

Jumpstart 2000--The Maine Economic Improvement Strategy: A Targeted Investment in Research and Development

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In recent years Maine has ranked fiftieth in per capita spending on university-based research and development in the United States, a distinction that an increasing number of Maine policy makers, citizens, business representatives and researchers find alarming. Citing the positive gains R&D investments have shown in other states--not the least of which is improved economic performance--the authors set forth an argument for investing in Maine's public R&D infrastructure. Whether and how to make such investments have been the subjects of recent debate in many states. The Review is committed to covering these varied perspectives in future issues.

*by Mark W. Lawrence
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This article states the case for a legislative initiative called *Jumpstart 2000--The Maine Economic Improvement Strategy*, which proposes both base-budget support and bond authority for targeted areas of science and engineering in the University of Maine System. The initiative is predicated on one stark fact: The State of Maine ranks fiftieth in the United States in per capita spending on university-based research and development.

While this last-place status is troubling as a measure of state funding for the University of Maine System, its implications for the state's economic future are even more disturbing. Throughout the United States, regions with vital universities conducting cutting-edge research in science and engineering have experienced growth in related industries. Good examples include the business development along Route 128 outside Boston, the Research Triangle Park area of North Carolina, Silicon Valley in California, and similar areas in Austin, Texas, and other regions with strong university research facilities. States such as Montana, South Carolina, and Georgia, which historically did not provide strong support for university-based science and engineering, recently have begun investing heavily--and with good results. The goal of the Maine Economic Improvement Strategy is to spur economic growth, especially growth in high skill, high wage jobs, by increasing targeted research and development efforts within the University of Maine System.

Maine's National Rank in R&D Investment

Maine lags far behind the rest of the country in university-based research and development. The 1996 Development Report Card for the States, prepared by the Corporation for Enterprise Development (CFED), reveals that in annual per capita investment in university research and development, Maine ranked fiftieth--dead last--at \$23.68 per person. According to CFED, "This

measure gives us a sense of the scale of research and development spending at universities in each state and, indirectly, its capacity to generate technology-related business development." In a related measure, Maine ranks forty-second among states in total federal research and development funding per capita (reported by the National Science Foundation's Report on Federal Funding of R&D). These two low ratings are related, because it is investment by the state that allows successful competition for federal funds.

The goal of Jumpstart 2000 is for Maine to increase by \$20 million its annual base-budget investment for research and development in the University of Maine System. This proposed level of spending is based upon an analysis of institutional needs in Maine and the evaluation of expenditures made by comparable Land Grant universities in Arkansas, Connecticut, Idaho, Massachusetts, New Hampshire, Rhode Island, Vermont, and Wyoming--institutions considered to be peers of the University of Maine. While the \$20 million increase would raise Maine's annual per capita expenditure to approximately \$40, it would still leave us ranked below fortieth in the nation. By way of comparison, Georgia, with five times the population of Maine, recently increased its investment by \$120 million per year for this purpose with strong positive economic consequences. In less than a decade, Georgia's per capita income, which once lagged behind, has surged to bypass Maine's. Our state simply must make this investment if it is to have a chance to compete in the increasingly fast-paced global economy.

Although Maine researchers, both public and private, have enjoyed some success when applying for federal funds (with approval rates equal to or slightly higher than the national average), the University of Maine's overall ability to compete is severely hindered by lack of facilities, equipment, personnel, and matching funds needed to secure federal funding. Consequently, Maine lags behind the rest of the country in obtaining federal grants for research and development. The number and dollar amount of federal funds obtained to date would have been substantially higher had the infrastructure and personnel been adequate for Maine scientists to compete on an equal footing with those from other states. Examples of those missed or delayed opportunities include federal programs designated specifically for support of scientific infrastructure. Grants for facilities or equipment (as opposed to specific research projects) typically require matching in the state-to-federal ratio of anywhere from 1:1 to 1:3. Unfortunately, because the University of Maine System historically has had little money available for matching, our researchers often forego writing proposals for grants that likely would be awarded. In recent years, federal grants totaling several million dollars actually have been awarded to the University of Maine to build or upgrade analytical facilities that are central to industry-oriented research, but lack of state matching has delayed expenditures of the federal money, in one case for more than three years. Obviously, Maine businesses have not been helped by these unfinished analytical facilities.

