March 1999

REINVENTING THE RESEARCH UNIVERSITY

A Blueprint for the University of Rhode Island

"While everyone sees the need for a better-skilled work force, each economic actor thinks that she cannot recoup her costs if she must bear the costs alone. The individual does not know where she will be employed and does not want to invest in skills that will become worthless if she is laid off.
Someone else should make the necessary investments.

Because of high labor-force turnover rates, firms feel that they cannot educate their workers. If they did, their newly trained workers would simply go off to other employers who could pay higher wages because they did not have to incur training costs.
Someone else should make the necessary investments.

Local governments don't want to pay for first-class schools. They know that less than half the population has children in school at any one time, that students will leave home and use their skills in different geographic regions of the country, and that the high taxes necessary to pay for good schools would drive industry away. Firms would locate next door and free ride on their well-educated work force.
Someone else should make the necessary investments.

In recent years the federal government has come to see education more and more as an individual or local responsibility. Student grants have been converted to student loans, and federal aid to education both at school and on the job is one of the few places where government spending was actually cut under the Reagan administration.
Someone else should make the necessary investments.

When it comes to skill investments, individual rationality (let someone else do it) produces collective irrationality (**it doesn't get done**)."

Lester Thurow
Head to Head (1992)

Preface

I decided to write what follows during a meeting of Agricultural Experiment Station Directors in Kansas City in September 1998. Terry Nipp of AESOP Enterprises, an agricultural research expert and Washington lobbyist, had presented a gloomy analysis of the future of agricultural research funding. His picture portrayed a federal government fiscally entrapped by huge national debts and politically invulnerable entitlement programs. Given the political alternatives of raising taxes or cutting discretionary programs, the outlook for research funding looked dim. Like most of the Directors present, I went away seriously worried about the future of my research enterprise.

As I returned from that meeting, I thought for a long time about how Nipp's pessimistic message clashed with a far more optimistic message sounded earlier in the year by the Provost in her Academic Plan for the University, presented to the Board of Governors in May. In her Plan, Provost Swan set five goals for the University, including a goal of attaining Carnegie Research University I status (defined herein). The Provost's endorsement of growth in the University's commitment to research was very encouraging to me, both as a scientist and as an administrator concerned for the University's research mission.

The URI community needs to think about how the Research University I goal is important to the academic future of the University — as envisioned by the Provost and President Carothers — and to the economic future of the State. I conclude here that pursuit of the goal is crucial to both the University and the State.

To meet the goal of becoming a Carnegie I institution will take more than a simple increase in faculty efforts to compete for federal grants. State and University funding for research must be significantly invigorated, brought up to relative levels found in virtually all other public Research Universities. At the same time, the State and the University must work together in an aggressive alliance to develop new interfaces for collaborative University-industry research and development.

Without serious new commitments to research from the State and the University, it is doubtful to me that URI scientists can improve their position in the increasingly competitive federal grants arena. Indeed, I do not see how they can maintain their current level of accomplishments given many of the factors discussed herein. Success in obtaining research funding is a prerequisite for faculty to remain engaged in research, and active research is the primary means to maintain scholarly relevance. It is more critical than ever that faculty actively *practice* what they are called upon to teach, especially in the technologically fast-moving sciences and engineering. The academic quality of URI's sciences and engineering is thus inextricably linked to State, federal, and industrial fiscal support for research. For many of the same reasons, the State's economic outlook is also tied strongly to support for URI research.

State and University support of URI science and engineering research will also determine the State's economic future. Other states experience major returns from investing in their state research university as an intellectual driver for industrial growth. Rhode Island remains in the shadow of neighboring states who are now positioning themselves and out-competing us in the New Economy. We cannot afford Lester Thurow's tragedy of the higher-education commons, with each actor assigning responsibility to someone else, while we collectively suffer in what John Casey calls our "State of lowered expectations." For our posterity, too much is now at stake.

The people of Rhode Island need to understand the critical role of URI research in determining Rhode Island's economic future. The investments in the public research universities made by other states are visibly greater than those made in Rhode Island, even on a per capita basis, and the positive *returns* of increased investment in university research and development are patent elsewhere. State levels of support for URI are too low when the University is forced to impose unpalatable restrictions on its research so that tuition can remain competitive. This is a dangerous situation. We must comprehend that a University whose science and engineering faculty are not significantly engaged in research is one that is not prepared to offer a state-of-the-art curriculum and that has little to contribute to high-technology industries seeking intellectual affinities. To enhance undergraduate education and to assist the State in reinventing its economy, we must begin by reinvigorating the Research University.

Many minds, both at URI and nationally, are now focussed on the issues discussed in this paper, and on support for higher education in general. I have borrowed much of what follows from the literature cited, especially from excellent web-accessible materials from the American Association for the Advancement of Science and the National Science Foundation. I have also benefitted immensely from discussions with faculty from the Graduate School of Oceanography and the College of the Environment and Life Sciences, led by Associate Dean William Wright and Dean Margaret Leinen. I hope that I have done at least some justice to the excellent thinking of these scholars through my efforts to capture collective concerns.

I thank John Peterson for the cover, advice on editing and layout, and for research on the New Economy. I also thank Liliana, Jonathan, Jessica, and Kirsten for their understanding while I was focussed on these matters.

Patrick Logan
March 9, 1999

Summary

The University of Rhode Island is the State's only public Research University. It is also a Land Grant, a Sea Grant, and an Urban Grant institution. For each designation, URI has unique responsibilities as part of a system of national research universities.

The University is charged with conducting research for the public good and of educating the next generation of scientists, technicians, teachers, and leaders. URI differs from the other two Rhode Island public colleges in its commitment to offer advanced masters and doctoral degrees and by a commitment to sophisticated research and outreach.

URI research is concentrated in the sciences and engineering. Half of URI grants are awarded to the Graduate School of Oceanography. Engineering, Environmental and Life Sciences, and the Cancer Prevention Research Center make up much of the rest. Over the past 5 years, 48% of URI's ~600 faculty have received grant awards totalling $114 million: 24% of faculty won 95% of this total.

Faculty awards make up 57% of total external grants. Another 30% comes to administrative units (e.g., federal support for buildings) and 13% to research associates. Total awards for 5 years were just over $200 million.

A strong research commitment at URI is also critical to integrating undergraduate access to the activities and high-technology investigations of the research faculty. URI research has also traditionally been under-used as an engine for State economic development, especially in high-tech. Both of these roles argue strongly for significant investment in University research.

The classification scheme of the Carnegie Foundation for the Advancement of Teaching is a nationally recognized means for assessing the science and engineering research capacity of U.S. colleges and universities. The Nation's 125 Research Universities conduct the bulk of its academic research and play a dominant role in awarding academic masters and doctoral degrees in the sciences and engineering.

URI is currently classified as a Research University II. By increasing the average dollar value of federal grants for science and engineering by 25% (~$8 million) per year, the University could be reclassified as Research University I. The Carnegie classification should be regarded as a measure of the University's research capacity (e.g., its ability to meet University visions for academic programs, to contribute to state economic development, and to advance human knowledge) rather than as a goal in itself.

URI faces a daunting external funding environment for research. Federal support for academic research and development is expected to remain flat or to decline slightly, with increases likely only in health and basic science (i.e., NIH and NSF). Much of URI's traditional funding base will decline slightly by 2003. State, University, and industrial support for research at URI are an *atypically* low percentage of URI's total research funding, the lowest of any of the 125 Carnegie Research Universities. URI expenditures for research capital (buildings, laboratories, major equipment) were exceptionally low throughout the 1970's and 1980's, with some (but lower than average) expenditures in the mid 1990's.

As federal funding agencies increase requirements for matching state funds, shortage of non-federal research support in some quarters of the University is becoming critical in determining whether to pursue or to accept federal grants. The State to Federal matching rate for the University's land grant programs (Agricultural Experiment Station and Cooperative Extension) is atypically low compared to all other states.

It is suggested that the University and the State review commitments to support research, and that investment of state funds for research be brought in line with URI's peer Research I and II universities. The University's role in economic development similarly needs to be enhanced to the level of activity in other successful states.

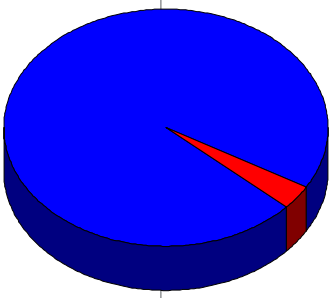
REINVENTING THE RESEARCH UNIVERSITY

The Nation's Research Universities

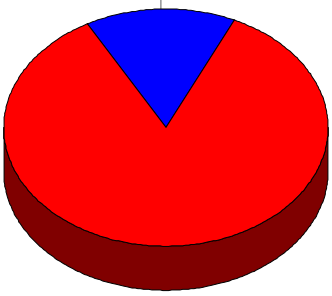
U.S. higher education serves as a wellspring of American artistic and scientific culture. It is a reservoir of intellect vital to our own generation and our greatest legacy to our posterity. The nation's campuses deliver an enormously broad and sophisticated curriculum to the largest and most diverse student body in human history.

In the 21st century, the greatest global impact of U.S. culture has been the advances in science and engineering made possible by the Nation's universities. Discoveries from universities add directly to the storehouse of human scientific and technical knowledge. In many fields, scientific and technical knowledge more than doubles each decade, making active engagement in research *essential* for university faculty to keep relevant in their discipline. University research is also the primary vehicle for the advancement of graduate students, our next generation of scientists, professors, and technological innovators.

