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## Maine Economic Improvement Fund Annual Report, FY2019

University of Maine System

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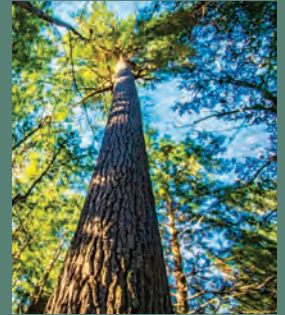
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# MAINE ECONOMIC IMPROVEMENT FUND



## Annual Report FY2019 Presented to Maine State Legislature



A successful partnership among Maine's government, private sector and public universities to build Maine's economy and future workforce through research and development.



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## Memo from the Chancellor

The Maine Economic Improvement Fund (MEIF) represents Maine's ongoing commitment between the state and our public universities, working together to advance research and economic development for the benefit of all Maine people. In July 2014, the University of Maine System Board of Trustees (UMS BOT) established strategic outcomes and metrics to measure the performance of the University of Maine System and its campuses. Included in these strategic outcomes are specific goals for research, economic development and workforce development. The UMS BOT has applied these overall strategic outcomes to research and development, and has established specific goals and metrics for the Maine Economic Improvement Fund to help achieve the strategic outcomes. These metrics were approved at the end of FY2014, and are applied to all FY2019 MEIF activity and included in this annual report. New goals for FY2020 and beyond are presented at the conclusion of this report and are aimed at advancing the goals of the University of Maine System Research and Development Plan, and the Maine Economic Development Strategy. By statute, MEIF-funded activity is restricted to Maine's seven statutorily established R&D sectors.

In FY2019, the state's \$17.35 million MEIF investment was leveraged at a rate of 4.4:1 by our UMS campuses for an additional \$76.57 million in federal and private-sector grants and contracts in the seven sectors.

- MEIF funds, and the external grants and contracts they leverage, supported the work of 587 researchers and technicians, and 1,054 graduate and undergraduate students.
- These grants and contracts provided more than \$2.22 million to purchase major equipment to upgrade and outfit university laboratories.
- Maine's public universities secured new patents, worked on development projects with large and small businesses and start-ups, and provided R&D support to 530 companies and individuals.

As required in the statute that created MEIF, included with this FY2019 MEIF report are financial and informational details.

If you have any questions about MEIF projects, this report or other University of Maine System research and economic development programs, please contact me.

Sincerely,



Dannel Malloy  
Chancellor

## MEIF Background

The Maine Economic Improvement Fund (MEIF) represents the ongoing commitment between the state, the private sector and our public universities, working together to advance research and economic development for the benefit of all Maine people.

Since the Maine Legislature established MEIF in 1997, MEIF has positioned the University of Maine System (UMS) at the center of statewide efforts to leverage economic development through targeted investment in university-based R&D. MEIF continues to be funded through an annual state appropriation to UMS.

These funds provided through state appropriation to the University of Maine System are dollars specifically directed to support university-based research, development and commercialization in the state's legislatively designated seven strategic technology areas:

- Advanced Technologies for Forestry and Agriculture
- Aquaculture and Marine Sciences
- Biotechnology
- Composites and Advanced Materials Technologies
- Environmental Technologies
- Information Technologies
- Precision Manufacturing

The University of Maine and the University of Southern Maine have well-established research, development and commercialization activities accounting for 97 percent of the MEIF activity. In 2009, the University of Maine System established the Small Campus Initiative Fund to promote seven-sector research and development activity at the other five UMS campuses and, as of 2013, Maine Maritime Academy (MMA).

## Role of MEIF

The role of MEIF is to support the solution of fundamental problems and discover new solutions, and to provide researchers at Maine's public universities with the investment necessary to:

- attain external grants and contracts to support R&D activities in Maine's seven sectors
- attract and retain world-class researchers
- provide support for modern laboratories and state-of-the-art equipment
- create new products, patents, technologies, companies and exciting job opportunities in Maine
- create and sustain economic development and innovation

MEIF funds often provide the required match to acquire federal or private sector grants, and this investment in Maine's public university R&D helps faculty, staff and students successfully leverage tens of millions of dollars in grants and contracts annually.

MEIF directly supports faculty, grad students and staff who are working to make the universities more competitive for federal grants, expanding opportunities to support Maine companies and involve students in research learning and real applications of their education.

MEIF increasingly fosters university partnerships with business and industry through economic development collaborations, entrepreneur training programs, business incubators, technology accelerators, business research and other programs. These efforts lead to new Maine-based products, technologies, patents and spin-off businesses.

The University of Maine and the University of Southern Maine are the two universities with established research and graduate programs in the seven targeted research sectors and have received MEIF funds, with 76.6 percent to the University of Maine and 19 percent to the University of Southern Maine. In addition 1.4 percent of MEIF funds are awarded to the University of Maine Machias and 3 percent to the other campuses and Maine Maritime Academy.

### **Indicators of success show that Maine's MEIF investment is paying dividends by:**

- Creating businesses and jobs, including the jobs of more than 587 faculty and staff, and over 1054 students working on MEIF-funded projects
- Boosting Maine's economy by leveraging MEIF funds to bring federal and private-sector grants and contracts to Maine.
- Building capacity and expertise to help Maine companies solve problems and commercialize innovation.
- Generating new intellectual property and working to commercialize patents and innovations.
- Capitalizing on natural resources and core strengths by focusing R&D efforts on economic sectors where Maine can make real gains. University research personnel use MEIF resources to support the staff, equipment and facilities they need to successfully pursue and develop research projects.

# Progress in FY2019 Strategic Outcomes, Goals and Metrics

In July 2014, UMS BOT developed and approved Strategic Outcomes to measure the performance of the University of Maine System and its campuses. In October 2014, UMS BOT approved the use of these newly developed Strategic Outcomes to create MEIF specific goals and metrics. Several of the UMS Strategic Outcomes are performance targets for all R&D and economic development activity. The MEIF goals recognize that MEIF activity is restricted to Maine's legislatively selected seven R&D sectors and are, therefore, MEIF goals and metrics, and a subset

of the overall UMS goals. The UMS Strategic Outcomes that apply to R&D activity are:

**UMS Strategic Outcomes Target 1 –**

Increase Research Capacity and Activity

**UMS Strategic Outcomes Target 2 –**

Support New Technologies, Licensing, and Commercialization

**UMS Strategic Outcomes Target 4 –**

Increase Economic Development Partnerships

**UMS Strategic Outcomes Overall Goal –**

Support R&D Workforce Development

This report addresses these goals. In addition, the University of Maine System reports R&D outcomes annually through the statutorily required survey of Maine R&D activity administered by the Maine Department of Economic and Community Development Office of Innovation (5 MSRA 13107).

**The R&D Strategic Outcomes and related MEIF goals are:**

## MEIF Target 1

UMS maintains a sponsored programs grant and contracts effort growing greater than 3 percent annually on a three-year rolling average from a 2013 baseline of \$45 million and NSF-defined total research expenditures of \$45 million in the MEIF sectors. Activity from the seven MEIF sectors will account for 50 percent of the total R&D grants and contracts, with a 3 percent annual growth on a three-year rolling average. The FY2013 baseline was a calculated percentage of total activity.

Table 1 below shows the actual FY2013 baseline at slightly less than \$45 million at \$44,228,964 million.

Table 1

FY2019 Total Grants and Contracts (ALL Activity Inclusive)	Number of Awards	Total Award Value
Total Proposals Submitted	1,285 submitted	\$218,825,415
Total Proposals Awarded	1,113 awarded	\$106,326,636