Current Status of Maine's Economy

Maine's economy has not performed well during this decade. The 1990s began in a recession that struck Maine more severely than most of the nation. Although our economy has improved during the recent recovery, growth in personal income and the gross state product has lagged behind the national average. In January 1997, the Maine Economic Growth Council released its third Measures of Growth report, indicating that the gross state product increased 1.5 percent in

1996, significantly less than the 2.6 percent increase in the New England economy. As of 1995 (the last year for which figures were available), Maine's per capita income was \$20,105, ranking thirty-sixth among the states. However, income and unemployment levels differ significantly between urban and rural areas of the state.

One effective way to improve the standard of living for Maine residents is to develop and attract new high technology companies. Such commercial firms exploit new ideas in science and engineering and require highly educated employees to bring those ideas to fruition. Maine is fortunate to have a few reasonably large and successful high technology companies, including Fairchild Semiconductor. However, during the past decade, the greatest business growth has not been in large established corporations, but rather in small start-up firms. Jumpstart 2000 is designed to set the stage for the establishment and growth of many more new businesses by bringing to the state highly trained professional scientists and engineers from carefully selected disciplines to conduct research and to educate Maine students.

An Opportune Time for Investment

The University of Maine System, especially the Land Grant and Sea Grant University of Maine (located in Orono, the state's only comprehensive research institution), has gone through an extremely difficult period since the economic downturn that began in 1989. Faced with slower increases in revenues, state government chose to trim spending for the University of Maine System. The University of Maine has been especially hard hit, with total employment reduced by more than 500 since 1990. As a consequence of this budget reduction and a recent early retirement offer, nearly 25 percent of faculty positions currently are open. These unfilled faculty positions at the University of Maine limit the institution's current capacity to conduct research and cooperate with state businesses. And yet, the many open faculty positions present a rare opportunity for rapid change. With increased funding in the target areas, the University of Maine can bring in young, energetic scientists and engineers who will provide a major boost to the institution's research and development efforts, increase the academic opportunities open to Maine students, and strengthen the interactions between researchers and businesses.

Genesis of the Strategy

Jumpstart 2000 grew out of the efforts of a great many people who care about economic growth and development in Maine and the level of research and development within our universities. Frustrated by recent budget cuts and the state's small investment in university research and development, five University of Maine professors--George L. Jacobson Jr., Stephen A. Norton, George Markowsky, Malcolm L. Hunter, and David C. Smith--initiated a study and a yearlong public education program designed to generate a dialogue among Maine's business, community, and political leaders about the role of science and engineering in the state's economic future. Members of the group traveled around the state, talking to business leaders, civic organizations, legislators, and anyone else willing to listen to the case for this critical investment in Maine's economic future.

The faculty group argued that Maine's historically low level of investment in university science and engineering is one of the primary reasons for the state's relatively poor economic performance. Maine's failure to invest in academic science and engineering started just after World War II and has continued to the present. That failure effectively has conceded to other states the large amounts of federal research funding from the National Science Foundation and other agencies that had been established for that purpose after the war. Allocating Federal Funds for Science and Engineering, a 1995 report by the National Academy of Sciences, points out that the federal government then spent nearly \$70 billion annually on research and development. Of this total, approximately \$12 billion went to support research in academic institutions; the remainder to federal laboratories, industry, etc. Thus, Maine's \$20-30 million per year in federal research support is disproportionately low by any measure. By comparison, in 1996 the state of New York had more than \$900 million in funding from the Department of Energy alone. On the positive side, this recognition of Maine's historical failing highlights the opportunity for future investments in science and engineering in the University of Maine System to capture a more appropriate share of federal funding, and to support research that ultimately will stimulate commercial development in high technology industries. The Jumpstart 2000 initiative is designed to increase spending on research and development within the University of Maine System, focusing on five areas that have good potential for economic development. The initiative includes two complementary pieces of legislation. The first is a bond issue to provide one-time funds for capital improvements in infrastructure necessary to support increased research and development. The second is the creation of a special fund--The Maine Economic Improvement Fund--designed to provide long-term base-budget support to the University of Maine System for the five areas outlined below.