Nationwide, university research in science and engineering is concentrated in a relatively small number of institutions. Only one-fourth (882) of the nation's 3,681 colleges and universities received federal research grants in 1995. Of these, 125 are classified as Research Universities by the Carnegie Foundation for the Advancement of Teaching, based in part on the amount of federal funding they spend for science and engineering research (Appendix I). Overall, 83% of all federal grants for academic research are awarded to the 125 Research Universities.



3.4% of U.S. universities...



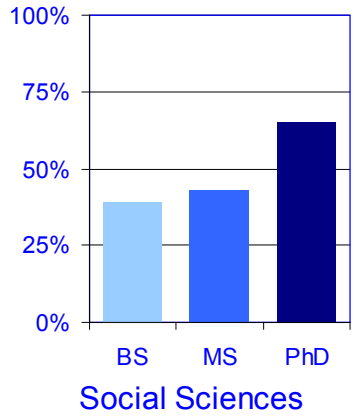
...conduct **83%** of federally funded academic research

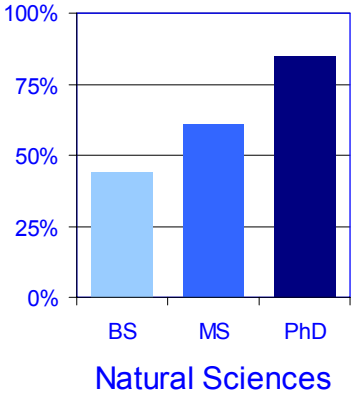
The Research University's Unique Role

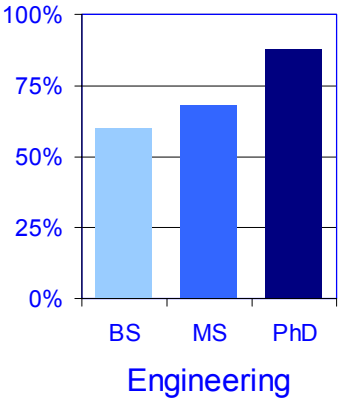
Research Universities emphasize research for the long-term public good (as contrasted to industrial research for short-term private profit). They conduct over half of the Nation's basic science research. They also serve as society's principal source of scientific knowledge and technology used for the creation of public policy for resource management and environmental stewardship.

Research Universities conduct research in many applied fields neglected by industry or government. Examples of areas of investigation in which the Research Universities play a unique role include studies in health (other than pharmaceutical product development), alternative energy sources and energy conservation, and sustainable agricultural technologies which require lower use of fuels, fertilizers, and pesticides. Research Universities provide research and expertise needed for sophisticated environmental monitoring, ground water protection, land-use planning, and natural resource management and conservation.

% of U.S. degrees awarded by Research Universities:







Education in the Research Universities

Beyond basic and applied research, the Research Universities play a huge role in education. Despite being only 3.4% of the total number of higher education institutions, they award 32% of all bachelor's degrees in the U.S., including 44% of undergraduate degrees in the natural sciences (physical, earth, atmospheric, oceanographic, biological and agricultural sciences), 39% of bachelor's in the social sciences, and 60% of the bachelor's in engineering.

Because research is the primary vehicle for advanced studies, the Research Universities play a dominant role in educating the Nation's graduate students.

Research Universities award 39% of master's degrees and 75% of all U.S. doctoral degrees. The Research Universities are especially important to meeting national needs for scientists and engineers. They award 54% of the nation's science and engineering master's degrees and 80% of the total Science & Engineering doctoral degrees. For the natural sciences, the Research Universities award 61% of all master's degrees and 85% of all doctoral degrees. For the social sciences, they award 43% of master's degrees and 65% of doctoral degrees. They also award 68% of master's and 88% of the Nation's doctoral degrees in Engineering..

Rhode Island is home to two Research Universities, Brown

Rhode Island's Public Research University

University and the University of Rhode Island. Brown is a prestigeous private institution that derives its income from high tuitions, a large endowment, and government and private philanthropic grants. Brown is affiliated with a medical school. The University of Rhode Island is a distinguished state-assisted public university that derives income from affordable tuitions, a modest endowment, and state, federal, and private grants. URI has no medical school.

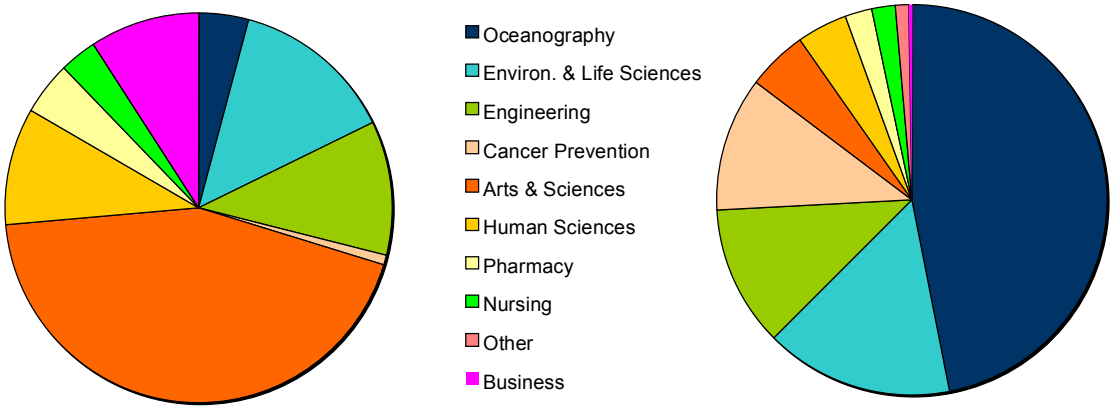
The Research agenda at URI is influenced strongly by faculty interests and external funding opportunities. Nearly half of funded research is conducted by faculty and staff in the Graduate School of Oceanography, and another quarter is performed by the College of Engineering and the College of the Environment and Life Sciences.

Although all URI faculty are expected to teach a nominal minimum of 3 courses per semester, they may be released from the expected teaching commitment to perform research. Faculty may also engage in research in the summer. Most faculty have 9-month academic year appointments, and they may obtain summer salary for work on funded grants (paid for by the grant), but many conduct summer research without compensation.

{Note: In what follows, it is understood that grantsmanship is imperfectly related to scholarship, and that many faculty engage in research *without* grant support. Grant funded research is, however, very important to the sciences and engineering, which are the focus of this analysis.}

"The University of Rhode Island is the principal public research and graduate institution in the State of Rhode Island with responsibilities for expanding knowledge, for transmitting it, and for fostering its application. Its status as a land grant, sea grant, and urban grant institution highlights its traditions of natural resource, marine, and urban related research."

U.R.I. Mission Statement



% of total URI Faculty

% of total URI Grant Awards, FY1993 - FY1998

Rhode Island's Land Grant University

URI is a land grant university, as are many public Research Universities. The Morrill Act of July 2, 1862 provided federal funds (in the form of a grant of 30,000 acres of federal property for each senator and representative) to each state. The sale of the land was to be used by the state to endow at least one college where the leading object should be, "without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life."

The language of the Morrill Act still makes up most of the single paragraph of Rhode Island General Laws that defines the purpose of the University and the mandate of its Board of Governors. Rhode Island's land grant was accepted by the state and applied first to Brown University on January 14, 1863. Nearly 30 years later, after Brown failed to develop the requisite programs of study, the land grant was transferred to the State Agricultural School in Kingston, on May 19, 1892. The school was renamed in the same Act as the Rhode Island College of Agriculture and Mechanic Arts. The Agricultural School had been founded only four years earlier as the official home of the Rhode Island Agricultural Experiment Station. Experiment Stations were created and funded by the Hatch Act of March 2, 1887, which granted each state $15,000 annually to help in the acquisition and diffusion of "useful and practical information on subjects connected with agriculture."

Maintenance of the Experiment Station in support of the purposes of the Hatch Act remains the second of the two official purposes of the University according to the current General Laws of the State of Rhode Island.

The link between applied research and affordable practical education was made clear at the founding of the University. The Smith-Lever Act of 1914 created the Cooperative Extension Service, formally adding outreach to the mission of the College. The tripart mission of teaching, research and outreach of the Land Grant Colleges and Universities creates a special status in the national higher education system and explains why so many of the land grants are included among the Research Universities. Their roots were in *practical education and problem solving for the public good* and this continues to be at the core of their tremendous importance to the Nation today.

The Purpose of the University

The board, as now constituted, and their successors, for the terms for which they have been or for which they hereafter may be appointed regents, shall continue to be a body politic and corporate for the purpose of continuing and maintaining the University of Rhode Island as a university where the leading object shall be, without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life, as provided in the act of the congress of the United States, approved July 2, 1862, entitled "An Act Donating Public Lands to the Several States and Territories Which May Provide Colleges for the Benefit of Agriculture and the Mechanic Arts," and for the purpose of continuing and maintaining an agricultural experiment station as a department of the college under and in accordance with, and to carry out the purposes of, the act of congress approved March 2, 1887, entitled "An Act to Establish Agricultural Experiment Stations in Connection with the Colleges Established in the Several States Under the Provisions of An Act Approved July 2, 1862, and of the Acts Supplementary Thereto."

General Laws of Rhode Island, 1956
As Reenacted in 1988
Cpt. 32: University of Rhode Island
Section 16-32-3: Purposes of University.

Undergraduates in the Research University

Clearly, the Research Universities are important to addressing national research priorities and to meeting the Nation's needs for scientists, engineers, professors, and leaders. Less clear, however, is the relationship of university research to undergraduate education. There is a pervasive view that research and undergraduate teaching are generally antithetical in the research universities. Scathing criticisms of academic research such as Charles Sykes' **Prof Scam** (1988) make sensational news by ridiculing titles of esoteric research papers while crying scandal over light teaching loads.