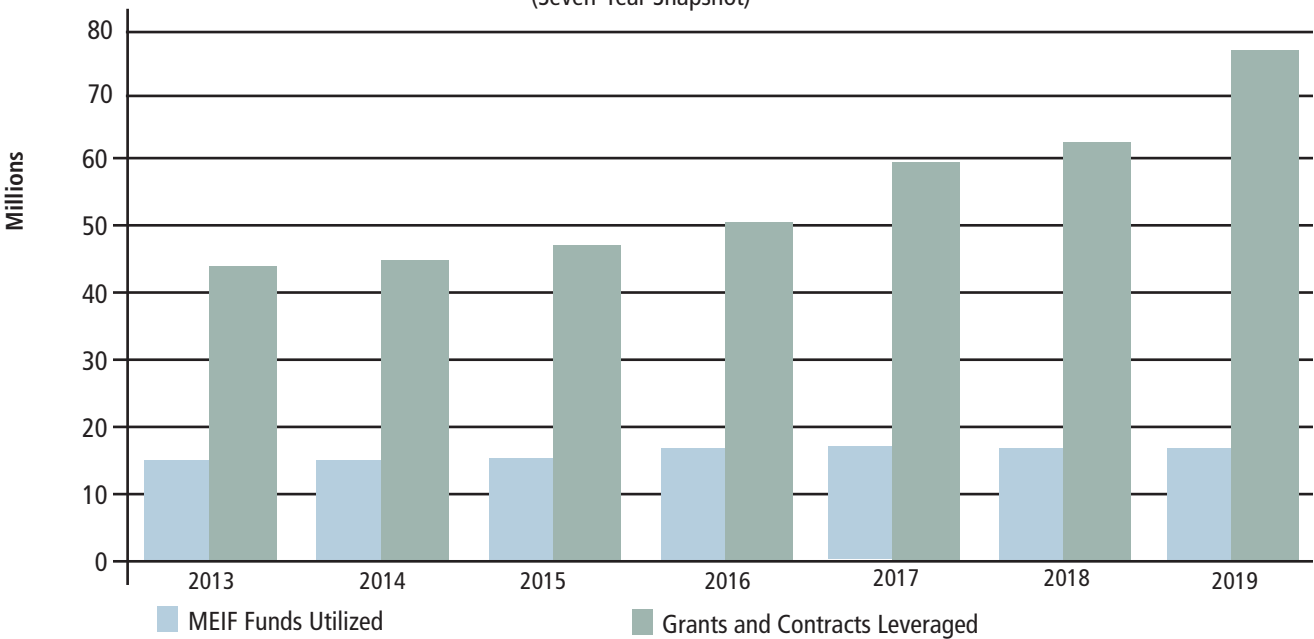
### Grants and Contracts

Awarded in MEIF Sectors ONLY	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018	FY2019
Aquaculture and Marine	7,045,322	9,153,389	15,187,566	12,631,690	21,229,069	16,032,068	8,084,961
Biotechnology	1,985,295	6,353,450	1,524,204	2,399,487	3,821,390	6,552,964	16,035,473
Composites	9,230,715	5,135,033	5,247,712	6,974,264	13,504,642	9,952,947	11,478,611
Cross Sector	2,990,129	4,681,209	1,018,132	507,842	4,274,394	3,034,812	21,301,337
Environmental Technologies	5,781,658	7,959,264	4,349,651	5,045,536	5,543,121	7,407,213	7,250,820
Forestry and Agriculture	8,642,424	7,654,060	14,194,009	10,317,799	4,660,014	10,685,631	9,598,475
Information Tech	7,422,675	2,520,521	4,473,781	11,497,199	5,292,726	5,582,266	951,594
Precision Manufacturing	1,130,746	1,414,700	780,694	1,009,921	1,602,646	3,099,123	1,870,527
Total	\$44,228,964	\$44,871,626	\$46,775,749	\$50,383,738	\$59,928,002	\$62,347,024	\$76,571,798

FY2018–FY2019 Increase 23%



**Figure 1 MEIF Return on Investment (UMS)**  
Tens of Millions Leveraged in Grants and Contracts  
(Seven-Year Snapshot)



In summary, the MEIF Target 1 for increasing external grants and contracts leveraged through MEIF investments saw an increase of 23 percent over the previous fiscal year exceeding the goal of 3 percent per year. This favorable trend continues in a positive direction after decreases from FY2010 through FY2012. This is largely related to changes in the economy and the federal agencies that have stabilized budgets and funding for R&D. In addition, UMS campuses have seen turnover in faculty researchers resulting in over 150 new faculty in the last few years. New faculty researchers typically need several years of

start-up activity to become competitive proposal writers, and their success is starting to show. Another key contributor to this growth is larger multi-principle investigator proposals at well-established centers.

Recognizing the lead time for proposal preparation, sponsor review and selection, and contract activity to begin, there can be a one- to two-year lag in output. Proposal preparation and submissions remain steady. For the purpose of this report, a private-sector contract is counted as a single proposal submission.



## MEIF Target 2

*Derived from UMS BOT Research and Economic Development Target 2*

UMS annual revenue from commercialization including intellectual property licensing increases at least 20 percent annually on a three-year rolling average from a baseline of \$150,000, from the MEIF sectors.

Table 2

MEIF Target 2 — Commercialization Activity	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018	FY2019
Revenue from Commercialization	\$121,250	\$263,758	\$359,723	\$204,709	\$329,840	\$914,120	\$289,088
Rolling three-year average	N/A	N/A	\$248,244	\$276,063	\$298,091	\$482,890	\$511,016
Number of Patents Filed	15	32	28	19	18	20	17
Number of Patents Issued	16	12	6	5	8	6	6
Number of License Agreements and License Options	6	6	16	8	7	9	11

**FY2018–FY2019 Change in Three-Year Average Revenue 6%**

In summary, three-year rolling average revenue from commercialization has shown an overall increase since FY2013. Commercialization relies on private companies utilizing UMS intellectual property to secure private investment to advance technology, products and services into markets. Maine continues to rank very low in comparison to other states for its industry R&D and innovation. This has been recognized by the state economic development agencies and is addressed in the 2020 Maine Economic Development Strategy.

The timeline for commercialization of newly invented technology is hard to predict, but it is lengthy. U.S. patent applications take four to five years from initial application to issuance. Newly issued UMS patents reported above and detailed in Appendix 1 were filed four to five years ago. In addition, UMS technologies generally fall into categories, such as transportation infrastructure, pulp and paper and sensors and biotechnology. These sectors have longer timelines from lab to market at five to ten years. UMS is focusing additional effort to accelerate commercialization with private-sector partners and other investment programs, such as the Maine Technology Institute and Maine Venture Fund.

## MEIF Target 3

*Derived from UMS Research and Economic Development Target 4*

The UMS annual revenue from activities with business and industrial partners in the MEIF sectors increased from an FY2013 baseline of \$4,156,184 million to \$7,211,422 million by FY2019, and the number of business and industry contracts in the MEIF sectors increased from a baseline of 407 in FY2013 to 530 in FY2019. The number of business and industry contracts is included in the total grant and contract count in Table 1.

Table 3

**MEIF TARGET 3 —**

Business and Industry Contracts	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018	FY2019
Revenue from Business and Industrial Contracts	\$4,156,184	\$4,371,999	\$5,759,572	\$4,836,138	\$5,035,394	\$6,339,260	\$7,211,422
Number of Business and Industrial Contracts	407	500	624	519	565	528	530

**FY2018–FY2019 Revenue Revenue Change 13.76%**

In summary, many MEIF investments not only leverage external grants and contracts, but through a combination of MEIF funds, and grant and contract funds, help UMS campuses build capacity to work directly with industry partners. Figure 2 illustrates the variety of campus-based programs that work directly with companies. Some industry partners will be companies licensing and commercializing UMS intellectual property, while many companies are working with UMS

campuses to get assistance with solving their problems or perfecting their inventions and innovations. UMS projects with business and industry are steady and activity is meeting the goals and metrics of this Target. Figure 2 demonstrates the statewide nature of these partnerships for those contracts that are currently tracked. Many additional companies, inventors, and entrepreneurs receive advice and guidance but do not result in formal contracts.



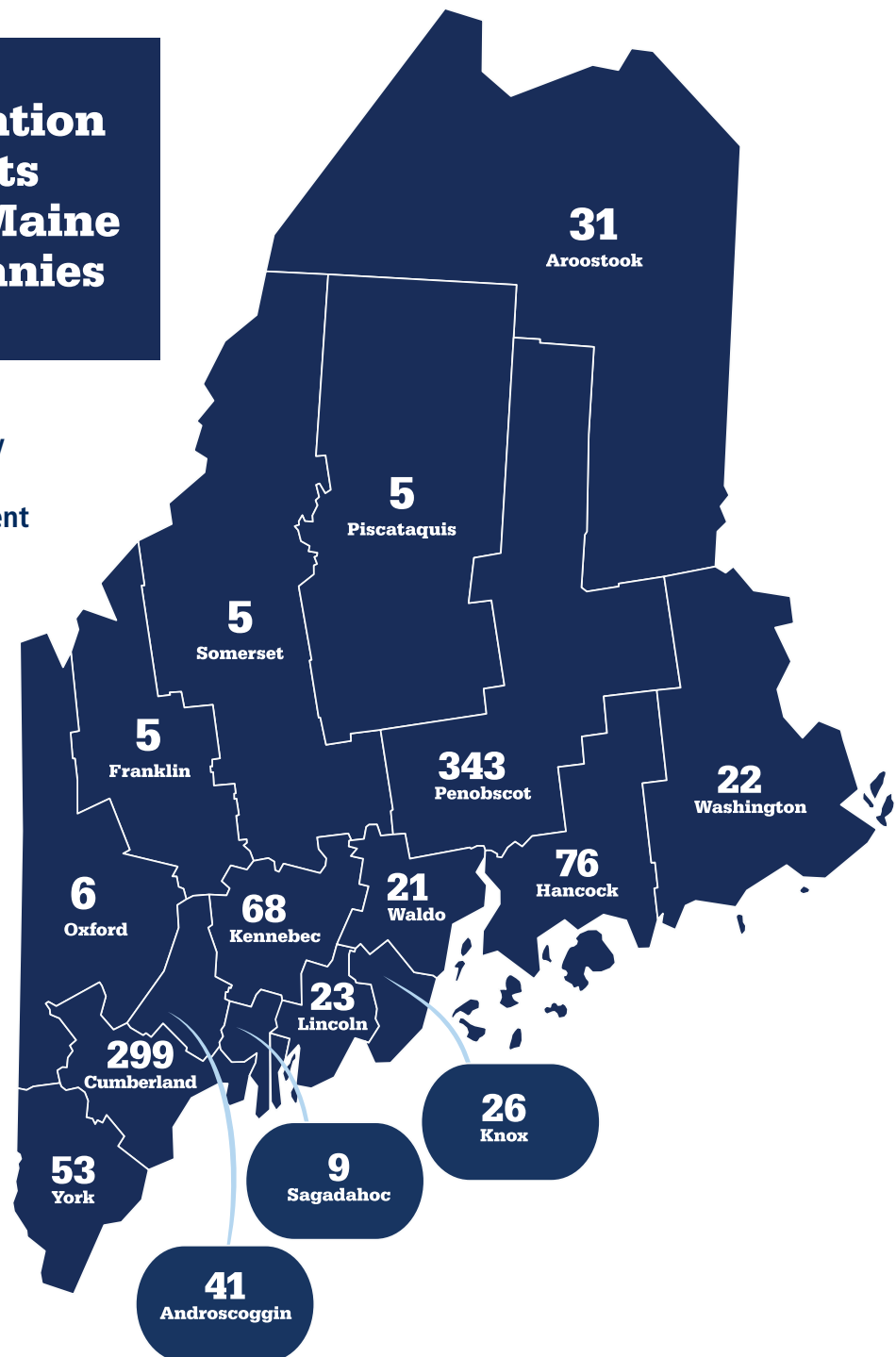


Figure 2 Innovation projects with Maine companies FY2015–FY2019

**1033 Innovation projects with Maine companies**

Every day, the University of Maine strives to turn research and development activities into new opportunities that will create jobs and grow Maine's economy.

