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University of Maine System Research and Development Plan FY 2020 – FY2024

R&D to promote industry, business, and community growth in Maine

Joan Ferrini-Mundy, President, University of Maine and University of Maine at Machias

Executive Summary

We propose that the University of Maine System advances three R&D goals for the state of Maine over the next ten years:

1. Make Maine the best state in the nation in which to live, work, and learn by 2030.
2. Establish an innovation-driven Maine economy for the 21st century.
3. Prepare the knowledge-and-innovation workforce for Maine.

The University of Maine System (the System), with its seven distinct campuses, its more than 5,000 employees, its 28,040 students, and its $550M overall budget, is a vital and vibrant asset to the state of Maine.[i] As the heart of the state's public system of higher education, the students, faculty, and staff at the System campuses are defining the future of Maine. Our institutions provide a broad suite of educational programs designed to prepare future generations of professionals, leaders, and innovators for our state and beyond. Here we propose a framework for research and development (R&D) for the System.

The University of Maine, the state's only public research university, has a comprehensive portfolio that addresses the most challenging problems of our time (i.e. "grand challenges") through basic and applied research, development, and commercialization, with direct impact in Maine. We emphasize the importance of basic, foundational research in this context, knowing that the applications of the new knowledge generated from those research programs will provide unpredictable benefits to our state and our society in the decades to come.

The University of Southern Maine provides research leadership in economic, social, environmental, health, and workforce development policies that advance the state's economy, and with its greater Portland location, advances workforce development and applied learning, and tackles the pressing community and state policy issues that weigh on the minds of Maine people. The University of Maine at Augusta, the University of Maine Farmington, the University of Maine at Fort Kent, the University of Maine at Presque Isle, and the University of Maine's regional campus, the University of Maine at Machias, all add vital and distinctive opportunities for geographic and place-based R&D specialization, where researchers and students, in partnership with their communities, strive to find solutions to critical challenges that span our state.

Most critically, there are active, internationally recognized scholars and researchers who are moving society forward through their scholarship and research on all of the University of Maine System campuses.

In December 2018, the University of Maine System Board of Trustees issued a Declaration of Strategic Priorities,[ii] the first of which is Advancing Workforce Readiness and Economic Development, with a priority action item: Strengthen research and economic development efforts to support Maine industries and to foster business formation and expansion. The President of the University of Maine and University of Maine at Machias was charged by the Chancellor to deliver a multi-year plan for expanding research and development across the System by March 2019.

The plan we present here has been developed in consultation with faculty, professional staff, and researchers from throughout the System; the presidents of the System universities; and the Vice Chancellor for Academic Affairs. In particular, the findings and recommendations listed below emerged through a number of open sessions with faculty and staff, through web-based inputs to the plan, and through engagement with external stakeholders.

Maine has a history of linking university-based R&D to economic needs across the state's urban and rural landscapes. The University of Maine System has a remarkable span of research, scholarship, development, commercialization, technical assistance, policy analysis, and creative contributions across disciplines resulting from the efforts of faculty, staff, and students. That work is of significance not only to the state of Maine, but also to the nation and beyond.We provide examples and discuss the importance of that diversity of scholarly work and knowledge building, including how such work can intersect and bolster the science and technology R&D enterprise as specified in the state's seven legislated technology sectors. Because of the emphasis on economic development, this plan includes special focus on research in science and technology, using national indicators and metrics available in those areas. But, to achieve the three goals listed above and to fulfill our missions as universities, the full, broad, and comprehensive set of creative, knowledge-building, translational, and community-engaged scholarship must be sustained, supported, and celebrated across the System.

The state of Maine, the University of Maine System, and the University of Maine are underperforming in R&D activity and expenditures.[iii] We clearly need to boost our R&D performance as a state, a System, and a research university in order to serve the state and its people, and to be competitive nationally. We need to establish research focus in Maine that will support the future economy, and to ensure that all campuses are able to participate in R&D as appropriate to their mission. There are clear steps proposed in this plan that the System universities, in partnership with other entities, can implement to improve the situation.