Targeted Areas of Investment

The strategy calls for investment within the University of Maine System in five specific areas of research and development. These are (1) aquaculture and marine sciences, (2) biotechnology, (3) composite materials engineering, (4) environmental technology, and (5) information technology. The University of Maine System already has significant expertise in these fields, and major opportunities exist for commercial growth and development in Maine. During the past few years, the University of Maine has begun to make notable contributions in these areas. We know of at least two dozen companies "spun off" from the institution's research (nine in marine science and aquaculture; nine in information technology; three in environmental technologies; one in biotechnology; and two in food products).

This list of five target areas is not unique to the University of Maine System. Other organizations that have reviewed research and development and its relation to economic growth within Maine have identified these same areas. For example, The Maine Science and Technology Foundation's Action Plan, released in February 1997, recommends that the state "invest in the University of Maine's infrastructure to support the target industries and technology areas." The foundation's targets include all five areas identified in the strategy.

The Maine Chamber and Business Alliance, in its economic action plan, *The Course for 1995 and Beyond: An Implementation Strategy for Charting Maine's Economic Future*, set forth the ambitious goal of "putting Maine in the top half of all states for research and development" by

investing in a number of areas, including the five areas targeted in the strategy. Dana F. Connors, president of the Maine Chamber and Business Alliance, has endorsed the strategy publicly, an indication of the support within the business community for targeted investments in research and development within the University of Maine System.

1. Aquaculture and marine sciences

The University of Maine has a long history of marine research and is Maine's Sea Grant university. The university's new School of Marine Sciences focuses the institution's expertise in those fields so as to enhance Maine's ability to attract federal research dollars and assist in the development of marine-related industries in the state. Opportunities exist for Maine to develop aquaculture not only for seafood products, but also for applications in biotechnology, which may hold even greater potential for economic growth. Furthermore, the clean, cold, nutrient-rich waters of the Gulf of Maine provide an outstanding natural setting for these developments.

Another emerging industry in Maine and beyond is marine engineering, also an area of significant expertise at the University of Maine. Continued research in this area could provide growth opportunities for Maine's marine construction industry and lead to a complete revitalization of the state's failing coastal infrastructure. Beyond fisheries and aquaculture, Maine's transportation and tourism industries also stand to gain from these developments.

In pursuing these goals, university personnel will continue to work closely with the Maine Department of Marine Resources, the Maine Geological Survey, the Maine Aquaculture Innovation Center, the Maine Aquaculture Association, private finfish and shellfish growers, and other marine research institutions in Maine and around the Gulf of Maine.

2. Biotechnology

Biotechnology, already an important growth industry in Maine, currently has at least fifty companies employing almost 2,000 people. The industry is focused primarily on the development and manufacture of diagnostic assays and reagents for agricultural and medical uses. In addition to well-publicized pharmaceutical applications, ongoing research deals with developing agricultural crops that have enhanced resistance to disease and higher yields. Researchers at the University of Maine and the University of Southern Maine have been working with several biomedical and biotechnology firms throughout the state. For example, since the mid-1980s, basic research in poultry science at the University of Maine has resulted in the development of an array of diagnostic tests, including one of the first products marketed by IDEXX Inc., a company that employs hundreds in Maine. Researchers at the University of Maine and the University of Southern Maine continue to collaborate with IDEXX.