In the past five years, UMaine has supported more than 1,000 innovation projects, providing access to facilities and expertise to help organizations with research, new products and business development.



## MEIF Target 4

### *Support R&D Workforce Development*

UMS shall maintain a concerted effort to involve faculty, staff and students participating in research, development and commercialization, and shall report annually the number of employees directly supported by MEIF funds and by grants and contracts in the MEIF sectors. As external funding is hard to predict, there is no specific numerical goal for employee count, but UMS shall report the annual number of faculty, staff and students to indicate trends and identify opportunities for growth.

In summary, state economic analysis predicts economic growth in Maine based on an available trained and educated workforce. Growth in the seven MEIF sectors is especially dependent on the available workforce. MEIF seven-sector projects at UMS rely on regular faculty and staff, as well as many “soft money” employees — those hired to work on specific grants and contracts, and paid by those grant and contract funds. UMS employees and students gain valuable on-the-job training and experience, and may then contribute to the employment base within these sectors after completion of the grants or graduation. Grant and contract revenue is a strong contribution to this workforce development. UMS counts employees involved in this activity, and will continue to pursue the growth in employment numbers related to growth in grant and contract activity. Non-student employees are tracked as full-time equivalents (FTEs) based on a 40-hour/52-week work year. Student employees, tracked by head count, generally work less than 20 hours per week during the academic year.

Grant and contract revenue also is an important source of funding for students’ salary, tuition and other types of support,

allowing many research-active students to offset their cost of education while getting valuable skills and on-the-job experience, positioning them well to be leading contributors to Maine’s key growth sectors.

### **Success and Strategic Impact**

By investing MEIF funds in researchers, facilities and matching for grants, UMS has attracted more than \$384.5 million since 2013 in federal and private-sector grants and contracts related to the seven strategic research areas. This funding directly results in Maine products and technologies, such as biofuels, pulp and paper products, new potato varieties, aquaculture technologies and software, which lead to improvements in Maine’s industries.

### **Return on Investment**

Each year, the state’s MEIF appropriation is expanded by tens of millions of dollars in federal and private funds for important research, development and commercialization. The University of Maine as the state’s land grant, sea grant and space grant institution utilizes its long-established research capacity and infrastructure to attract the majority of these external funds. Other UMS schools continue to build and partner within federal and private-sector grants and contracts.

### **Developing Workforce and Creating Jobs**

Five hundred plus full-time equivalent jobs are funded in Maine through the grants and contracts leveraged and expended related to MEIF. These positions include faculty, technicians and research staff. Currently 1,054 graduate and undergraduate students are funded for their involvement in research, development and commercialization. This student involvement in research, development and commercialization projects is comparable to an internship and gives students great real-world experience as well as life-long networks and connections.

Table 4-A

<b>MEIF Target 4 — Workforce Development</b>	<b>FY2019 Wages Paid from MEIF</b>	<b>FY2019 Wages Paid from External Grants/Contracts</b>	<b>Totals</b>
Number of Faculty and Staff Supported (FTE = Full-Time Equivalent)	130.72	456.65	587.37
Number of Graduate Students Supported (Headcount)	15	307	322
Number of Undergraduate Students Supported (Headcount)	116	616	732

Table 4-B

<b>Graduate and Undergraduate Student Costs Paid from Grants and Contracts</b>	<b>FY2014</b>	<b>FY2015</b>	<b>FY2016</b>	<b>FY2017</b>	<b>FY2018</b>	<b>FY2019</b>
Student Salaries and Wages from Grants and Contracts	\$4,877,650	\$4,603,696	\$5,255,861	\$4,957,536	\$4,853,956	\$6,361,381
Student Tuition Paid by Grants and Contracts	857,781	835,961	956,963	870,787	373,118	457,884
Student Fellowships Paid by Grants and Contracts	199,400	552,944	197,744	233,111	214,000	298,386
Student Health Insurance Paid by Grants and Contracts	282,848	62,967	247,960	203,406	795,339	916,618
<b>Total Soft Money Student Support</b>	<b>\$6,217,679</b>	<b>\$6,055,568</b>	<b>\$6,658,528</b>	<b>\$6,264,840</b>	<b>\$6,236,413</b>	<b>\$8,034,269</b>

**FY2018–FY2019 Change 29%**

# MEIF Success Stories

## Aquaculture and Marine

### ■ Optimizing Growth and Removing Barriers in Maine Aquaculture

Aquaculture companies in Maine are leading efforts to culture high-quality seafood products, but notable barriers to expansion and increased production affect different sectors in different ways. Several awards aim to help Maine aquaculture evolve and thrive, taking advantage of new technology, global expertise and novel approaches to managing common issues.

#### *Shellfish Opportunity*

Two awards from the National Oceanic and Atmospheric Administration (NOAA) are supporting research related to sustainable shellfish aquaculture in Maine.

A team led by Damian Brady and Emmanuel Boss of the University of Maine School of Marine Sciences was awarded \$692,216 under the National Sea Grant Aquaculture Initiative for a project to inform sustainable aquaculture development using water quality data.

Prospective shellfish farmers must determine what species to grow and where to grow them. Building on the success of previous Sea Grant work that established satellite imagery as an effective tool for aquaculture site selection, the Maine Sea Grant team members will use the maps they have developed to refine a bivalve growth model. The goal is to identify optimal growing locations for American oysters, European oysters, scallops and mussels. Findings will be shared in training sessions with growers and other practitioners interested in using satellite imagery for siting shellfish farms in their own regions.

In another project, funded through a \$295,380 NOAA Saltonstall-Kennedy Grant, Brady and Dana Morse of Maine Sea Grant will focus on optimizing production and products for scallop aquaculture in Maine. Presently, upward of a dozen farms in Maine are producing sea scallops.



Scallop culture in the state has progressed with advances in spat collection, nursery culture, and ear-hanging production, thanks in part to strong collaboration with Japan, which has a long history of scallop aquaculture. Ear-hanging — a Japanese technique in which a hole is drilled in one of two flat corners of the scallop shell near the hinge (the so-called “ear”) so that it can be tied to a submerged line for grow-out — is equipment and capital intensive, so it is critical to optimize farm operations. This award aims to identify and help overcome common issues in the production process in order to improve returns and advance scallop production as a profitable industry.

## ***Solving for Salmon***

The National Sea Grant College Program awarded \$725,365 to Heather Hamlin, Deborah Bouchard and Ian Bricknell of the Aquaculture Research Institute to research an integrated approach to sea lice control in the commercial culture of Atlantic salmon.



The economic impact of sea lice infestation to the U.S. salmon aquaculture industry is estimated at \$15 million annually and \$740 million per year globally. Sea lice infestations remain the greatest barrier to continuing and expanding marine salmon aquaculture.

This project will address gaps in knowledge of sea lice biology and control methods, such as integrated pest management, and new, ecologically sensitive chemical compounds and their effects on nontarget species, such as lobsters.

Hamlin is working with industry and regulators to understand the factors that prevent adoption of new sea lice control techniques and to identify other impediments faced by the salmon industry.

Maine Sea Grant's investment in aquaculture research, outreach and education programs continues to make a difference in Maine's coastal communities. From February 2017 to January 2018, Maine Sea Grant invested approximately \$1.4 million in aquaculture research, technology transfer and outreach in Maine and reported \$5.9 million in economic impacts, including support of 123 businesses and 200 jobs. In 2018, the total harvest value of Maine aquaculture topped \$71 million.

The Maine Sea Grant College Program at the University of Maine is a program of the National Oceanic and Atmospheric Administration and the state of Maine.

## **■ UMaine Researcher Undertaking Massive Lobster Population Study**

A \$149,636 grant awarded by Maine Sea Grant and the Maine Department of Marine Resources is supporting an exhaustive study of the state's lobster population by UMaine Professor of Marine Sciences Robert Steneck.



The work aims to understand the health of the state's lobster population and help inform future landing predictions for an industry that helps to drive Maine's economy.

Steneck is revisiting the same areas and using the same methods he employed during a 10-year in situ study conducted from 1989–1999 to look at lobster population densities, body size and habitat use. The research seeks to answer whether lobster population densities have declined over the past 20 years in certain regions and to determine if lobster habitat use has changed, among other key benchmarks.

### ■ USM Aquaculture Course Supports Expanding Industry

An aquaculture course that has grown out of the Suds to Shrimp Project at the University of Southern Maine is helping to prepare students for careers in related fields. Directed by the University of Southern Maine's (USM) Environmental Science and Policy Department, the Suds to Shrimp Project began in the summer of 2018 with the goal of creating a retail and wholesale network focused on polyculture aquaponic systems in Maine. Aquaponics is a system that combines aquaculture (raising fish and other aquatic animals in tanks) with hydroponics (cultivating plants in water) into an indoor ecosystem. USM has developed an Aquaponics Lab centered around a multi-species, zero-discharge aquaponics system in which waste beer grains are used to grow prawns, tilapia and vegetables.