The headlines were again critical when the Carnegie Foundation released the report, "Reinventing Undergraduate Education, a Blueprint for America's Research Universities," in April 1998. The report was written by an 11-person Commission chaired by SUNY Stony Brook President Shirley Strum Kenny. It is commonly referred to as the Boyer Commission report, after the late President of the Carnegie Foundation, Ernest Boyer. The popular press, and indeed many academics, interpreted the report as a general condemnation of the undergraduate experience in the Nation's Research Universities. The New York Times (April 20, 1998) wrote "The acclaimed research universities of the United States are shortchanging their undergraduate students..."

A more careful reading of the report reveals the Commission's belief that "Research universities are distinctly different from small colleges, and they need to offer an experience that is a clear alternative to the college experience." That is, the strength and importance of the Research Institutions is not challenged by the Commission. Rather, the Commission's primary issue is undergraduate *access* to learning through *participation* in the Research University. Participation in research can *strengthen* undergraduate learning and can better prepare students for the modern workplace, where the technical and thinking skills of the research community are required to compete.

The New Model

What is needed now is a new model of undergraduate education at research universities that makes the baccalaureate experience an inseparable part of an integrated whole. Universities need to take advantage of the immense resources of their graduate and research programs to strengthen the quality of undergraduate education, rather than striving to replicate the special environment of the liberal arts colleges. There needs to be a symbiotic relationship between all the participants in university learning that will provide a new kind of undergraduate experience available only at research universities. Moreover, productive research faculties might find new stimulation and new creativity in contact with bright, imaginative, and eager baccalaureate students, and graduate students would benefit from integrating their research and teaching experiences. Research universities are distinctly different from small colleges, and they need to offer an experience that is a clear alternative to the college experience.

From "Reinventing Undergraduate Education"

The Boyer Commission uses the metaphor of an ecosystem to describe the Research University. "The ecology of the university depends on a deep and abiding understanding that inquiry, investigation, and discovery are the heart of the enterprise, whether in funded research projects or in undergraduate classrooms or graduate apprenticeships. Everyone at a university should be a discoverer, a learner."

Like a true ecosystem, the university is full of communities made up of individuals, competing for survival in a resource-limited world. Individual survival strategies may lead some faculty to devote themselves to research, at the expense of teaching, and vice versa. Because the teaching and research communities don't always walk hand in hand, it will take changes in academic culture and new resources to stimulate the harmony needed to reinvent undergraduate education.

Access to the Research University

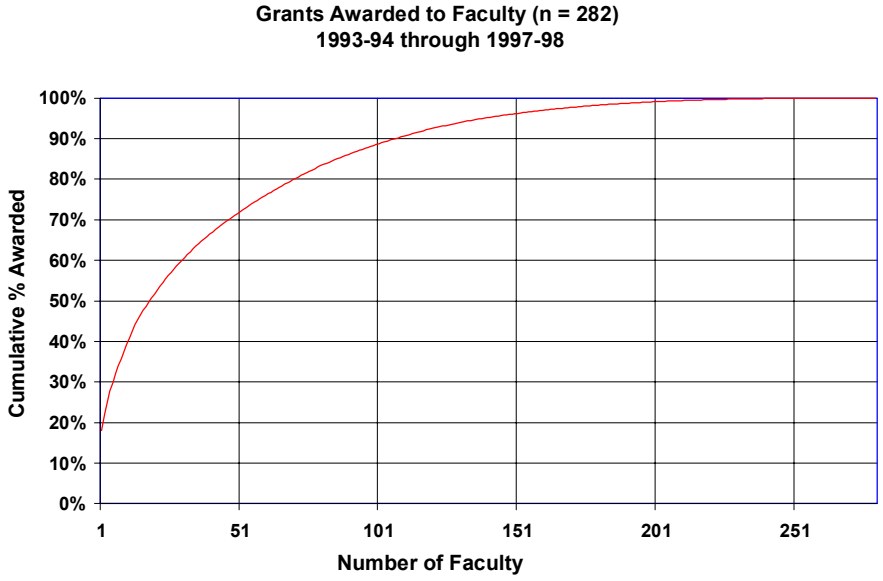
In the spirit of the Boyer Commission, the University of Rhode Island is pursuing new ways to use existing research strengths to improve undergraduate education. Four innovative learning partnerships were created in 1995 — Sensors and Surface Technology, Public Health Partnership in Infectious Disease Control, Partnership for the Coastal Environment, and the Health Promotion Partnership. Each was designed to stimulate experiential learning and an inquiry approach, creating a student "who knows what it is to inquire, who can more easily move from field to field, who can be critical minded, and who can synthesize as well as analyze." Reports on the experiences of partnership fellows have been positive, but faculty reviews have been mixed.

In a second approach, the President has asked academic departments to develop new paradigms for learning, also based on the Boyer Commission. In response, the Department of Natural Resources Science proposed a plan that would have students produce a professional development portfolio to bring together knowledge attained via traditional classrooms and experiential learning, and to also include involvement in practical research experiences. Linking URI undergraduates to the research university requires a binding spirit of inquiry and researchers who care to nurture formative students while maintaining highly competitive research programs.

Not all faculty are involved in research to the same degree. Over the past 5 years, nearly half of all grant dollars went to the Graduate School of Oceanography, which has 5% of URI's faculty, while 52% of URI's ~600 faculty received no grants at all. URI research was concentrated in three of eight colleges, plus the Cancer Prevention Research Center (see figure, p. 3). CPRC's Dr. Prochaska alone accounted for 18% of the total dollars received by faculty. One-quarter of all grant money went to just *three* URI researchers, and 75% of awards went to only 55 faculty.

Many faculty find it difficult to balance research and teaching commitments, and funding for undergraduate participation in research is rare in grant agency requests for proposals.

To integrate undergraduates into active research programs will require institutional money for stipends, graduate assistants, and new program coordinators. The federal government assumes that primary responsibility for funding undergraduate education belongs to each institution or state. The University, therefore, must be able to sustain budgets for support of new partnerships or paradigms, as it has done for the first partnerships and has been asked to do in the proposed NRS paradigm.



The New Economy

It is called The New Economy. The Progressive Policy Institute defines it as "a set of qualitative and quantitative changes that, in the last 15 years, have transformed the structure, function, and rules of the economy ... [and it is] ... a knowledge and idea-based economy where the keys to job creation and higher standards of living are innovative ideas and technology embedded in services and manufactured products."

Scientists engaged in applied research and engineers working on technological innovations are the drivers of this new era. Successful new industries are not driven by machinery, skilled shopfloor workers or even capital, but are fueled by research, design and development. Employment in these new companies requires a very new set of skills and knowledge. Today's high-skilled employees must have access to continued education and training to keep up.

Higher education must meet this need for a knowledge infrastructure. If the Nation's colleges and universities fail, we will not have the skilled workers and cutting-edge abilities to create enterprises with well-paying jobs, the foundation of healthy state economies. Because of their dominant position in the sciences and engineering, the Research Universities have a very special role to play in this goal.

The key to competing in the New Economy, says economist Lester Thurow is an educated work force. "Skilled people become the only sustainable competitive advantage." To maintain a lead in inventing new products, the education of the smartest 25% of the labor force is critical. To compete at being the cheapest and best producer of products, new or old, the education of the bottom 50 % is equally important so that they learn to use the essential new high-tech processes.

In the New Economy, the Nation's Research Universities must continue to lead in basic research and in long-term research for the public good. They must continue to provide the Nation with advanced graduates in science and technology, Thurow's smartest 25 percent, the innovators of tomorrow's industry.

Ironically, while the U.S. economy depends on growth in science and engineering, federal investment for nondefense R&D has steadily *dropped*, from about one percent of Gross Domestic Product in the 1960's to half that (.4%) today, and from about 5.7% of the federal budget in 1965 to 1.9% in 1997.

Funds supporting academic research are withering as well. As federal investment declines, states that muster resources to make up the difference have the best chance to prosper. States that do not recognize the full implications of either the New Economy or declining federal support for research will fail to invest in essential technologies and higher education.

Like third-world countries, they will find themselves becoming poor, dependent on the economies of wealthier neighbors.

The New Economy Enterprise

The New Economy is a metal casting firm in Pittsburgh that uses computer-aided manufacturing technology to cut costs, save energy, and reduce waste. It is a farmer in Nebraska who sows genetically altered seeds and drives a tractor with a global satellite positioning system. It is an insurance company in Iowa that uses software to flatten managerial hierarchies and give its workers broader responsibilities and autonomy. It is a textile firm in Georgia that uses the Internet to take orders from customers around the world.

It is also as much about new organizational models as it is about new technologies. The New Economy is the Miller brewery in Trenton, Ohio, which produces 50 percent more beer per worker than the company's next-most-productive facility, in part because a lean, 13-member crew has been trained to work in teams to handle the overnight shift with no oversight.

"The New Economy Index"
Progressive Policy Institute

State Partnerships for Economic Growth

Many states have recognized the importance of science and technology to their economic futures and are seeing the payoffs of public investments.

Ohio, for example, has launched the Edison program, a public/private partnership that promotes technology through seven technology centers and seven technology incubators. The incubators help start-up businesses by providing low-cost space, shared facilities and services, as well as technical expertise. In the 1990's, the Edison program created over 8,000 jobs and helped retain 10,000 more.