Another growth industry that relies on biotechnology research is bioremediation of contaminated soil and water. The cleanup of sites such as the former Loring Air Force Base can provide economic opportunities for companies specializing in this new area of environmental recovery.

Nationally, biotechnology industry revenues have increased three-fold during just the past five years, and they are expected to double again by the year 2001. However, a recent analysis by the

Center for Innovation in Biotechnology revealed that despite some important collaborations with the University of Maine System, the state's biotechnology firms rely predominantly on out-of-state universities for research support and key personnel because the companies are unable to fill positions fast enough or to keep them filled with technically capable staff. Although the automated DNA sequencer at the University of Maine (one of only two in the state) provides some capacity for biotechnology research, the supply of other equipment and highly trained personnel must be increased to sustain and enhance the industry's current growth.

3. Composite materials engineering

The University of Maine currently is among the nation's leaders in wood composite technology. Its researchers have developed new technologies to combine wood with advanced synthetic materials (composites) for use in structural applications. The resulting hybrid composites have received national acclaim as a vehicle to introduce advanced composites into construction markets, while making better use of Maine's timber resources. Ongoing collaborations with Brunswick Technologies, Inc. promise to produce new applications for that firm's woven composite materials.

Several other companies are planning to expand and improve their product lines, and a new glue-laminating plant is being planned for the Lewiston area. Development of this field has near-term implications for civil infrastructure (buildings, bridges, and marine structures), boat building, sporting equipment, and other industries. Obviously the potential for significant value-added contributions exists for the forest products, composites, and numerous other manufacturing industries in Maine. In 1995, University of Maine researchers constructed for the Bar Harbor Yacht Club the world's first wood composite ocean pier. These developments at the University of Maine are being coordinated with training programs at Eastern Maine Technical College and are broadly supported by the Marine Composites Alliance (forty Maine companies) and the Composites Institute (400 companies nationwide).

4. Environmental sciences and technology

Environmental sciences and technologies encompass a wide range of disciplines, including engineering, chemical, biological, and geological sciences. University of Maine scientists are respected internationally for their research on the transport and fate of natural substances and pollutants. The negative economic consequences associated with pollutants such as dioxin, mercury, ozone, and herbicides, among others, have stimulated new business opportunities in improving the accuracy, precision, and adaptability of environmental sensors and other analytical tools. To that end, scientists and engineers at the University of Maine have been among the leaders in developing sensors capable of measuring minute quantities of constituents in gases and fluids.

All these accomplishments provide significant benefits for Maine's air and water quality, but good potential also exists for commercial applications. University of Maine research on environmental sensors already has fostered two new companies, Biode of Hermon and Cape Elizabeth, and Sensor Research and Development of Bangor. Future opportunities include a wide

variety of environmental applications, including assessment of ambient air and water quality, and monitoring of work place conditions. Sensor development for automated manufacturing processes is another rapidly growing application.

Environmental engineering will develop solutions to many common practical problems involving risk assessment, waste reduction, and recycling technologies. Demands for work in environmental remediation, such as developing safe and cost-effective methods for dredging and treating pollutant-bearing harbor sediment, will provide opportunities for these industries and challenges for the researchers who support them.

5. Information sciences and technology

Information technology involves both research and technology transfer. University research already has begun to play an important role in modernizing Maine's manufacturing industries such as shoe manufacturing (Dexter Shoe) and pulp and paper making (S.D. Warren). Development of "intelligent systems" for efficient process control may well determine the future viability of many Maine companies.

Research in computer science and engineering should continue to stimulate Maine's emerging software industry, which grew by 16.5 percent last year and is among the fastest growing industries in the state. Everything necessary should be done to ensure that Maine companies participate in the national and international explosion in commercial software development, currently the fastest growing industry in the world.