The findings and recommendations that follow acknowledge many positive features of the current context for R&D across the System. However, for the University of Maine System institutions to collectively move to the next level and lead in the accomplishment of the three broad goals will require substantial new investment from a variety of sources, as well as realignment of current resources. In addition, re-examination and reformulation of certain policies, practices, and collaborative mechanisms will be needed to support the R&D enterprise.

Data from the past 20 years, along with national benchmarking, give every indication that such investment in the research, realignments, and reformulations will yield tangible benefits and significant returns for Maine's economy, its people, and, most importantly, its learners, for generations to come.

Finding One: Investment by the State of Maine and the University of Maine System in R&D has been essential to reach our current R&D capacity.

The Maine Economic Improvement Fund (MEIF) was established by the Maine Legislature in 1998, and the Research Reinvestment Fund (RRF) was established by the System Board of Trustees in 2015. Without these resources, it is quite possible that engagement in R&D at the University of Southern Maine and other System campuses would have been minimal, and the capacity at the University of Maine to seek and obtain external funding would have been severely impeded. These state funds have leveraged significant external funding, and enabled hundreds of students to participate in research. To sustain and grow a university-based R&D infrastructure in Maine in the next ten years that is properly scaled to achieve the goals will require increased investment from state and System sources. It will also require re-alignment over time within campus budgets. Clear metrics and accountability expectations will be necessary to track the outputs, outcomes, and impacts of these changes. Such investment stands to raise our national ranking and competitiveness with similar institutions in other states for federal funds, leading faculty, and excellent students. But, most importantly, these investments will yield benefits for the students and people of the state of Maine by enabling preparation of a knowledge-and-innovation workforce to fill key positions and attract business in a growing Maine economy.

Recommendations:

First, we recommend that the Research Reinvestment Fund be renewed for five years, at a level of $4M per year beginning in FY20. Additional new selection priorities should be considered, such as partnerships with private-sector entities or local communities to solve practical problems, or collaborations among researchers on different System campuses. These investments should promote strong networks of researchers; allow adequate time for faculty to conduct research, and expand opportunities for paid student research experiences. Outcomes should include return on investment, effectiveness in leveraging external funding, and the quality and impact of student engagement in research.

Second, we recommend regular increases in the MEIF investment to reach a steady level of $40M annually by the end of FY24. This fund supports the on-campus capacity, including researchers, students, and facilities that allows success in the intense national competition for federal research funding from the National Science Foundation, the National Institutes of Health, and other agencies. Additional MEIF resources would sustain and enhance infrastructure, and expand research capacity and expenditures in the highest-priority R&D areas for Maine's future well-being and economic success. Improving Maine's standing in national rankings of higher education expenditures in R&D (Maine is 51st)[iv] will help attract R&D-intensive industry to the state. But the most important outcome of this investment will be expanded opportunity for Maine students to be educated in R&D-rich environments so they can be tomorrow's Maine

leaders and innovators. System campuses will be asked to consistently track and report the number of students involved in R&D. An interim review of return on investment on MEIF funding should be undertaken in FY22 for the years FY20 – FY22 to allow for mid-course correction.

Third, the System institutions will collaboratively develop a plan for integrating R&D expenses in the Educational and General (E&G) budget, in parallel to the way that instructional costs are embedded. In addition, universities will consider realigning resources within their E&G budgets to provide additional support as appropriate for their R&D goals, e.g., by directing indirect cost recovery back into the research enterprise. This commitment will contribute to attracting students in Maine and to Maine by expanding the breadth of learning opportunities, including such options as paid internships with Maine companies interested in R&D expertise. Students with exposure to undergraduate research are likely to continue into our graduate offerings, establishing a pipeline and improving the quality and capacity of the System graduate student body. These students will be prepared for the jobs of the 21st century and will be competitive in the national job market.

These changes would raise the profile of the University of Maine and other System campuses in ability to recruit students who are interested in undergraduate research, to attract and retain first-rate research faculty and graduate students, to compete for external federal funds, and to partner with the private sector to engage in R&D. All of these potential outcomes should be considered in designing accountability measures.

Finding Two: Each System campus has its own unique, engaged R&D core of expertise that should be further strengthened.