In spring 2019, the lab was showcased in an online course titled "Practical Guide to Aquaculture" that was inspired by the announcement of two land-based aquaculture systems being proposed for midcoast Maine.

The course presented an overview of aquaponic growing and recirculating aquaculture taught at a lay level for non-scientists, and addressed the business of land-based farming and aquaculture. Content for the course was developed in collaboration with a number of local and industry partners, including Maine Adult Learning Centers, Whole Oceans, Nordic Aquaculture, Springworks Farms, Maine Agrotech, Mook Sea Farm and the University of Maine Center for Cooperative Aquaculture Research. While mostly online, the class also incorporated in-person field experience and participants met over several weekends to tour aquaponic and related facilities in Maine.



The course was open to both full-time USM students and people across the state as part of ongoing efforts to develop the skilled workforce that will be needed as aquaponics and aquaculture continue to grow in Maine.

The course was supported in part by a U.S. Department of Agriculture (USDA) Rural Business Development Grant, which helped lower course fees and tuition for part-time students or those only interested in the single class.

### ■ UMaine Machias Research Examines Ocean Acidification Effects on Key Species

University of Maine Machias Professor of Marine Ecology Brian Beal is studying the effects of ocean acidification on lobsters, crabs, clams, mussels and scallops with funding from the Maine Economic Improvement Fund (MEIF) Small Campus Initiative.

Beal is leading three projects that were awarded a total of \$300,000, increasing capacity for applied marine research and development in Down East Maine. The research projects also will engage undergraduate students.

The first project examines effects of ocean acidification on commercially important, calcified marine organisms, such as lobsters, crabs, clams, mussels and scallops — a global problem that has implications for healthy, sustainable wild and cultured fisheries in Maine. A postdoctoral research associate has been hired to help conduct the research and to assist in assembling a lab at UMM's marine science field station at the Downeast Institute in Beals, Maine.



A second project builds on work initiated in 2018 to create a selective breeding program designed to improve genetic lines of American and European oysters for growth in the cold waters of Down East Maine. The goal of the project is to produce a line of fast-growing, disease-resistant animals that eventually will become commercially available to eastern Maine oyster farmers.

A third project focuses on the Atlantic razor clam, an aquaculture species typically harvested in the fall and winter in Maine. Researchers are examining culture techniques in the hatchery to produce juveniles for eventual grow-out under field conditions.

## Biotechnology

### ■ Townsend Lab Research Supported by NSF, NIH Awards

A University of Maine research team led by associate professor of neurobiology Kristy Townsend received grants from the National Science Foundation (NSF) and National Institutes of Health (NIH) in FY2019.

The Townsend Lab explores how the brain coordinates energy balance and how the central and peripheral nervous systems undergo plasticity. This research impacts the study of obesity, diabetes, metabolic syndrome, aging and neurodegenerative diseases.

Understanding the creation of new nerve cells in adult brains while engaging more Maine college students in biomedical research is Townsend's focus in a five-year study funded by a \$1 million NSF CAREER grant.

The NSF Faculty Early Career Development (CAREER) Program offers the foundation's most prestigious awards in support of the early career-development activities of those teacher-scholars who most effectively integrate research and education within the context of the mission of their organization.

Townsend's research focuses on adult neural plasticity and neurogenesis. The broader impact goals of the project are to expand a capstone course for seniors to conduct original biomedical research, and the development of an outreach program and summer fellowship with community colleges and other underrepresented groups in Maine in order to engage students in research and increase access to biomedical careers.



NIH awarded Townsend nearly \$713,000 for a two-year study investigating brain-adipose communication and how peripheral nerves in fat tissue function. FY2019 marked the second year of study for this award, which considers how nerves and fat tissue interact to affect metabolic health.

Metabolic disorders that stem from excess and unhealthy body fat are a major public health issue. Currently, Maine is the most obese state in



New England, and obesity is linked to other metabolic conditions, such as Type 2 diabetes and cardiovascular disease. Unhealthy adipose tissue, such as tissue that lacks proper innervation, may exacerbate these conditions, Townsend has found.

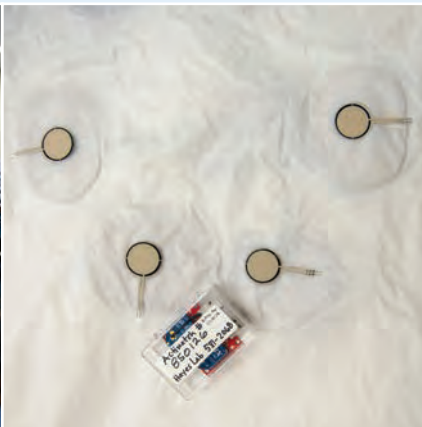
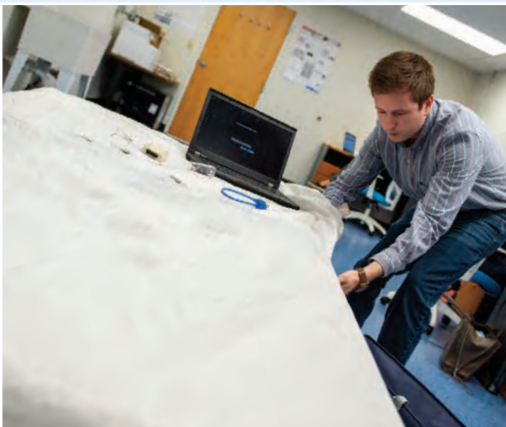
Townsend also co-founded the UMaine biotech spinoff Neuright, which has developed a medical device for early detection and diagnosis of peripheral neuropathy (the dying-back of nerve fibers). Neuright, a graduate of UMaine's technology accelerator programs MIRT and Top Gun, took home one of two \$25,000 grand prizes at the Top Gun Showcase pitch event in May 2019. Rosemary Smith, professor of electrical and computer engineering at UMaine, is the lead biomedical engineer for the design and fabrication of Neuright's product. Smith received a \$60,000 grant from the U.S. Department of Health and Human Services and Mount Desert Island Biological Laboratory to optimize and validate the company's prototype.

### ■ Activas Spinoff Developing UMaine Technology with Potential to Detect Early Symptoms of Alzheimer's, Cognitive Impairment

The University of Maine was issued a key patent in FY2019 for a device that detects brain injury by measuring sleep movement patterns and intends to license this technology to Activas Diagnostics, a UMaine spinoff company.

The invention is a fitted mattress sheet equipped with more than a dozen sensors that allow it to gather information about a person's sleep-wake and respiratory patterns. The advantage is that the sheet can be used while a person is sleeping in the comfort of their own home rather than in a sleep study facility. The SleepMove monitoring system has the potential to detect early symptoms of mild cognitive impairment and Alzheimer's Disease.

The UMaine inventors are Marie Hayes, professor of neuroscience, and Ali Abedi, assistant vice president for research, and professor of electrical and computer engineering. Together, they formed Activas Diagnostics to commercialize the technology. The company has received Maine Technology Institute funding and in 2018 was awarded \$1 million from the National Institutes of Health Small Business Innovation Research (SBIR) program to continue product and market development. Activas Diagnostics graduated from UMaine's Top Gun accelerator program in 2013. Based at the UpStart Center for Entrepreneurship, Activas Diagnostics participates in UMaine's business incubation program, which is funded in part through MEIF.



Through the funding they have received and the licensing opportunity, their next steps are to complete the ongoing clinical sleep study to test this technology. The results from the home sleep studies on early Alzheimer's will allow Activas to then seek approval from the U.S. Food and Drug Administration.

## Composites

### ■ \$20 Million Research Partnership Opens New Market for Maine Forest Products

A new research collaboration between the University of Maine Advanced Structures and Composites Center and the Department of Energy's Oak Ridge National Laboratory (ORNL) in Tennessee will advance efforts to 3D print with wood products, creating a new market for Maine's forest products industry.

The \$20 million effort, funded by DOE's Advanced Manufacturing Office, aims to strengthen regional manufacturing by connecting university-industry clusters with DOE's Manufacturing Demonstration Facility at ORNL.

The ORNL and UMaine research team is working with the forest products industry to produce new bio-based materials that will be conducive to 3D printing a variety of products, such as boat hull molds, shelters, building components, tooling for composites and wind blades. They also will position the industry to print large, structurally demanding systems, such as boats.



ORNL is a world leader in advanced manufacturing and is DOE's largest science and energy laboratory, conducting basic and applied research to deliver transformative solutions to compelling problems in energy and security. UMaine is a world leader in cellulose nanofiber (CNF) technology, including development of nano- and micro-cellulose reinforced thermoplastic composites through its Advanced Structures and Composites Center.

The collaboration provides students, faculty and companies associated with UMaine's Advanced Structures and Composites Center access to ORNL's assets and expertise in advanced manufacturing. ORNL researchers, in turn, gain access to UMaine's facilities and expertise in CNF and composites.

Scientists from ORNL and UMaine are conducting fundamental research in several key technical areas, including CNF production, drying, functionalization and compounding with thermoplastics, multiscale modeling and sustainability life cycle analysis. By placing CNF into plastics, strong, stiff and recyclable bio-derived material systems can be developed that may be 3D printed at deposition rates of hundreds of pounds per hour and up to 50 percent cellulose fiber loading. Printing with 50 percent wood promises to open new markets for the pulp, paper and forest products industries.