The National Center for Geographic Information and Analysis (NCGIA) at the University of Maine, one of two such NSF-funded centers in the United States, is a leader in developing systems for a host of applications, including interpreting satellite data for municipal planning and for management of natural-resource-based industries such as forestry and aquaculture. Already, a dozen businesses in Maine have benefited substantially from research and teaching at the NCGIA and the University of Maine Department of Computer Science; several new firms (including AI Systems, BSB Electronic Charts, Geo-systems, Keating, Photo Science, Vision International, and Blue Marble Graphics) have been established in just the past two years.

The Bond Issue

Democrats and Republicans in the Legislature have agreed to postpone any action on a research and development bond issue until January 1998. Meanwhile, a Joint Select Committee made up of legislators from both political parties will work through the summer and fall to develop recommendations regarding a legislative plan for state-funded research and development. It is the expressed goal of both parties to develop and approve a plan to be presented to the Legislature in January 1998. The plan is expected to include a bond issue that will go to the voters in a statewide referendum in June 1998.

A starting point for the upcoming study may well be a bill originally before this legislature--LD 1658 An Act to Authorize a General Fund Bond Issue to Implement a Statewide Economic Improvement Strategy. This bond issue request included \$17 million to "fund major facilities

improvements, construction, and equipment purchases for research and development necessary to implement a statewide economic improvement strategy whereby funds are invested in the five target areas: aquaculture and marine sciences, biotechnology, composite materials engineering, environmental technologies, and information technologies." As envisioned in that bill, the funds would be used for capital improvements in four areas:

- New construction, which likely will include an aquaculture research facility, an oceanographic research facility, and a food-processing pilot plant;
- Laboratory renovations, including biotechnology laboratories at the University of Southern Maine, aquaculture research facilities at the University of Maine, "intelligent" manufacturing systems laboratories, and environmental engineering laboratories;
- Major equipment, including composite materials manufacturing and "intelligent" manufacturing systems equipment; and • Matching funds needed to leverage federal and private investment.

This will lay the groundwork for future investments by providing the facilities and equipment for use by the researchers who will be hired as the base-budget fund reaches significant levels.

The Maine Economic Improvement Fund

As discussed above, the long-term goal for the fund is \$20 million in annual, base-budget support for science and engineering in the University of Maine System. Although this amount would increase Maine's investment in university research and development significantly, we still would be ranked below fortieth in the nation on a per capita basis. The initial down payment on this investment already has been made by the Legislature. The budget for the coming biennium, fiscal years 1998 and 1999, was approved by the Legislature and signed by Governor Angus S. King in March 1997. It provides \$500,000 for the fund in each year, and an additional \$2,000,000 in fiscal year 1999 from any surplus that exists at the end of fiscal year 1998. Although this level of investment is less than we would like, it does represent a commitment from the Legislature to the Jumpstart 2000 initiative and provides a basis on which to build in coming years.

The annual appropriations for Jumpstart 2000 and the fund will be used to retain and support key researchers and to purchase necessary resources. The researchers retained will be nationally recognized scientists and engineers with the proven ability to attract federal and private sector research and development investment within the five targeted research areas. The investment also will provide for additional personnel to assist in this research, including laboratory technicians and research interns.

The fund will provide necessary resources for researchers, including additional and/or modernized laboratories, equipment, and information resources. Significantly, the fund will provide matching funds for federal and private sector research and development investment. Some support will be provided for this through the bond issue, but those one-time funds are limited in that they must be utilized for capital projects.