Research now and in the future will have a major role in "Making Maine the most desirable state in which to learn, work, and live by 2030." Across the System, we have a rich and diverse set of interests, and great expertise among the faculty to continue ongoing R&D, and to undertake new lines of work in connection with their students. Each institution has distinct identifiable strengths and emerging goals for their role in R&D, and R&D is differentially central to the different universities in the System. For the University of Maine, the state's comprehensive land and sea grant public research university, basic and applied research, development, and commercialization are core to the mission. At the University of Southern Maine, the R&D strength also spans many areas, and much of the work is applied. Goals for applied learning and workforce development are important there. On the other System campuses, there are excellent examples of research and scholarship fully integrated into instruction and service, together with some externally funded research.

Recommendations:

First, each of the System campuses should develop a five-year R&D implementation plan for increasing research expenditures aligned with the goals of this plan and appropriate to each campus. Coordination and collaboration across campuses in R&D can then be considered. Existing and emerging signature R&D strengths at the University of Maine and other campuses will provide a foundation for this effort. By

connecting to those established and emerging areas of strength, all campuses can design research agendas that are tailored to specific needs of their communities and geographic regions, that suit the interests and expertise of their faculty, and that will engage their students. Coordinated and public campus plans will be useful to potential new businesses and partners.

Second, the System universities, working together with AFUM and Human Resources units, should design and implement creative approaches to joint faculty appointments, including membership in the University of Maine Graduate Faculty. Such appointments will help to reduce barriers to conducting research and allow direct engagement with doctoral students. R&D faculty and student exchange and residency programs will be considered. The idea is to cultivate more cross-campus R&D collaboration that will generate tangible results for specific problems in Maine.

Third, the universities should collaborate on data governance in R&D to achieve consistency in reporting and to ensure appropriate credit for R&D expenditures. Methods to consistently include credit for a range of types of scholarly production should be explored when national surveys are not sufficient. By addressing these matters, we would support accountability and enable measurement of progress. In addition we should assess System-wide access to research databases of interest to scholars on multiple campuses and create cost-effective solutions.

Finding Three: Across the University of Maine System, we have been failing to compete as well as we should for significant federal funding, and our facilities, infrastructure, and administrative support for R&D are inadequate in several fields important to Maine's future.

The System as a whole is underperforming in higher education R&D expenditures. Between 2007 and 2016, Maine's total R&D expenditure declined nearly 40%, the largest decline of any state over that period. Many federal competitive-grant programs provide funding for R&D in areas that are highly relevant to the state of Maine. There are dozens of federal competitive grant programs available across the major science agencies[v] annually in R&D areas of relevance to the state of Maine for which few or, in some cases, no applications are made from System universities. This unacceptable situation results from a combination of lack of faculty, graduate students, and postdoctoral research associates to prepare proposals; insufficient administrative capacity to support proposal planning and submission; inadequate faculty time to prepare proposals because of competing teaching and service loads; and lack of postdoctoral associates and technicians. In addition, there is a critical need for improved facilities, acquisition of modern and innovative instruments, and research resources, and procedures for sharing equipment and instruments. Sometimes faculty cannot pursue research funding opportunities because the needed equipment and facilities do not exist in the System, or the costs of compliance and purchasing licenses would be too great for faculty to cover on their own. Other similar universities have this research infrastructure in place already, which puts our faculty at a disadvantage when competing for federal grants. And there are opportunities to engage undergraduate students in research that are not being realized because of the lack of needed equipment and personnel. Improving modernized

equipment has the added benefit of training our students for the jobs of the future that would use this instrumentation. All campuses report a large need for more administrative support in R&D. *Despite all this, we believe that System faculty and staff are resourceful and deeply committed to their students, their research, and to Maine, and that we can remedy much of this situation with relatively modest resources, and increased coordination and communication.*

Recommendation:
With combined additional resources, the universities will review and address needs for coordinated hiring of faculty in key areas of importance to the state as determined, for instance, by System Board of Trustee goals, or recommended in the reports of the Maine Economic Growth Council or other statewide processes. Similar coordination or information-sharing should be applied to hiring of postdoctoral associates, and technicians, and graduate students. In addition, a System-wide inventory of R&D instruments and facilities should be assembled and made available to all new faculty. Campus master plans should address needs for expanded and renovated R&D facilities. In addition, the comprehensive research administration and development capacity currently in place at the University of Maine should be made available to support faculty research needs across the System. Intercampus research administration collaborations between the University of Maine and other System campuses have been established (e.g. with the University of Maine at Machias and the University of Maine at Fort Kent). Research administration services also exist at the University of Southern Maine. Both the University of Maine and the University of Southern Maine house expertise for research compliance, which could become shared resources with other System campuses.