As a forest product, CNF could rival steel properties, and its successful incorporation into plastics shows great promise for a renewable feedstock suitable for additive manufacturing.

## Environmental Technologies

### ■ Maine-Greenland Collaborations Offer Climate Insights

A multidisciplinary team of 16 University of Maine System researchers and faculty traveled to southwest Greenland June 21-29 to address 21st century challenges throughout the Arctic, North Atlantic and Maine by experiencing the impacted region first-hand. The “Arctic Futures Workshop” was organized by Paul Mayewski, director of the Climate Change Institute at the University of Maine, and Charles Norchi, director of the Center for Oceans and Coastal Law at the University of Maine School of Law. This UMS initiative included participants from UMaine, University of Southern Maine and University of Maine School of Law, and was made possible through MEIF and other funding.

The first-of-its-kind workshop explored aspects of climate change and adaptation in South Greenland. The eight-day field visit allowed the multidisciplinary team to study the monumental cultural, environmental and socio-economic challenges facing this region of the Arctic as it grapples with a rapidly warming climate. The adaptation issues are similar to those in Maine. However, Greenland’s terrestrial and marine environment changes are occurring at a far more accelerated pace.

During the South Greenland workshop, faculty and researchers identified potential research projects and points of collaboration. These included essays and grant proposals, USM and UMaine collaborations to employ satellite data to map shifts in landscape and vegetation changes across South Greenland over a 40-year time period, an artistic animation series that brings to life narratives about Greenland and the “Greenland Bridge” and compilation of a matrix of geodata resources relevant to researchers and faculty across many disciplines.

Students in geography, GIS, anthropology, art, social work and tourism studies will benefit from planned courses related to the South Greenland collaboration. In summer 2022, students will go to South Greenland for a field research project focused on understanding human-environment interactions and adaptations in fragile environments. In addition to field data collection, students will use geospatial tools and techniques to supplement their field understanding of relevant issues.



## ■ Winter Survival Rates of Ticks and Implications for Tick-borne Diseases in Maine



With tick-borne illnesses on the rise in Maine, Allison Gardner, UMaine assistant professor of arthropod vector biology, is studying over-winter survival rates for two types of ticks. Gardner's work addresses the hypothesis that winter temperatures currently constrain the geographic distribution of both the black-legged tick (already established in Maine) and the lone star tick (not yet established in Maine, but increasingly prevalent elsewhere in the Northeast). It is further hypothesized that climate change may increase over-winter tick survival and thus contribute to the spread of tick-borne disease.

With a grant from the Maine Department of Inland Fisheries and Wildlife, Gardner will conduct an over-winter survival assay for both tick species in five locations spanning a statewide climate gradient. Another component of the research involves studying the geographic distribution of the blacklegged tick in 13 locations throughout the state and testing small animals in these regions for a variety of tick-borne pathogens.

## Forestry and Agriculture

### ■ Wood to Jet Fuel Program Gets a Big Boost



The University of Maine's groundbreaking work to convert woody biomass into biofuels recently got a big boost in the form of a \$4 million grant from the U.S. Department of Defense.

Many Maine communities have felt the effects of declining paper industries. In order to revitalize the economies of these towns across the state, it is crucial to find alternative and innovative uses for the mills and resources that are currently underutilized. The Forest Bioproducts Research Institute has been addressing this problem through research into nanocellulose, a forest-based bioproduct, that is showing a variety of useful applications in a range of industries.

The new grant funding will allow UMaine to expand and scale up its wood-to-fuel technology, putting in place the research infrastructure needed to produce sufficient quantities of diesel and jet fuel needed for fuel certification testing. Additionally, it allows for follow-up work on co-production of chemicals derived from carbon

sugars and advanced materials derived from nanocellulose and biochar.

The pilot plant at the University of Maine's Technology Research Center in Old Town, Maine, is able to process up to 1 ton of woody biomass every day, with the ability to run 100 continuous hours.





### ■ Blueberry Research Supports Health of Key Maine Industry

Several projects aim to help Maine's wild blueberry growers and processors to improve safety, efficiency, and profitability.

Lowbush blueberries are a historically important crop in Maine, and our state remains the number one domestic source for wild blueberries, producing an average of more than 100 million pounds annually.

Research led by University of Maine Cooperative Extension wild blueberry specialist and assistant professor of horticulture Lily Calderwood and supported by a \$199,828 grant from the U.S. Department of Agriculture considers nutrient and weed management strategies for the state's organic wild blueberry growers. With the price of conventional wild blueberries reaching a record low in 2017, more growers are exploring organic production. Organic berries command significantly higher prices, but low yields are a chronic problem without effective nutrient and weed management plans. Difficulty developing and implementing such plans is commonly cited as a barrier to transitioning to organic production, and Calderwood's work focuses on both research and related education to support Maine's blueberry growers.

Calderwood also is studying the role of fertilizers in the wild blueberry system in order to draft revised guidance for growers in an effort to improve farm efficiency and profitability. This work, supported by a \$43,887 grant from the U.S. Department of Agriculture, evaluates new fertilizer products and their impact on weed and disease pests, as well as studies the effect of warmer temperatures and fertilizer application on wild blueberry productivity, weed pressure and disease incidence.

In addition, Jennifer Perry, UMaine assistant professor of food microbiology, continued work to improve the safety of Maine's wild blueberry products with grant assistance from the Wild Blueberry Commission of Maine. The study is an academic and industry collaboration to examine the use of emerging aqueous treatments on the safety of wild blueberries during simulated commercial processing. More than 90% of Maine's wild blueberry harvest is diverted to frozen product, and changes in the way people consume blueberries demand that frozen berries be delivered ready-to-eat. A transition away from baking means that many people do not heat the product before consumption, bringing bacterial control to the fore. Perry is studying the utility of underutilized and emerging aqueous treatments including ozone, electrolyzed water and peracetic on the survival of *Listeria* bacteria. The commercial processing simulations involved in the research are designed to mirror existing processing operations so that solutions can be easily and cost effectively implemented by the industry.

This study builds on Perry's prior work in this area, which was supported by a grant from Maine's Agricultural Development Grant Program in 2018.

## ■ UMaine Continues to Lead the Way in Potato Research

A \$433,370 grant from the U.S. Department of Agriculture is the latest award in a multiyear integrated study of potato breeding and variety development for improved quality and pest



resistance in the Eastern United States. Greg Porter, a professor of crop ecology and management at UMaine who leads the university's potato breeding and development program, is working with colleagues at universities in six other states as part of ongoing research to develop attractive, highly productive disease- and insect-resistant potato varieties that can be employed by small and large producers to enhance marketing opportunities, farm sustainability and profits.

It takes 12 to 14 years to develop a new potato variety, and Porter's work at UMaine's 425-acre Aroostook Research Farm focuses on every aspect of potato growth and development. In recent years, UMaine's breeding program has released several varieties, including the Caribou Russet, which has white flesh and lightly russeted skin, and the Pinto Gold, a yellow-flesh gourmet potato.

The Caribou Russet hit store shelves with limited supply in 2016. A year later, Hannaford stores began stocking the new variety in its produce sections throughout Maine. Today, Hannaford and Stop & Shop stores are carrying the Caribou Russet and it is available to some smaller supermarkets as well. In 2019, demand for Caribou Russet grew to include chefs and the food service industry. In the time since the release of the Caribou Russet, acreage has increased to 3,900

acres which accounts for 7.5% of all the potatoes planted in Maine. The Pinto Gold, released in 2018, is earlier in its development trajectory and has received acclaim for its excellent roasting and eating qualities.

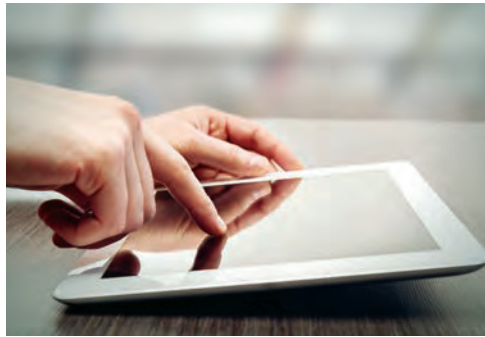
The management of insects, diseases and other pests is key to sustaining Maine's \$500 million potato industry, and the University of Maine Cooperative Extension's long-established Potato Integrated Pest Management Program is vital to that goal. Without reliable and sustainable pest management strategies, potato growers face the potential for severe crop losses resulting in significant reductions in profits and threats to long-term viability. Funded through the USDA via the Maine Department of Agriculture for \$99,571 in 2019, the Potato Integrated Pest Management Program provides ongoing support to growers through field monitoring, disease forecasting and distribution of educational materials.



## Information Tech

### ■ Learning Platform Expands STEM Access for Blind or Visually Impaired Students

Development and evaluation of a first-of-its-kind remote learning platform providing people who are blind or visually impaired (BVI) nonvisual access to STEM-related graphical information is the focus of a \$748,000 National Science Foundation grant to the University of Maine.



The project, “A Remote Multimodal Learning Environment to Increase Graphical Information Access for Blind and Visually Impaired Students,” is led by Nicholas Giudice, UMaine professor of spatial informatics who directs the Virtual Environment and Multimodal Interaction (VEMI) Laboratory.

The system uses combinations of nonvisual inputs, such as vibration, speech and auditory information, that allow BVI users to feel and hear the visual

content of graphics as they move their hand around the touchscreen of smartphones and tablets. With graphical educational materials at the core of all STEM disciplines, this information access is critical for improving BVI students’ classroom outcomes. The project will conduct one of the largest experiments ever performed on graphical access with BVI participants, with results leading to the development of a robust and economically viable solution for the BVI community.