Another example is **Pennsylvania**'s Ben Franklin partnership program. Four technology centers, each affiliated with at least one university, act as funding agencies for a range of research and development activities. Pennsylvania invested $265 million from 1983 to 1994 and generated $954 million in match from the private sector and federal grants. This led to creation of more than 6,500 jobs and retention of 11,500 more. It created 825 new firms and expanded more than 1,000 others.

A third example is the **Kansas** Technology Enterprise Corp., established in 1987, which again uses a model of industrial and university collaboration to stimulate business growth. By 1995 it had helped start 131 new businesses, created nearly 6,500 new jobs, and trained more than 7,800 employees.

Virginia's Center for Innovative Technology was designed to enhance R&D capabilities of the state's major research universities and to bring businesses and universities into cooperative and innovative relationships. The Center launched 836 research and technology projects that helped 786 companies and brought $155 million to Virginia universities.

The investments are paying off. Fueled in part by an explosion in information technology, the U.S. economy boomed in the second half of the 1990's. Industries that process information—biotechnology firms, financial services, software development, management consulting, and the entertainment industries—reached new highs, leading the economy on a surge that few experts in the early 1990's saw coming.

Rhode Island has an Economic Development Corporation to help stimulate economic growth. It has begun to support business-oriented centers of excellence at institutions of higher education. For example, an Ocean Technology Center was established at the URI Graduate School of Oceanography in 1993 to support marine-related research with high potential for business innovation.

Rhode Island is not investing in research and development to the extent that other states are. Rhode Island ranks 33rd in total R&D expenditures (0.5% of the Nation's total). Most of this money is spent for defense research.

The State of Rhode Island itself spends only 0.02% of its state budget on R&D (75 cents per capita), ranking it **48th in the Nation**. Nationwide, states spend an average of **$9.59 per capita** on research and development, more than 12 times Rhode Island's spending.

Rhode Island needs to commit more seed money to put economic development in full gear. Rhode Island should look to successful states for guidance, finding those who are doing best, measuring our performance against theirs, and studying *why* they are the best. This process, which is called 'bench marking' in the business world, is essential for a state that wants to insure its future.

There is little reason for further complacency with the Rhode Island economy. There is plenty of reason to assume the worst, and more reasons are being written every day in the newspapers. Rhode Island needs to overcome a very strong tendency to resist change, acting as though we have cause to expect imminent economic growth. It may be good politics to claim that we really have no problems and that things are okay as is. Reality, however, requires preparing for what actually exists. We live in a new economy. It's time for change.

Toward a New Rhode Island Economy

Rhode Island *needs* the New Economy. There are just too many signs that Rhode Island's old economy isn't doing so well:

- Rhode Island ranks 43rd in personal income growth in the 1990's (Newsweek, Feb. 7, 1999).
- One in three Rhode Island children live below federal poverty lines (Prov. Journal, Feb. 15, 1999).
- Rhode Island ranks 49th in moving people off welfare (Prov. Journal, Feb. 1, 1999).
- Rhode Island State government earns an F for management of human resources and a D for use of information technology in a Syracuse University rating (USA Today, Feb. 1, 1999).

The Rhode Island economy once relied on textiles, jewelry, and submarines, but these industries are now all but gone. "In Rhode Island we are still looking for a growth industry, something to move this economy along," says URI economist Glenworth Ramsay. "We just don't have it." (Prov. Journal, Feb. 23, 1999)

Rhode Island is falling behind. According to Rhode Island Economic Development Corporation data, the RI economy is growing more slowly than neighboring Connecticut and Massachusetts, and has fallen well behind national average growth.

For example, between 1987 and 1996, the average Gross State Product of the 50 states increased by 16.2%, in real dollars. At the same time, Rhode Island's GSP increased by only 2.1%.

Rhode Island personal income is also seriously lagging behind neighboring states. In 1997, per capita income was $25,689 in Rhode Island. It was 21% higher in Massachusetts ($31,207) and 40% higher in Connecticut ($35,954). In the previous decade, personal income in Rhode Island had grown at a rate 2.7% slower than in Massachusetts and 10% slower than in Connecticut.

Like the rest of the country, Rhode Island has seen jobs move from manufacturing (down 31% in 10 years) to services (up 33%). Total RI unemployment rose, from 3.8% in 1987 to 5.3% in 1997 while the National average dropped, from 6.2% in 1987 to 4.9% in 1997. Rhode Island is not keeping up, and many worry that the State will be the first to fall when the national economy once again looses steam. The problem is clear: the State needs greater productivity from a more diverse set of industries. To again borrow from Thurow, the solution is also known — more investment, more skills, better strategies. The question is not "What should Rhode Island do?" but "How does Rhode Island force itself to do what it knows needs to be done?"

Rhode Island has the wealth and knowhow to make the investments needed to begin the long process of catching up. It remains to be seen whether it has the political will to get moving.

Falling Behind

In 1870, Britain was the worldwide leader in high-technology industries of the day. Its leadership in the early stages of the Industrial Revolution gave its citizens a significantly higher standard of living than enjoyed in the United States or any other large country in the world. But over the next 125 years, income per capita grew in Britain at a rate that was slightly smaller, just one half of one percentage point per year, than the rate in the United States. Because of the power of compound rates of growth, this seemingly small difference had a dramatic effect. In 1870, average income per person was 1.3 times larger in Britain than in the United States. By 1994, it was only 0.72 times as large. Stating the difference in dollars makes this reversal all the more stunning. In 1994, income per person in the United States was about $6,000 higher than it was in Britain. That means that for every man, woman, and child in the United States, we now produce an additional $6,000 in resources each year. These are resources that we would not have if we had merely caught up and kept up with the British.

from Innovation: The New Pump of Growth
Paul Romer, *in* **Blueprint** / Winter 1998.

Prospering in the New Economy

To be sure, Rhode Island's old economy does include some companies that understand the New Economy and are mastering it, but there are just not enough of them.

From its home in West Kingston, 10-year-old American Power Conversion has turned heads worldwide with its dazzling success. APC both designs *and* manufactures computer backup power products on U.S. soil. The company has embraced New Economy methods, allowing it to compete in a global marketplace. APC relies on a web-based management system to maintain a competitive edge against leading Japanese and German competitors.

Management information systems and computer-aided design have eliminated the need for old-fashioned clerical and draftsman jobs, but have created high-paying new positions and the cost-savings that have allowed APC to grow steadily in every quarter since it opened. The company is a model of what it takes to survive in the New Economy, a model that other companies — and indeed all agencies of government — need to understand and emulate if Rhode Island is to improve its economic future.

APC has benefitted from Rhode Island higher education. Its founder and president is a URI graduate, as are many of its employees. APC hungers for graduates trained in management information systems, but often has trouble finding skilled applicants.

URI's land grant mission must evolve with the economy. The state college once answered the need for affordable education for scientifically educated farmers and mechanics. It must now respond to new needs for education for the modern work force. Its capacity to train —to meet the needs of modern sciences and to keep pace with technology — is related to its capacity to conduct leading-edge research.

New Economy Attitude

Our primary objective is to identify and solve our customers' power related productivity problems faster and better than anyone *in the world*. We strive to exceed expectations by providing high quality products at a reasonable price, and by backing those products with *excellent customer service and support*.

We consider our shareholders and employees to be our partners in prosperity. We develop opportunities we believe will enhance the return on our shareholders' commitment. We seek to grow *worldwide market share* and serve *markets that represent opportunities for long-term success*. We focus our efforts and expenditures on success in that mission.

We apply both leadership and teamwork to every aspect of our business. We value and reward *creativity, productivity, initiative and loyalty*. We encourage *independent thinking* and respect. We communicate our accomplishments and mistakes so we may learn from each other. We work to extend our reputation for valuable products and *knowledgeable, talented people*. We strive for uninterrupted but managed growth for the Company, our shareholders and our employees, and believe that ownership in the Company drives our success.

Mission Statement
American Power Conversion Company

Keeping Up

"It will have taken the Internet less than *seven* years to be adopted by 30 percent of Americans, compared to *13* years for PC's, *17* for televisions, and *38* for telephones."

from The New Economy Index
Progressive Policy Institute

The Capacity to Excel

The most widely known measure of the capacity of colleges and universities to meet the needs of modern society is the Carnegie classification, developed by the Carnegie Foundation for the Advancement of Teaching in 1970.

The University of Rhode Island is classified Research University II. This means that it offers a full range of baccalaureate programs, is committed to graduate education through the doctorate, and that it gives high priority to research.

The University of Rhode Island has many elements of national and international distinction, a trait in common with all Research University I and II institutions. The quantitative distinction of Research I designation, however, reinforces recognition that the scholarship of the University is of the highest scope and national significance, and that the University's scientists are addressing the nation's most pressing needs for fundamental and applied science, a recognition affirmed by success in a terribly competitive grants arena.

The University averaged $32.3 million in federal research and development (R&D) expenditures for the 3 fiscal years 1994 through 1996 (in constant FY1992 dollars) according to the National Science Foundation's database. In the simplest terms, therefore, a move to Research I will require a 25% increase in federal grant dollars.

As URI moves to Research I it also moves toward providing the undergraduate student with access to cutting-edge research. This is also critical to providing firms with a highly-skilled workers, something Rhode Island has been lacking.

"Our land-grant legacy assigns to the University a vital role in knowledge creation and knowledge application.. This is most tangibly embodied in the University's research programs...

The University is committed to achieve Carnegie Research I classification [to] place the University among the nation's top research institutions."

University of Rhode Island
Academic Plan
May 22, 1998

Increasing Funds for URI Research

Several factors affect the prospects for URI to increase its external support for research:

➢**Administrative will.** Giving research high priority is vital for future growth.