Finding Four: Across the System undergraduate students are engaging in authentic research experiences and community-engaged research initiatives that are benefitting the region and the state.

The opportunity to participate in research, development, and commercialization activities is highly attractive to undergraduate and graduate students, and a significant number of faculty across the System are effectively integrating research with instruction, including community-engaged research on problems of specific local interest. However, this student involvement is not as widespread or systematic as would be necessary to attract many more students to the System institutions.

Recommendation:

The System must provide leadership in incentivizing and enabling every undergraduate student in the University of Maine System to have a meaningful/authentic experience in research, scholarship, development, creative production, policy analysis, translation, or commercialization. System Program Innovation Funds should be considered as a resource. The use of Course-based Undergraduate Research Experiences (CURES) should be piloted across the System according to campus capacity and interest, supported with campus resources, and evaluated. Impact on recruitment, enrollment, and retention will be assessed, as well as the ability of students to obtain paid summer internships and future employment after graduation, including whether students remain in Maine.

Finding Five: The private and nonprofit sectors and the Maine State Government are eager for expanded R&D interactions with higher education.

Private-sector entities already partner in R&D relationships with several System universities, with a large number at the University of Maine. External companies considering moving to Maine also have expressed great interest in partnering with entities in the System to extend their R&D capabilities. However, pairing System research experts, and gaining access to R&D to respond to those external interests is challenging. If System institutions were more easily able to partner well with private-sector industries and businesses, we can tap a great source of economic stimulus in the state and opportunity for student interaction.

In the context of a dispersed and locally driven ecosystem in Maine for economic development, University of Maine System faculty and staff are deeply engaged in efforts to support commercialization, business development, and incubation, and private sector needs in R&D. Those efforts could be expanded with potential impact statewide. And, in areas of policy and business that are key to the state, ranging from ecosystem health, health care and new uses of forest resource products, to education, aquaculture, renewable energy, and agriculture to balancing competing interests related to marine resources, and biomedical and biotechnology applications, the System institutions already are positioned, because of the breadth of research expertise, to more systematically provide background information and analyses to the state and to the members of our federal delegation.

Recommendation:
The universities should continue to work closely with the private and government sector to establish productive collaborations. Such approaches as the creation of a *Maine R&D Fellows* program designed to connect System faculty, state government, Maine's federal delegation, and potential private/nonprofit partners to work collaboratively should be considered.

The University of Maine will undertake a high-level review of existing doctoral graduate programs in the STEM fields. The review should consider how program emphases align with current and projected state needs, whether basic, discovery research is sufficiently supported, and whether new directions in science and technology, including convergence, machine learning, and shared datasets are being incorporated. Program consolidations, new program development, and other realignments should be undertaken to lead to increased production of doctoral degrees, an important part of building R&D capacity.

The institutions will engage in more robust communication of System R&D accomplishments statewide and nationally. Finally, we call for strategic interactions with the Governor and the Maine State Legislature in identifying and responding to changing priorities needing R&D inputs.

The success of the R&D enterprise in the University of Maine System depends, ultimately, on the creativity, willingness to innovate, and productivity of the individuals and groups engaged in that R&D. The System must make strategic shifts in policies,

practices, and resource allocation to enhance the abilities of our faculty, students, and staff to reach their potential. They will then become the regional, state, national, and international leaders in research that they are already qualified to be, and the students and people of Maine will benefit.

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[i] http://www.maine.edu/about-the-system/ums-data-book/

[ii] https://thinkmissionexcellence.maine.edu/wp-content/uploads/sites/1/2019/01/BOTDeclaration.pdf)

[iii] https://www.nsf.gov/statistics/2019/nsf19303/nsf19303.pdf

[iv] Ibid.

[v] National Science Foundation, National Oceanic and Atmospheric Administration, NASA, U.S. Department of Agriculture, National Institute of Standards and Technology, National Institutes of Health, Department of Defense, and U.S. Department of Education.