This newest award is the latest in six years of research by Giudice and the VEMI Lab focused on using commercial smartphones and tablets to provide BVI people with nonvisual and multimodal access to visual graphics. The work has been supported by two other NSF grants and has been published in over 30 papers and conference presentations.

The research has led to the development of a new class of information access technology that has gained significant national attention and has potential for solving the longstanding graphics access problem for people with visual impairment. By creating an accessible remote learning platform that can work on a BVI user’s personal smartdevice, this most recent project takes the research outside of the lab and directly to the people who can most benefit from its application.

### ■ USM Municipal Data Consortium Pilot Project Identifies Key Needs

The University of Southern Maine Data Innovation Project is dedicated to partnering with organizations to increase their capacity to utilize data to clearly define their work, achieve results and demonstrate impact in Maine. Part of this effort has been the Municipal Data Consortium project, which began in spring 2018.

This work has focused on reviewing open data movement initiatives for local municipalities, as well as data-sharing platforms that exist around the U.S. and Canada. Through dialogue with greater Portland-area town managers to explore their primary data needs, staff undertook a data collection pilot project with the towns of Falmouth, Scarborough, Gray, Yarmouth, Gorham and Cape Elizabeth.

The participating towns identified being able to make meaningful comparison data across towns and benchmarking as high priorities. The pilot found that the data collected and maintained by



towns lack uniformity, making cross-town comparisons or benchmarking very difficult.

At the municipal level, the two most significant data files are budgets and town parcel and assessor files. While Maine has created voluntary guidelines to standardize each of these common data files, they are not mandated for

use. For example, the Office of the State Auditor has a model chart of accounts that could standardize budgets, and the Maine GeoLibrary created recommended land use codes for assessor data and standards for digital parcel files. Neither of these efforts appears to have been widely publicized beyond the year in which they were created.

As a result of this project, the staff has a much stronger vision for a data consortium, its functionality, the process by which it could be developed, as well as a draft business plan/proposal that outlines the stages, resources necessary and stakeholders to involve in the future.

## Precision Manufacturing

### ■ Advanced Manufacturing Center Pioneering 3D Metal Printing for Maine

A broad-based coalition of Maine companies is taking advantage of additive metal manufacturing services and training available at the University of Maine as part of a concerted effort to make 3D metal printing accessible for Maine businesses.

The work is being done at UMaine's Center for Additive Manufacturing of Metals (CAMM), based at the Advanced Manufacturing Center (AMC) on the Orono campus. It is the only Maine facility currently offering these services, which focus on the process of fusing small metal particles together through 3D printing to form solid metal objects. The technology is ideal for creating small parts used in tooling or fixturing.



CAMM's funding comes from a nearly \$500,000 Maine Technology Institute (MTI) cluster initiative program grant, with matching funds from the university and 35 Maine companies, bringing the total to \$1 million. The funds also will be used as a partial match for a \$750,000 U.S. Economic Development Administration grant AMC recently received. With matching funds, the grant totals \$1.5 million.

The companies who have contributed funding — including GE Power in Bangor — are true partners in CAMM's work. GE's location in Bangor manufactures steam turbine rotors and blading and specializes in gas turbine components. The AMC has been working with GE on test parts for a gripper system that the company uses to hold blades and parts for machining, as well as testing for a high-temperature masking operation they use in the blade-coating process. The ability to experiment with CAMM is an asset to businesses who want to try this new technology, and the hope is to facilitate the adoption of 3D metal printing in businesses around the state.

## Cross Sector

### ■ Maine Regulatory Training and Ethics Center Interns in the Field

The Maine Regulatory Training and Ethics Center (MeRTEC) project focuses on an interdisciplinary, educational partnership between the University of Southern Maine (USM) and Maine's businesses and community partners. Regional business, industry leaders and community partners have conveyed to USM the need for guidance in regulatory training, workforce development and ethics. In partnership with the University of Maine School of Law, MeRTEC has established Regulatory Navigation Certificates consisting of a professional training curriculum focused on core competencies within law, ethics and the social sciences. The program draws from USM's recognized strengths in these areas to offer in-person and online courses, training, and student internships. The successful pilot launch of the Professional Certificate in 2017-2018 resulted in 10 students in the pilot cohort receiving a Certificate of Compliance.

Over the course of 2019, MeRTEC has also helped to meet the needs of Maine's businesses, industry leaders and community partners through providing MeRTEC interns/graduate assistants. These individuals provided technical assistance to community partners with at least two projects in each of the emphasized sectors: agricultural, marine, health and life science. MeRTEC also piloted a student internship exchange with Reykjavik University at Eimskip Portland and Reykjavik.







Table A1-1

## University of Maine System New Patent Applications Filed FY2019

Title	Application Type	Filing Date	Inventor	Campus
METHOD OF ASSEMBLING A FLOATING WIND TURBINE PLATFORM	US-DIVISIONAL	5/15/2019	HABIB JOSEPH DAGHER ANTHONY M VISELLI	ORONO
SPENT GRAIN PAPER AND PAPERBOARD PRODUCTS AND RELATED METHODS	US-PROVISIONAL	3/22/2019	KAI SMITH	ORONO
HYBRID COMPOSITE CONCRETE BRIDGE AND METHOD OF ASSEMBLING	US	3/12/2019	WILLIAM G DAVIDS JAMES M ANDERSON JOSHUA DAVID CLAPP HABIB JOSEPH DAGHER *	ORONO
ADVANCED SEGMENTED PRE-CAST CONCRETE HULLS FOR WAVE ENERGY CONVERTERS	US	3/4/2019	ANTHONY M VISELLI* HABIB JOSEPH DAGHER	ORONO
NON-ORTHOGONAL ADDITIVE MANUFACTURING AND THE TREATMENT OF PARTS MANUFACTURED THEREFROM	US	1/17/2019	MATTHEW JOHN IRELAND JAMES M ANDERSON *	ORONO
COMPOSITIONS AND METHODS FOR MODULATING ENDOTHELIAL CELL MIGRATION AND ANGIOGENESIS	PCT	11/15/2018	PANAGIOTIS TSAKIROGLOU DOROTHY J KLIMIS *	ORONO
IMPROVED FILAMENTS FOR 3D PRINTING	PCT	11/15/2018	JORDAN E SANDERS LU WANG DOUGLAS JEROME GARDNER *	ORONO
TUNE MASS DAMPER FOR FLOATING STRUCTURES	US-PROVISIONAL	11/2/2018	ANDREW JOSEPH GOUPEE ANTHONY M VISELLI HABIB JOSEPH DAGHER *	ORONO
METHOD TO PRODUCE COMPOSITE-ENHANCED MARKET PULP AND PAPER	PCT	10/10/2018	MICHAEL BILODEAU * MARK A PARADIS	ORONO
STYLIZED ADAPTIVE MOBILITY DEVICE	US	9/20/2018	VINCENT CACCSE ELIZABETH DEPOY * STEPHEN F GILSON	ORONO
CONTROLLED POROSITY STRUCTURAL MATERIAL WITH NANOCELLULOSE FIBERS	US	9/20/2018	DAVID GREGG HOLOMAKOFF MUHAMMAD RADOWAN HOSSEN MICHAEL D MASON *	ORONO
PARASITE TREATMENT COMPOUND	PCT	9/12/2018	DEBORAH A BOUCHARD * IAN BRICKNELL	ORONO
TREHALASE-RESISTANT TREHALOSE ANALOGUES AND USES THEREOF	US-PROVISIONAL	8/22/2018	PETER WOODRUFF	USM
NON-ORTHOGONAL ADDITIVE MANUFACTURING AND THE TREATMENT OF PARTS MANUFACTURED THEREOF	US-PROVISIONAL	8/9/2018	MATTHEW JOHN IRELAND JAMES M ANDERSON *	ORONO
PHOTOVOLTAIC FABRIC WITH WOVEN BUS ARCHITECTURE	PCT	7/30/2018	KARL PEPIN *	ORONO
A NOVEL BARRIER CONCEPT TO REDUCE SEA LICE INFESTATION OF SALMON FARMS	US-PROVISIONAL	7/26/2018	IAN BRICKNELL KRISHNA THIAGARAJAN *	ORONO
DOPPLER RADAR BASED BEE HIVE ACTIVITY MONITORING SYSTEM	US-PROVISIONAL	7/10/2018	HERBERT AUMANN NURI EMANETOGLU	ORONO
TOTAL 17				