➢**Available research funds**. Federal funds are volatile and change with national politics.

➢**Competitive edges**. Research strengths must be congruent to federal funding priorities.

➢**State, institutional, and industrial support**. These affect *capacity* to do research, a critical variable in all federal grant competitions.

➢**Matching funds**. Federal agencies either *require* matching state or university funds or *favor* proposals that include it.

Overview of R&D Funding Sources

Research and development in the U.S. is *funded* by federal, state, industrial, and private sources, and *performed* by federal and state research labs, universities, industry, and private organizations. Federal and state funds have traditionally provided most support. Industrial collaborations have increased in the 1980's and are adding hope to the research equation.

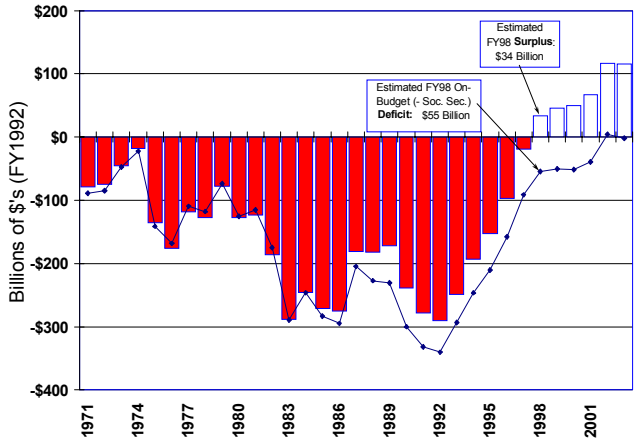
Federal agencies expect non-federal funds (i.e., state, university, or private) to support academic research laboratories, centralized analytic equipment, technical staff, graduate research assistants, and faculty research salaries. Federal agencies support research following individual agency agendas, announced annually in formal requests for proposals. Priorities are set in conjunction with the Congress, which has ultimate authority over agency budgets.

State governments support R&D and economic development partnerships either through direct *state agency* support, as outlined earlier, or through *university* budget allocations. States principally rely on their public universities to meet research needs.

Industry support is a significant part of total R&D funding at most institutions. Partnering with select companies strengthens a university's ability to compete for federal funds, strengthens local economies and enhances academically important research programs.

Federal R&D Expenditures

The U.S. federal budget has been in deficit since 1960. The surplus that President Clinton and members of Congress talk about in the nightly news treats receipts from social security payments as though they were available for current spending. If social security payments are accounted as payments into a trust fund, the government is now in deficit and will be until 2002. It will remain under pressure to restrict spending, constraining future support for academic R&D.



Federal deficit or surplus in constant (1992) dollars, 1971 to 2003. Bars include social security revenue; lines do not.

Cumulative deficits have raised interest payments on the national debt to 14% of today's federal budget. Social security, medicare, medicaid, and other mandatory outlays require another 53%.

Less than 32% of the federal budget is available for discretionary spending, and this is split between defense and domestic programs.

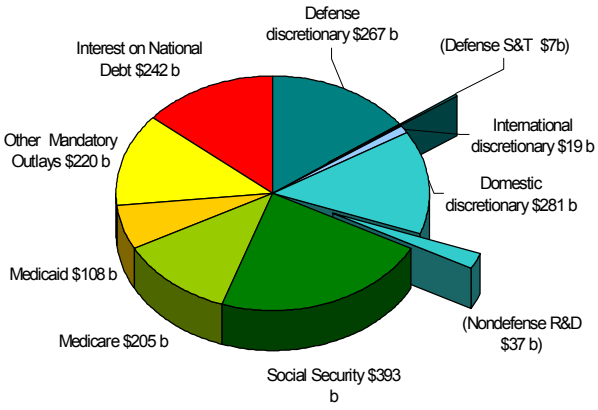
In FY1999, federal support for all U.S. research is ~$43 billion, including $7 billion in defense R&D. Given the national deficit, the current payments on past debt, and tremendous political pressures to cut taxes by cutting discretionary spending, it is surprising to many observers that federal support for research remains as strong as it is.

To be sure, what the nation spends its research funds on is subject to national politics. For example, an emphasis on nonmilitary R&D in the 1970's yielded to the Reagan administration's high priority for the military's 'star wars' missile defense system in the 1980's. In the 1990's, the Clinton administration cut defence research in favor of deficit reduction and nonmilitary R&D priorities

Industry R&D Expenditures

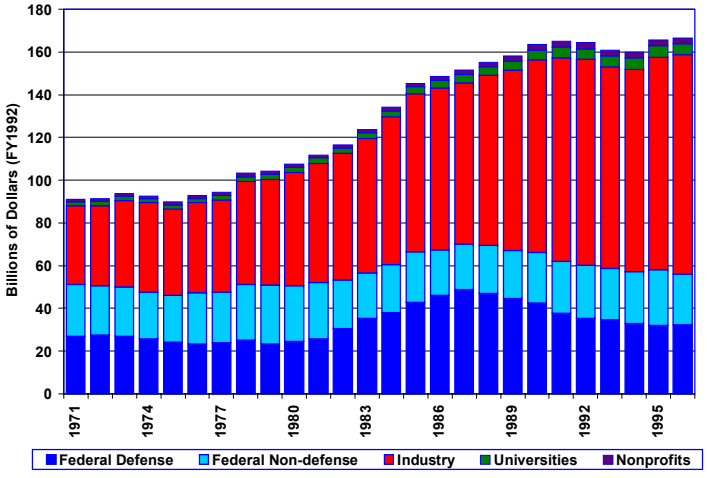
Industry performs most of the R&D in the United States. The fundamental mission of industry R&D is not fully congruent with the mission of public university R&D. That is, industrial R&D is strongly affected by pressures for short-term profit for corporate shareholders. Universities must show long-term public benefits in return for public tax support.

Despite these differences, universities and industry have many reasons to work together: These include opportunities to train future employees, to exchange ideas, to share technology, and to realize profitable returns on co-operatively-developed intellectual properties. Many research universities realize substantial returns on patents and licences held by the institution, often developed through industrial liaisons. URI earned nearly $1 million in patent royalties and licence fees in 1997.



FY1999 federal budget.

"Public opinion is everything. With public sentiment nothing can fail; without it, nothing can succeed."
Abraham Lincoln



Funding sources for all U.S. research and development, in constant (FY1992) dollars.

Federal R&D Agencies

Six federal agencies account for 95% of all federal R&D funds:

- ⋖National Institutes for Health (NIH)
- ⋖National Science Foundation (NSF)
- ⋖Department of Defense (DOD)
- ⋖Nat. Aeronautics & Space Adm. (NASA)
- ⋖Department of Energy (DOE)
- ⋖Department of Agriculture (USDA)

Agency budgets change with national politics. In the mid-sixties, for example, as the Nation was racing to put a man on the moon, a whopping 68% of federal R&D went to NASA.

Oil shortages in the 1970's sent a flood of funding to the Department of Energy. The 1990's saw increased funding to the National Institutes of Health, largely because of AIDS.

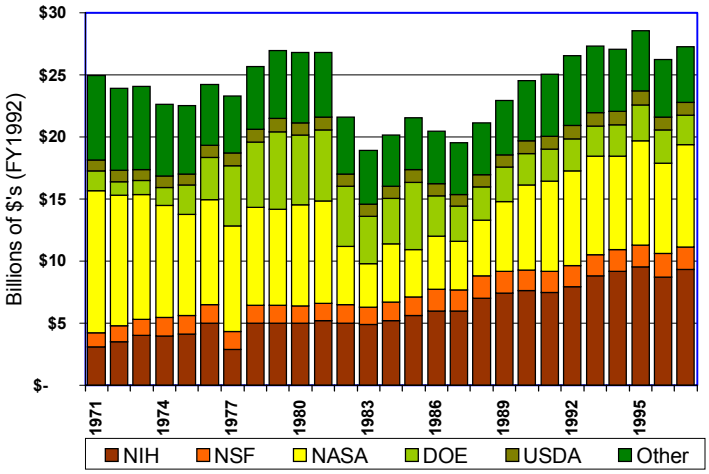
Overall, although federal research funding has shifted from agency to agency, real growth in federal R&D funding has been flat.

Federal Academic R&D Funding

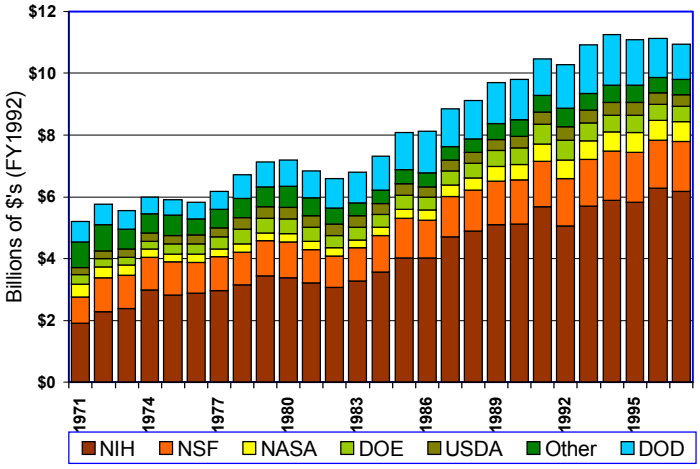
Much of the federal budget for R&D is awarded to universities. These funds grew steadily, nearly doubling from 1970 to 1994, when they began a gradual decline. Currently, 82% of federal funds for academic R&D comes from only three agencies — NIH (57%), NSF (15%), and DOD (10%).