Return on Investment

Maine's investment in Jumpstart 2000 will provide a return many times its size. The near- and long-term benefits of an eventual \$20 million in annual base-level state funding include the following:

- An increase in external funding (i.e., grants and contracts) from both federal and private sources, which within five years could increase from the current \$25-30 million up to \$100 million;
- Development of creative ideas that can produce additional new businesses and industries in Maine;
- Resulting employment opportunities with high quality, well-paying positions in Maine, all providing direct contributions to the state's economy and increased tax revenues;
- An immediate, significant increase in Maine's scientific expertise and analytical capabilities, reducing the need for both industry and state agencies to go out-of-state for technical advice or contract services;
- High quality educational opportunities in science and engineering that will allow the next generation of Maine students to compete in a rapidly changing and highly technical world-- one in which most good jobs will require graduate degrees;
- Positioning the University of Maine to attract the highest quality faculty and students, which will improve the stature and economic viability of the institution significantly; and
- A vibrant University of Maine that will serve as a magnet to attract new businesses to the state.

Although there is rarely a guarantee that any investment (including this one) will produce specific results, two things are clear: States that are competitive in science and engineering also have vital economies; and no state has developed a strong economy without a comprehensive research university that is strong in science and engineering.

The Joint Select Committee on Research and Development

In addition to reviewing the bond issue proposal, the Joint Select Committee on Research and Development will review research and development efforts in the five target areas. Other organizations and individuals in Maine also are working to develop new businesses and create jobs in those areas. For example, the Maine Science and Technology Foundation talks of promoting economic growth in industries that require science and technology, the Department of Marine Resources is supporting the development of the aquaculture industry, and Governor King has announced a "Jobs from the Sea" initiative. The committee will strive to prevent unnecessary duplication of effort and increase the efficiency and productivity of these initiatives.

The Joint Select Committee will include representatives from several legislative policy committees with responsibilities directly related to the Jumpstart 2000 plan, including Business and Economic Development, Taxation, Education, and Appropriation and Financial Affairs. They will be directed to seek input from representatives of the University of Maine System, the Maine Technical College System, the Maine Science and Technology Foundation, the President of the Senate, the Speaker of the House, and two members from among the Department of

Economic and Community Development, the Department of Marine Resources, the State Planning Office, and others. The committee will create a plan to coordinate and maximize policies and programs in support of research and development throughout the state.

Building Statewide Support for the Strategy

The five University of Maine faculty members already have spent a great deal of time speaking to legislative and business leaders throughout the state in order to build support for this project. The response has been positive wherever they have spoken. In our experience, business leaders generally understand that research and development are vital to economic growth. Many see the potential of Jumpstart 2000 to improve the Maine economy. Members of the Legislature from both parties now are working to build on that support both within the Legislature and throughout the state.

At a March 4, 1997 press conference to announce the Jumpstart 2000 program, Senate President Mark W. Lawrence was joined by a group of legislators, Chancellor Terrence J. MacTaggart and other representatives of the University of Maine System, and President Dana F. Connors from the Maine Chamber and Business Alliance, all of whom pledged their support for the proposal. We are especially pleased Connors and other members of the business community recognize the importance and value of this project.

Additional presentations about research and development will be held throughout the state to celebrate some of the businesses that currently and successfully are employing cutting-edge science and technology as examples of what Jumpstart 2000 can do for the state. Our hope is that during the next few months a bipartisan group of legislators, business leaders, and researchers can work together to build support for targeted investment in university research and development.

Conclusion

Jumpstart 2000--The Maine Economic Improvement Strategy will address one of the weakest areas in Maine's economic infrastructure, the low level of investment in university research and development. By increasing this investment in five target areas--those judged most likely to produce economic growth--Maine will spur economic growth in high technology businesses, produce high wage jobs, capture a significant level of federal and private sector research and development funds, and strengthen its university research and development infrastructure. Although this is only one strategy among many for strengthening Maine's public university research and development and the state's economy, it is surely a necessary step.

Acknowledgments

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Mark W. Lawrence has been president of the Maine Senate since December 1996. His priorities in this leadership role include building economic prosperity through investments in research and development and product innovation.

George L. Jacobson Jr. is a professor and director of the Institute for Quaternary Studies at the University of Maine. As a member of the "Faculty Five" Jacobson has worked extensively to build statewide support for university-based research and development.

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