Table A1-2 **University of Maine System — Patents Issued FY2019**

Title	Patent Number	Country	Issued Date
ENERGY EFFICIENT PROCESS FOR PREPARING NANOCELLULOSE FIBERS	602013056272.5	Germany	6/5/2019
ENERGY EFFICIENT PROCESS FOR PREPARING NANOCELLULOSE FIBERS	E 1140092	Austria	6/5/2019
ENERGY EFFICIENT PROCESS FOR PREPARING NANOCELLULOSE FIBERS	502019000070530	Italy	6/5/2019
ENERGY EFFICIENT PROCESS FOR PREPARING NANOCELLULOSE FIBERS	2861799	*European	6/5/2019
FLOATING WIND TURBINE PLATFORM AND METHOD OF ASSEMBLING	57.397	Chile	5/24/2019
POLYMERIC COMPOSITE MATERIALS AND METHODS OF MAKING THEM	364784	Mexico	5/7/2019
CELLULOSE NANOFIBRILS REINFORCED POLYPROPYLENE NANOCOMPOSITES: MECHANICAL AND MORPHOLOGICAL PROPERTIES	10280294	United States	5/7/2019
METHOD OF MOORING ONE OR MORE FLOATING WIND TURBINE PLATFORM	ZL201580007382.3	China	5/7/2019
SYSTEM AND METHOD FOR EARLY DETECTION OF MILD TRAUMATIC BRAIN INJURY CONTINUATION OF APPLICATION 13/106451 NOW PAT. NO. 9192333	10244977	United States	4/2/2019
FLOATING WIND TURBINE PLATFORM AND METHOD OF ASSEMBLING	2836708	*European	2/27/2019
HYBRID COMPOSITE MATERIAL SYSTEMS FOR OFFSHORE FLOATING PLATFORMS	602013051466.6	Germany	2/27/2019
HYBRID COMPOSITE MATERIAL SYSTEMS FOR OFFSHORE FLOATING PLATFORMS	2836708	UK, Spain, Denmark, France	2/27/2019
FLOATING WIND TURBINE SUPPORT SYSTEM	3049668	*European	2/27/2019
METHOD OF CONSTRUCTION, ASSEMBLY AND LAUNCH OF A FLOATING WIND TURBINE PLATFORM	10215161	United States	2/26/2019
HYBRID COMPOSITE MATERIAL SYSTEMS FOR OFFSHORE FLOATING PLATFORMS	2635489	*European	2/20/2019
BUOY WITH INTEGRATED MOTION COMPENSATION	10202174	United States	2/12/2019
HULL FOR A FLOATING WIND TURBINE PLATFORM	10202170	United States	2/12/2019
FLOATING WIND TURBINE SUPPORT SYSTEM	105793563	China	1/22/2019
METHOD OF FORMING A COMPOSITE STRUCTURAL MEMBER (APPARATUS)	2812942	Canada	1/20/2019
METHOD OF FORMING A COMPOSITE STRUCTURAL MEMBER (METHOD)	2812941	Canada	1/15/2019
METHOD FOR DRYING CELLULOSE NANOFIBRILS	2797681	Canada	12/18/2018
POLYMERIC COMPOSITE MATERIALS AND METHODS OF MAKING THEM	3004222	*European	12/5/2018
HYBRID CONCRETE - COMPOSITE TOWER FOR A WIND TURBINE AND METHOD OF MANUFACTURING	ZL201580019384.4	China	11/27/2018
BIODEGRADABLE MATERIALS AND METHODS OF MAKING THE SAME	10065080	United States	9/4/2018
<b>TOTAL 47: 6 U.S.; 41 foreign</b>			

\*European Patent Convention: Portugal, Poland, Norway, Netherlands, UK, France, Finland, Spain, Belgium, Sweden



Table A2-1

### A History of Legislative Actions on Appropriating State Research Funds

The following is a summary of the actions of the 118th–129th (first regular session) Maine Legislature with regard to appropriating research and development funds to the University of Maine System.

#### 118th LEGISLATURE

**March 26, 1997:** Governor signed into law the Economic Improvement Strategy (Chapter 24) that appropriated \$500,000 to UMS for research.

**April 1, 1998:** Governor signed into law the Economic Improvement Strategy (Chapter 643, Part LL, Sec. S-3) that appropriated \$4 million to UMS for research. These funds were allocated from the FY1998 year-end state surplus for use in FY1999.

#### 119th LEGISLATURE

**March 15, 1999:** Governor signed into law the Part I Current Services budget (Chapter 16) that appropriated \$4 million in 1999–2000 and 2000–01 to UMS on a “base budget” basis for research. This extends the one-time FY1999 \$4 million research appropriation that was funded from the FY1998 year-end state surplus.

**June 4, 1999:** Governor signed into law the Part II Supplemental Appropriation budget (Chapter 401) that appropriated an additional \$5.55 million in 1999–2000 and an additional \$50,000 in 2000–01 to UMS on a “base budget” basis for research.

**April 25, 2000:** Governor signed into law the Part II Supplemental Appropriation budget (Chapter 731) that appropriated \$300,000 in 2000–01 to UMS on a “base budget” basis for the Maine Patent Program.

#### 120th LEGISLATURE

**June 21, 2001:** Governor signed into law the Part II Supplemental Appropriation budget (Chapter 439) that appropriated an additional \$2 million in 2002–03 to UMS on a “base budget” basis for research.

**March 25, 2002:** Governor signed into law a deappropriation (Chapter 559) that reduced the FY2003 \$2 million Supplemental Appropriation by \$1 million.

**July 1, 2002:** Governor signed a Financial Order that curtailed the FY2003 \$2 million Supplemental Appropriation by an additional \$1 million. This eliminated the FY2003 increase of \$2 million for research, bringing the FY2003 research and development appropriation back to the FY2002 level of \$10.1 million.

**November 18, 2002:** Governor signed into law a Supplemental Appropriation budget (Chapter 714) that deappropriated the \$1 million curtailment that was signed July 1, 2002.

#### 121st LEGISLATURE

**March 27, 2003:** Governor signed into law the Part I Current Services budget (Chapter 20, Part RR) that appropriated \$100,000 in 2003–04 and 2004–05 on a “base budget” basis for research.

**January 30, 2004:** Governor signed into law a Supplemental Appropriation budget (Chapter 513, Part P, Sec. P-2) that includes a provision to transfer to MEIF up to \$2 million of any unbudgeted State revenue remaining at the close of FY2004. The full amount was subsequently transferred to UMS. This same Chapter 513, Part P, Sec. P-3 made the \$2 million part of the MEIF FY2005 base appropriation.

#### 122nd LEGISLATURE

**March 29, 2006:** Governor signed into law a Supplemental Appropriations budget (Chapter 519, Part A, Sec. A-1) that includes providing one-time funding of \$600,000 in FY2007 for the commercialization of research and development activity, and for the Gulf of Maine Ocean Observing System.

#### 123rd LEGISLATURE

**June 7, 2007:** Governor signed into law a budget (Chapter 240, Part A, Sec. A-68) that provides an increase of \$1.5 million in FY2008 and an additional \$1 million in FY2009 on a “base budget” basis for research.

#### 124th LEGISLATURE

**May 28, 2009:** Governor signed into law a budget (Chapter 213, Part A, Sec. A-67) that maintains the annual funding at the FY2009 level of \$14.7 million.

#### 125th LEGISLATURE

**June 15, 2011:** Governor signed into law a budget (Chapter 380) that maintains the annual funding at \$14.7 million. May 29, 2012: PUBLIC Law (Chapter 698) creates the formula funding for the Small Campus Initiative, reserving a percentage of MEIF exclusively for the five smaller campuses of the University of Maine System.

#### 126th LEGISLATURE

**June 10, 2013:** Governor signed into law (Chapter 225) an amendment to the MEIF statute to include Maine Maritime Academy as a MEIF-eligible small campus.

**June 26, 2013:** Legislature approved into law a budget (Chapter 368) that maintains the annual funding at \$14.7 million.

#### 127th LEGISLATURE

**June 30, 2015:** Legislature approved into law a budget (Chapter 267) that increases the annual funding by \$2.65 million in each year of the biennium.

#### 128th LEGISLATURE

**July 4, 2017:** Governor signs into law the state budget that maintains the annual funding at \$17.35 million (FY2017/FY2018).

#### 129th LEGISLATURE

**June 17, 2019:** Governor signs into law the state budget that maintains the annual funding at \$17.35 million (FY2018/FY2019)

Table A2-2

## Legislative History of MEIF New Appropriations

### 118th LEGISLATURE

	<u>FY1998</u>	<u>FY1999</u>	<u>Total 2-Year</u>
UMaine	\$400,000	\$3,200,000	\$3,600,000
USM	100,000	800,000	900,000
Total	\$500,000	\$4,000,000	\$4,500,000

### 119th LEGISLATURE

	<u>FY2000</u>	<u>FY2001</u>	<u>Total 2-Year</u>
UMaine	\$4,440,000	\$40,000	\$4,480,000
USM	1,110,000	10,000	1,120,000
Total	\$5,550,000	\$50,000	\$5,600,000

### 120th LEGISLATURE

	<u>FY2002</u>	<u>FY2003</u>	<u>Total 2-Year</u>
UMaine	\$0	\$0	\$0
USM	0	0	0
Total	\$0	\$0	\$0

### 121st LEGISLATURE

	<u>FY2004</u>	<u>FY2005</u>	<u>Total 2-Year</u>
UMaine	\$80,000	\$1,600,000	\$1,680,000
USM	20,000	400,000	420,000
Total	\$100,000	\$2,000,000	\$2,100,000

### 122nd LEGISLATURE

	<u>FY2006</u>	<u>FY2007</u>	<u>Total 2-Year</u>
UMaine	\$0	\$540,000	\$540,000
USM	0	60,000	60,000
Total	\$0	\$600,000	\$600,000

### 123rd LEGISLATURE

	<u>FY2008</u>	<u>FY2009</u>	<u>Total 2-Year</u>
UMaine	\$1,200,000	\$720,000	\$1,920,000
USM	300,000	180,000	480,000
S.C. Initiatives	0	100,000	100,000
Total	\$1,500,000	\$1,000,000	\$2,500,000

### 124th LEGISLATURE<sup>20</sup>

	<u>FY2010</u>	<u>FY2011</u>	<u>Total 2-Year</u>
UMaine	\$0	\$0	\$0
USM	0	0	0
S.C. Initiatives	0	0	0
Total	\$0	\$0	\$0