Although there were predictions of a 25% drop in federal R&D as recently as 1996, the outlook for R&D has been improving. Current projections are for NIH funding to grow by 32% through 2003. NSF is projected for slight growth and other agencies for no growth or modest declines. Academic funds are expected to follow suit.

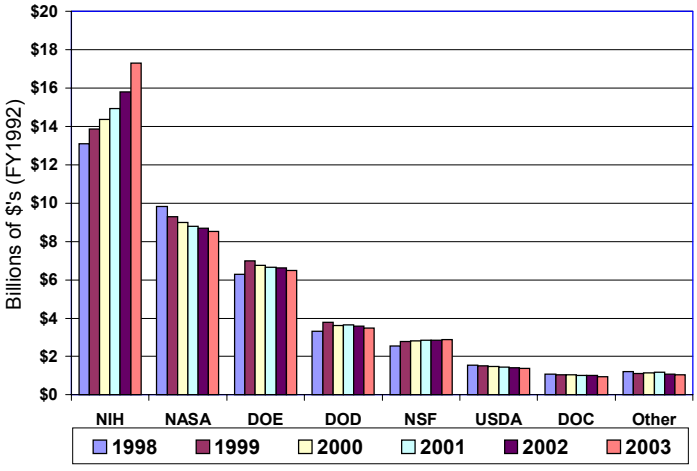
However, agencies that fund most of URI's research are not expected to grow. At the same time, all agencies are asking more in the way of matching non-federal funds as a condition of grant awards. If URI cannot develop sufficient match, it cannot compete for these funds.



Federal agency budgets for *all U.S.* research and development, in constant (FY1992) dollars.



Federal agency budgets for *academic* research and development, in constant (FY1992) dollars.



Projected federal agency budgets, FY1998 — 2003, in constant (FY1998) dollars.

Research Funding at URI

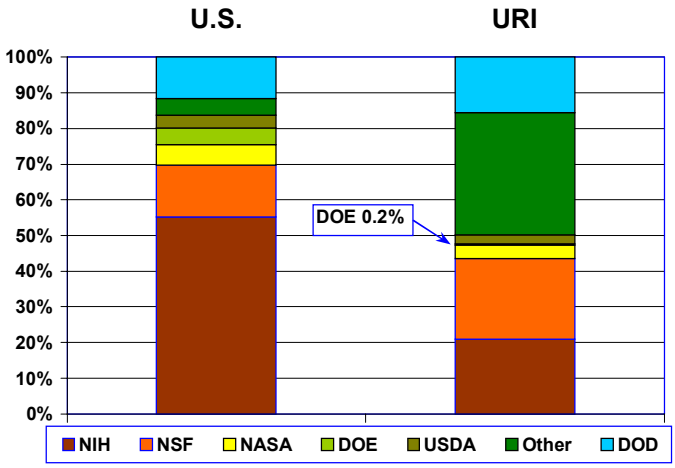
To be most successful in competing for grants, a university's research strengths must fit closely to federal funding priorities. URI is competitive in some areas (e.g., marine and environmental sciences) but overall, URI's strengths are not fully congruent with the relative availability of federal funds. Without a medical school, URI competes only for limited funding categories within NIH (e.g., behavioral psychology). URI competes successfully for funds from the Dept. of Commerce (NOAA and Sea Grant), the Environmental Protection Agency and the Department of the Interior, part of the relatively small (5% of total) pool of "other" R&D funding agencies.

NSF data show that federal support for university research *nationally* has grown *in real dollars* over the past 25 years, an increase of ~125%, and state and local funds have risen 92%. Universities are spending more of their own money on R&D, up 325%. Industry collaborations have increased 533%, although they still make up a relatively small part of the overall funds base. Nonprofit foundation contributions have risen by 170%.

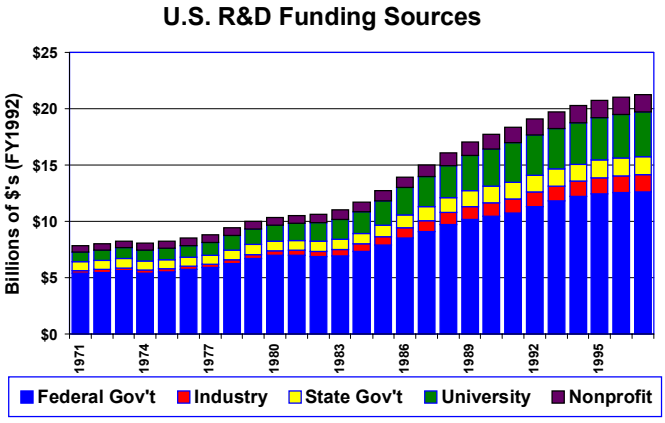
NSF data for FY1996 show that URI has the *highest percentage dependency* on federal grants of any Carnegie Research University I *or* II. The percentage of expenditures for academic research for the nation, for the 57 *public* Research University I's, and for URI for FY1996 are as follows:

Source	URI	Public Res. I's	US
Federal	91.8	55.8	59.9
State / Local	1.9	9.8	7.5
Industry	0.8	6.0	7.0
University	5.5	22.5	18.4
Private	0.0	5.9	7.2

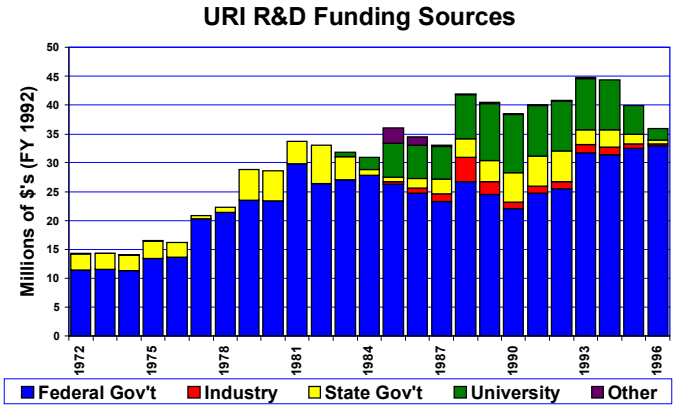
Support for the RI Agricultural Experiment Station shows a similar high dependency on federal funds. RIAES barely meets federal match requirements (1:1 state:federal), 54th of 55 Stations. Nationally, states match federal AES funds at an average rate of $5.95: $1 (FY1996).



Composition of national and URI academic R&D funding by primary agency sources, FY1998.



Total U.S. expenditures for academic R&D by major source, 1971 to 1997, in constant (FY1992) dollars.



URI expenditures for R&D by major sources, 1971 to 1996, in constant (FY1992) dollars.

URI R&D Capital Funding

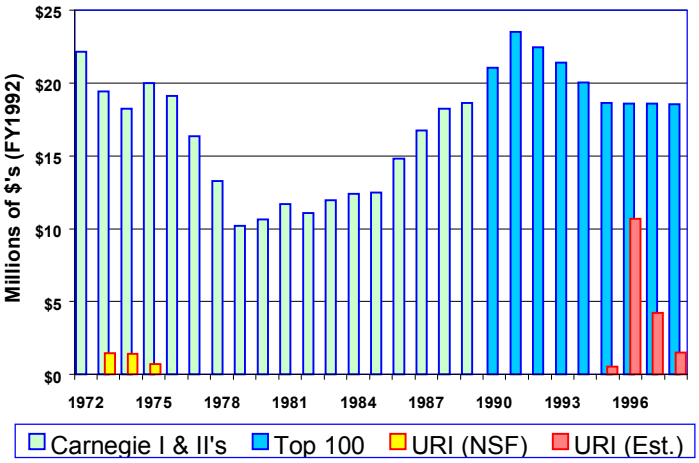
All grant competitions consider institutional *capacity* to perform proposed research. The state of an institution's equipment and laboratories thus affects grantsmanship. Research capacity is related to expenditures for R&D capital, which includes costs for major equipment, laboratory improvements, and buildings that are primarily for research.

In the last 25 years, URI annual capital R&D expenditures have been less than 5% of the average for other Research Universities. There was little spent on URI research facilities in the 1970's and virtually nothing in the 1980's. Things improved a bit in the 1990's to include the Kirk Applied Engineering Laboratory, the Cancer Prevention Research Center, the Center for Atmospheric Chemistry Studies, and the Coastal Institute Building on Narragansett Bay. Campus-wide improvements in computer networking also benefit research. Future investments include the Kingston Campus Coastal Institute Building , the Bay Campus Aquaculture lab, and the Ranger Hall Environmental Biotechnology renovation.

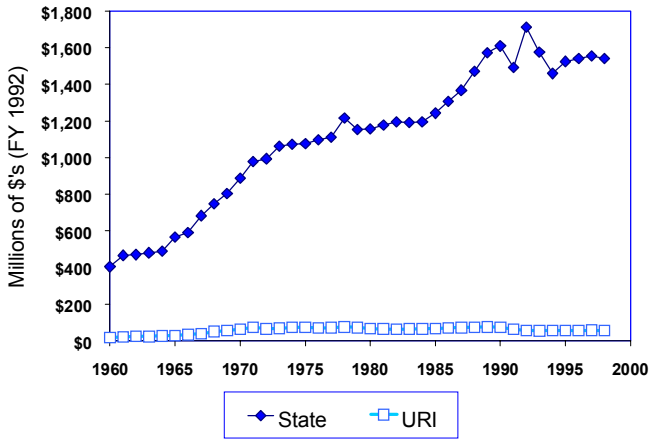
Doing More With Less

URI support for R&D has followed a general decline of state support for URI. FY1998 state funding for URI, adjusted for inflation, equals support in FY1969, although the total state budget has increased 92% since then. In 1971, URI was 7.7% of the state budget; it is only 3.7% today. Although there are the same number of faculty today as in 1970, there are 34% more students to teach. More faculty today are full professors (55%, up from 21% in 1970), and faculty salaries consume 56% of state funds today, up from 41% in 1970.

