov/pubs/2001/nsf0104/start.htm).

(36/p. 23) Engineering Research Centers (see www.nsf.gov/pubs/2000/nsf00137/start.htm).

(37/p. 23) Industry/ University Cooperative Research Centers (see www.eng.nsf.gov/iucrc/Centers/centers.htm).

(38/p. 23) Materials Research Science and Engineering Centers (see www.nsf.gov/mps/divisions/dmr).

(39/p. 23) The Environmental Biotechnology Initiative was initially proposed by faculty in 1999. See http://www.riaes.org/biotech/biotech.html

(40/p. 23) Note that Genentech, the first firm to be based explicitly on genetic engineering, was founded by UC San Francisco scientist Herbert Boyer in 1976.

(41/p. 24) An excellent primer on Bayh-Dole and other aspects of Technology Transfer is the 1999 Council on Governmental Relations document, "A Tutorial on Technology Transfer in U.S. Colleges and Universities" (download at www.cogr.edu).

(42/p. 24) A survey summary is downloadable from www.autm.net.

(43/p. 26) Geiger, op. cit.

(44/p. 26) http://web.mit.edu/newsoffice/founders/

Dr. Patrick Logan is Professor of Entomology at the University of Rhode Island. He holds a BA in English and MS and PhD degrees in Entomology from Michigan State University. He has been at URI since 1976. Following an active research career from 1976 to 1992, Dr. Logan served eight years in administration, as Associate Dean of the College of Resource Development and Associate Director of the RI Agricultural Experiment Station, then five years as Director of the Experiment Station, with two concurrent years as Director of RI Cooperative Extension. In 1999, Dr. Logan wrote "Reinventing the Research University: A Blueprint for the University of Rhode Island," which led to the present study. Dr. Logan presently teaches and writes in Kingston.