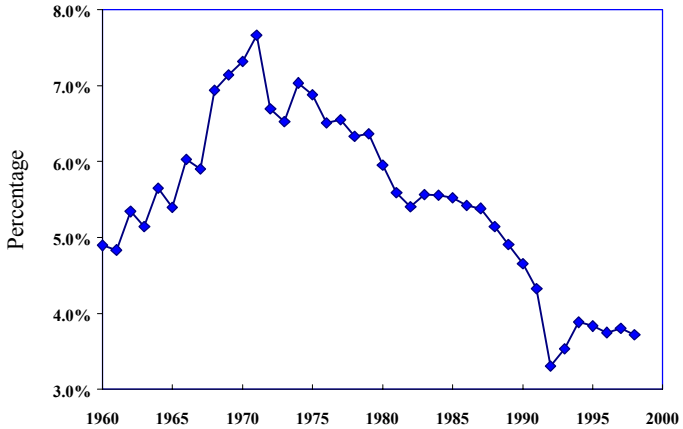
Given real increases in all costs , there is much less available at the University to support research today than there was 30 years ago. Despite this, faculty have been able to increase the amount of external grant awards (up 151% from 1972 to 1996).



Mean Capital Expenditures for Research Universities, 1971 to 1998 (see notes for explanation).



Growth of State and URI General Revenue Budgets, 1960 to 1998 (est.), in constant (FY 1992) dollars.



URI as Percent of State General Revenue Budget, 1960 to 1998

Conclusions

The University of Rhode Island has multiple missions to fulfill, missions that cannot be relegated to any other segment of government or to any other institution of higher learning. As Rhode Island's land grant university, it alone is responsible for environmental, agricultural, and natural resources research. As our sea grant institution, it has a singular mandate for stewardship over global marine resources, with special responsibility for Narragansett Bay and the near Atlantic ocean. As a Carnegie Research University, it has national and international imperatives to address a wide array of scientific and technological challenges to help human beings cope with life on a crowded planet.

As it enters the next century, URI must take on *new* responsibilities for education to meet the needs of a new economy that is driven by rapidly changing science and technology. As its land grant tradition evolves, URI's educational mission will be to create new generations of scientists, educators, and business and government leaders, and to prepare a sophisticated work force with the skills needed to prosper in a dynamic and competitive global economy. It must also live up to the legacy of the Morrill Act by elevating the University's curricula to the higher standards of sophistication needed in today's workplaces and by continuing to provide affordable higher education to all capable men and women who seek it.

To fulfill its many missions, the University must have resources to modernize its science and engineering facilities, to make them more relevant for teaching and competitive for research. URI must cope with the budget priorities of the federal government, and recognize the implications of incongruities between those priorities and the strengths of its faculty. The State must also understand that the federal government insists that the states bear primary responsibility for their public institutions of higher learning.

The University and the State need to find new ways to excite industrial interest in URI research. If there is little that the University is doing that is attractive to business investment or collaboration, we must find new ways to make relevant contributions to our State's economy. Although there are differences in the research missions of private industry and public universities, there are more than abundant reasons to develop new working relations based on intellectual affiliations and the exchange of ideas and people.

The State and the University need to understand that faculty compete in increasingly competitive grants arenas and that research capacity — sophisticated technical staff, instrumentation, matching operating funds, research buildings and laboratories — often determines who wins the competition. Without institutional support, research capacity in many areas of the University will remain a serious detriment in competition for grants.

Similarly, Rhode Islanders need to understand that it has never been a federal priority to provide state-of-the-art training facilities for *our* sons and daughters. Do we really need to ask ourselves, if our University science and engineering facilities do not keep pace with those in the economy surrounding us, will our teaching remain relevant, and will our graduates be able to compete? Rhode Island must choose to accept the necessary public investments to keep URI's Research University first-rate. Of all that we can do to leave a brighter legacy for our posterity, this is surely among our highest priorities.

Recommendations

URI has a goal of attaining the Carnegie Research University I level of federal funding. The campus community — faculty, staff, and administration — need help from the Board of Governors, the Rhode Island Legislature, the Governor, and the people of Rhode Island to reach that goal.

Certainly, it is within the demonstrated intellectual capacity of URI's faculty to compete effectively for many kinds of federal grants. We have several areas of strength. We have the ability to broaden these and to extend our research in new directions. Presumably, we have many reasons to do so, including the overriding need to fortify and diversify the Research University, and to open it to talented advanced students, including significant numbers of undergraduates. We also need to address the compelling economic needs of the state, and to reinvigorate our sciences and engineering to better serve the practical needs of our society.

There are several possible starting places:

INITIATE Strategic and Fiscal Planning. Specific plans to reinvigorate the Research University should be initiated by the Research Office, in conjunction with the research Colleges (led by GSO /CELS and EGR), the Agricultural Experiment Station, the Sea Grant College Program, and representatives from the research community. These plans should begin by assessing where the Research University needs to be strengthened and the means to accomplish this. The process needs to include assessment of future faculty hires, technical support staff, centralized support facilities, graduate research assistantships, operating funds, match funds, and funds for laboratory renovations

PRIORITIZE Institutional Policy. The University needs to revise the Program Contribution Analysis to more fully recognize the Research Mission. The PCA needs to acknowledge more than overhead income from grants. Most research faculty feel that the University needs to weigh the needs of the Research University equally to the Teaching University in developing long-term hiring plans, and to balance support for teaching with support for research in its policies for the allocation of graduate assistantships, departmental operating funds, and capital.

ESTABLISH Economic Development Alliances. URI and the Economic Development Corporation need to establish new industrial interfaces to link high-tech/ high-pay companies to relevant faculty expertise. The proposed link between URI plant genomics and AgriBioTech, Inc., is an excellent prototype. Others must follow, provided the State and University can develop adequate funding.

EXPAND Investment in Research Capital. Most of URI's research laboratories are too out of date to be fully competitive. Too many are overdue for renovation. The current low level of asset protection funds is forcing piecemeal rehabilitation, and renovations are lagging far behind needs.

RECOMMIT to a Strong Research Mission. The Rhode Island Legislature has mandated that the Board of Governors maintain the Agricultural Experiment Station. If it remains the intent of the legislature to support research at URI as originally institutionalized in the Station, then the Board needs to account for how it will do so. The Board should declare how it intends to enhance state and university support for research. It also needs to clarify its position on the relationship between research and education (both graduate and undergraduate), and the future of URI research as an instrument of state economic development.

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* Available as PDF or HTML file for download from WWW.

Notes

Frontispiece: Lester Thurow. 1992. Head to Head: The Coming Economic Battle Among Japan, Europe, and America. Warner Books. 336 p.

Preface: University of Rhode Island Academic Plan. May 22, 1998.

"State of lowered expectations" is from John Casey's **Spartina**.

Pg. 1: "Reinventing Undergraduate Education: A Blueprint for America's Research Universities." A.K.A. The Boyer Commission Report. Available from http://notes.cc.sunysb.edu/Pres/boyer.nsf.

Pie Charts: NSF S&E Indicators, 1998. See Refs.

Pg. 2: Three bar charts. NSF, *ibid.*

Pg. 3: Mission Statement is from 1998/98 URI Bulletin.

Faculty #'s Pie is from annual Instructional Report, URI Institutional Research Office.

Grant % Pie is total from annual report of the Research Office, 1993/95 through 1997/98.

Pg. 4: History from Herman Eschenbacher's **History of the University of Rhode Island**.

Purpose of the University is from RI General Laws, courtesy of Wm. M. Sullivan.

Pg. 5: Charles Sykes. 1990. **ProfScam: Professors and the Demise of Higher Education**. St. Martin's Press.

Boyer Commission. See pg. 1.

Pg. 6: All statistics are from Research Office Annual Reports. It is difficult to quantify the percentage of faculty within each college who have been awarded grants since 1993. Within 10%, appropriate estimates are 100% for faculty in GSO, ENG, and the CPRC, 90% for CELS, 70% for Pharmacy, 50% for HHS, 30% for A&S, 25% for Nursing, and 15% for Business.

Pg. 8: Thurow. *ibid.*

Descriptions of state economic development agencies is from F. Dietz. 1998. Technology Development Drives State Economies. Mechanical Engineering - CIME pub. by the Am. Soc. of Mech. Engineers.

Pg. 9: RI data from RI Economic Development Corporation website, www.riedc.com.

Pg. 10: APC mission from www.apcc.org.

"Keeping up" from Prog. Policy Inst. (See refs.)

Pg. 11: NSF data downloaded from WebCaspar, available off of NSF home page under science statistics, etc.

Pg. 12: Federal deficit data from OMB Historical Tables, Table 1.1 (see refs.)(before 1998). FY98 and later is from OMB FY99 Mid-session Review, Table 115.

Pg. 13: Pie is from OMB mid-session review. Also discussed on AAAS website, www.aaas.org/spp/dspp/rd/bdgt99p.pdf.

Bar chart from NSF, Nat. Pat. of R&D Res., 1996, Table C-3, and from OMB FY99 Budget Historical Tables, Tables 1.3 and 9.7.

Licence fees from AUTM Licensing Survey: FY 1996

Pg. 14: Top & middle charts from NSF S&E Indicators 1998, App. Table 5-8.

Bottom chart is from AAAS, Rep. 23, (refs), Table 5.

Pg. 15: Top chart is from NSF, ibid., and from URI Res. Office Annual Reports.

Middle and bottom are from NSF website, downloadable from WebCaspar under Science Stats page.

Agricultural Experiment Station data is from the USDA Cooperative Research Information System (CRIS), Inventory of Agricultural Research, FY1996.

Pg. 16: Top chart. Carnegie and "URI (NSF)" is from WebCaspar. NSF recorded individual institutional R&D Capital Expenditure data from 1972 to 1989, with no data in 1978 (points here are interpolated). After 1989, NSF provided robust estimators and recorded these as Cap. Exp. at the "Top 100," which includes mostly Carnegie I & II's. URI data for 1990's are estimated from data provided by the Cap. Projects Office. Costs for buildings are assigned to the *year the project was complete.*

Middle and bottom charts. State of Rhode Island budgets, 1950 - 1998.

Production Notes:
All graphs were prepared with MSExcel97.
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Appendix I — Carnegie Research Universities:

Research Universities I Public Institutions

ALABAMA	U. Alabama Birmingham
ARIZONA	
Arizona State Univ.	U. Arizona
CALIFORNIA	U.C. Santa Barbara
U. C. Berkeley	U. C. Los Angeles
U. C. Davis	U. C. San Diego
U. C. Irvine	U. C. San Francisco
COLORADO	
Colorado State Univ.	U. Colorado Boulder
CONNECTICUT	U. Connecticut
FLORIDA	
Florida State Univ.	U. Florida
GEORGIA	
U. Georgia	Georgia Inst. of Tech.
HAWAII	U. Hawaii Manoa
ILLINOIS	
U. Illinois Chicago	U. Ill. Champaign-Urbana
INDIANA	
Purdue University	Indiana U. Bloomington
IOWA	
Iowa State Univ.	U. Iowa
KANSAS	U. Kansas
KENTUCKY	U. Kentucky
LOUISIANA	Louisiana State Univ.
MARYLAND	U. Maryland College Park
MASSACHUSETTS	U. Mass. Amherst
MINNESOTA	U. Minnesota Twin Cities
MICHIGAN	Michigan State Univ.
Wayne State Univ.	U. Michigan Ann Arbor
MISSOURI	U. Missouri Columbia
NEBRASKA	U. Nebraska Lincoln
NEW JERSEY	Rutgers
NEW MEXICO	
U. New Mexico	New Mexico State Univ.
NEW YORK	
SUNY Buffalo	SUNY Stony Brook
NORTH CAROLINA	
U. N. C. Chapel Hill	North Carolina State U.
OHIO	
Ohio State Univ.	U. Cincinnati
OREGON	Oregon State Univ.
PENNSYLVANIA	Temple
Pennsylvania State U.	U. Pittsburgh

Research Universities I Public Institutions (cont.)

TENNESSEE	U. Tennessee Knoxville
TEXAS	
Texas A & M	U. Texas Austin
UTAH	
U. Utah	Utah State Univ.
VIRGINIA	U. Virginia
Vir. Commonwealth	Vir. Poly. Inst. & State U.
WASHINGTON	U. Washington
WEST VIRGINIA	West Virginia Univ.
WISCONSIN	U. Wisconsin Madison

Private Institutions

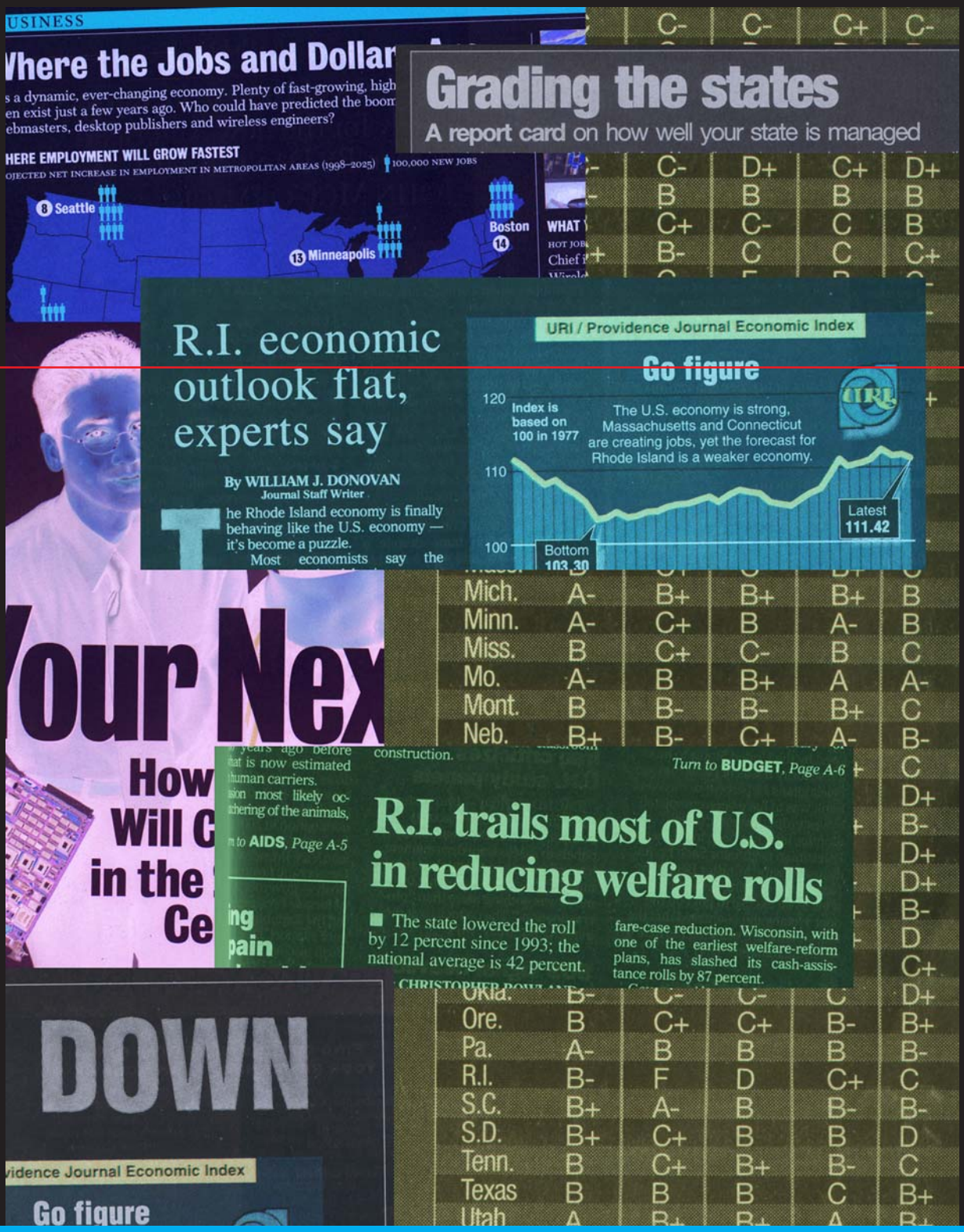
CALIFORNIA	U. Southern California
Calif. Institute Tech.	Stanford
CONNECTICUT	Yale
DISTRICT OF COLUMBIA	
Georgetown	Howard
FLORIDA	U. Miami
GEORGIA	Emory
ILLINOIS	
Northwestern Univ.	U. Chicago
MARYLAND	Johns Hopkins
MASSACHUSETTS	
Boston Univ.	Harvard
Tufts	Mass. Inst. Technology
MISSOURI	Washington Univ.
NEW JERSEY	Princeton
NEW YORK	
Columbia	Cornell
New York Univ.	Rockefeller Univ.
U. Rochester	Yeshiva
NORTH CAROLINA	Duke
OHIO	Case Western Reserve
PENNSYLVANIA	
Carnegie Mellon	U. Pennsylvania
RHODE ISLAND	Brown
TENNESSEE	Vanderbilt

Research Universities II Public Institutions

ALABAMA	Auburn
ARKANSAS	U. Arkansas
CALIFORNIA	
U. C. Riverside	U. C. Santa Cruz
DELAWARE	U. Delaware
FLORIDA	U. South Florida
IDAHO	U. Idaho
ILLINOIS	S. Ill. U. Carbondale
KANSAS	Kansas State Univ.
MISSISSIPPI	
U. Mississippi	Mississippi State Univ.
NEW YORK	SUNY Albany
OHIO	
Kent State Univ.	Ohio Univ.
OKLAHOMA	
U. Oklahoma	Oklahoma State Univ.
OREGON	U. Oregon
RHODE ISLAND	U. Rhode Island
SOUTH CAROLINA	
Clemson Univ.	U. South Carolina Columbia
TEXAS	
Texas Tech	U. Houston
VERMONT	U. Vermont
WASHINGTON	Washington State Univ.
WISCONSIN	U. Wisconsin Milwaukee
WYOMING	U. Wyoming

Private Institutions

DISTRICT OF COLUMBIA	
George Washington Univ.	
INDIANA	Notre Dame
LOUISIANA	Tulane
MASSACHUSETTS	
Brandeis	Northeastern Univ.
MISSOURI	Saint Louis Univ.
NEW YORK	
Syracuse Univ.	Rensselaer Poly. Inst.
PENNSYLVANIA	Lehigh
TEXAS	Rice
UTAH	Brigham Young Univ.



"Amid the *prosperity* of neighboring states, the economic outlook for Rhode Island is *decelerating* growth. **We need our leaders to realize the educational deficiencies here are in a crisis.**"

Economist Leonard Lardaro
The Providence Journal, February 23, 1999