**125th LEGISLATURE**

	<u>FY2012</u>	<u>FY2013</u>	<u>Total 2-Year</u>
UMaine	\$0	\$0	\$0
USM	0	0	0
S.C. Initiatives	0	0	0
<b>Total</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>

**126th LEGISLATURE**

	<u>FY2014</u>	<u>FY2015</u>	<u>Total 2-Year</u>
UMaine	\$0	\$0	\$0
USM	0	0	0
S.C. Initiatives	0	0	0
<b>Total</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>

**127th LEGISLATURE**

	<u>FY2016</u>	<u>FY2017</u>	<u>Total 2-Year</u>
UMaine	\$2,056,400	\$0	\$2,056,400
USM	514,100	0	514,100
S.C. Initiatives	79,500	0	79,500
<b>Total</b>	<b>\$2,650,000</b>	<b>\$0</b>	<b>\$2,650,000</b>

**128th LEGISLATURE**

	<u>FY2018</u>	<u>FY2019</u>	<u>Total 2-Year</u>
UMaine	\$0	\$0	\$0
USM	0	0	0
S.C. Initiatives	0	0	0
<b>Total</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>

**129th LEGISLATURE**

	<u>FY2020</u>	<u>FY2021</u>	<u>Total 2-Year</u>
UMaine	\$0	\$0	\$0
USM	0	0	0
S.C. Initiatives	0	0	0
<b>Total</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>

**Total Yearly Research Appropriations for FY2019****FY2019 Appropriation**

UMaine	\$13,289,194	76.6%
USM	3,290,306	19.0%
UMM	250,000	1.4
UMFK	0	0.0
UMPI	0	0.0
UMA	0	0.0
UMF	0	0.0
UMS	520,500	3.0
MMA	0	0.0
<b>Total</b>	<b>\$17,350,000</b>	<b>100.0%</b>

S.C. Initiatives ..... Small Campus Initiatives  
 University of Maine ..... UMaine  
 University of Southern Maine ..... USM  
 University of Maine at Augusta ..... UMA  
 University of Maine at Farmington ..... UMF  
 University of Maine at Fort Kent ..... UMFK  
 University of Maine at Machias ..... UMM  
 University of Maine at Presque Isle ..... UMPI  
 Maine Maritime Academy ..... MMA

Table A2-3 Maine Economic Development Fund

## Utilization of FY2019 Research Appropriation by Targeted Sector

UMAINE	Source of R&D Funds				Utilization of R&D Funds				Balance		
	FY2019 R&D Initial	Unused R&D Funds from Prior Years	Adjustment To Prior Years Unused R&D Funds	Adjusted Unused R&D Funds From Prior Years	FY2019 R&D Funding Transfers	FY2019 Total R&D Funds Available	FY2019 R&D Actual Expenditures	Transferred To Match Grants & Contracts	Transferred Between R&D Accounts	Total R&D Funds Utilized	Unused Funds Carried Forward To FY2020 <sup>1</sup>
Targeted Research Area	Base Budget	As Reported									
Adv. Technology Forestry & Agriculture	\$1,781,062	\$(1,049,667)	-	\$1,049,667	\$ -	\$731,395	\$2,951,359	\$184,418	\$(1,003,004)	\$2,132,773	\$(1,401,378)
Aquaculture & Marine Science	2,959,909	(2,400,098)	-	(2,400,098)	-	559,811	3,951,753	1,481,364	(1,356,823)	3,076,294	(2,516,483)
Biotechnology	1,208,714	(1,135,543)	-	(1,135,543)	-	73,171	1,800,930	213,161	(625,709)	1,338,382	(1,315,211)
Composites	1,844,246	2,028,201	-	2,028,201	-	3,872,447	2,237,710	237,576	(889,316)	1,585,970	2,286,477
Environmental	1,338,169	(570,030)	-	(570,030)	-	768,139	2,037,686	115,393	(738,844)	1,414,235	(646,096)
Information Technology	1,856,946	(290,256)	-	(590,256)	-	1,266,690	3,237,946	27,385	(998,705)	2,266,626	(999,936)
Precision Manufacturing	1,383,284	240,561	-	240,561	-	1,623,845	1,866,741	85,488	(655,964)	1,296,265	327,580
Cross Sector	916,864	(422,450)	-	(422,450)	-	494,414	1,113,696	98,300	(185,957)	1,026,039	(531,625)
Total State Funding	\$ 13,289,194	\$3,899,282	\$ -	\$ (3,899,282)	\$ -	\$ 9,389,912	\$ 18,197,821	\$ 2,443,085	\$ (6,454,322)	\$ 14,186,584	\$ (4,796,672)
UM Cost Sharing Funding <sup>2</sup>	6,454,248	-	-	-	-	6,454,248	-	-	6,454,248	6,454,248	-
Total Funding	\$ 19,743,442	\$(3,899,282)	\$ -	\$(3,899,282)	\$ -	\$ 15,844,160	\$ 18,197,821	\$ 2,443,085	\$ (74)	\$ 20,640,832	(4,796,672)

<sup>1</sup> Includes year-end equipment carry-over funds (equipment ordered, not received and not paid).<sup>2</sup> Salary and benefits from university.<sup>3</sup> Actual expenditures for FY2017 included a reversal of a \$1,533 FY2016 payroll accrual that was accrued under the instruction functional expense and not included in the FY2016 report.

USM	Source of R&D Funds				Utilization of R&D Funds					Balance	
	FY2019 R&D Initial	Unused R&D Funds from Prior Years	Adjustment To Prior Years Unused R&D Funds	Adjusted Unused R&D Funds From Prior Years	FY2019 R&D Funding Transfers <sup>3</sup>	FY2019 Total R&D Funds Available	FY2019 R&D Actual Expenditures	Transferred To Match Grants & Contracts	Transferred Between R&D Accounts	Total R&D Funds Utilized	Unused Funds Carried Forward To FY2020 <sup>1,2</sup>
Targeted Research Area	Base Budget	As Reported	R&D Funds	Prior Years							
Forestry & Agriculture	\$ -	\$ 452,099	\$ -	\$ 452,099	\$ 696,518	\$ 1,148,617	\$ 903,794	\$ 57,753	\$ -	\$ 961,547	\$ 187,070
Aquaculture & Marine	-	500,647	-	500,467	360,125	860,772	683,035	-	-	683,035	177,737
Biotechnology	-	14,272	-	14,272	254,432	268,704	251,157	-	-	251,157	17,547
Composites	-	1,089	-	1,089	3,351	4,440	3,550	-	-	3,550	890
Environmental	-	65,700	-	65,700	(27,095)	38,605	35,143	-	-	35,143	3,462
Information Technology	-	676,373	-	676,373	507,565	1,183,938	858,129	78,662	-	936,791	247,147
Precision Manufacturing	-	556	-	556	26,076	26,632	22,661	-	-	22,661	3,971
Cross Sector	-	26,107	-	26,107	1,278,603	1,304,710	1,046,485	-	-	1,046,485	258,225
Unassigned — reallocated by System	3,290,306	287,551	-	287,551	(3,095,575)	478,282	-	-	-	-	478,282
Total State Funding	\$ 3,290,306	\$ 2,024,394	\$ -	\$ 2,024,394	\$ -	\$ 5,314,700	\$ 3,803,954	\$ 136,415	\$ -	\$ 3,940,369	\$ 1,374,331

<sup>1</sup> Includes year-end equipment carry-over funds (equipment ordered, not received, and not paid).<sup>2</sup> At USM, projects are funded on a year to year basis with renewals contingent on performance. A majority of the unused funds carried forward into FY2019 are committed but not yet allocated to multi year projects.<sup>3</sup> Transfers for current year funding of USM R&D programs and awards from "Unassigned". UM base budgets the MEIF appropriation by sector and thus does not use funding transfers.



Table A2-4 Maine Economic Development Fund

**FY2019 Utilization of FY2019 Research Appropriation by Campus**

	Source of R&D Funds				Utilization of R&D Funds						Balance Unused Funds	
	FY2019 R&D Initial Budget	Unused R&D Funds from Prior Years As Reported	Adjustment To Prior Years Unused R&D Funds <sup>4</sup>	Adjusted Unused R&D Funds From Prior Years	FY2019 R&D Funding Transfers <sup>3</sup>	FY2019 R&D Funds Available	FY2019 Total R&D Funds	FY2019 R&D Actual Expenditures	Transferred To Match Grants & Contracts	Transferred Between R&D Accounts	Total R&D Funds Utilized	Balance Unused Funds Carried Forward To FY2020 <sup>1</sup>
UMAINE	\$13,289,194	\$(3,899,282)	\$ -	\$(3,899,282)	\$ -	\$9,389,912	\$18,197,821	\$2,443,085	\$14,186,584	\$(4,796,672)		
USM	3,290,306	2,024,394	-	2,024,394	-	5,314,700	3,803,954	136,415	3,940,369	1,374,331		
UMM	250,000	243,100	-	243,100	300,000	793,100	457,579	-	457,579	335,521		
UMFK	-	177,032	-	177,032	-	177,032	115,675	-	115,675	61,357		
UMPI	-	258,571	-	258,571	-	258,571	192,950	-	192,950	65,621		
UMA	-	7,288	-	7,288	85,129	92,417	7,287	-	7,287	85,130		
UMF	-	23,636	-	23,636	-	23,636	13,656	-	13,656	9,980		
UMS	520,500	13,853	-	13,853	(435,063)	99,290	49,839	-	49,839	49,451		
MMA	-	105,418	-	105,418	49,934	155,352	52,626	-	52,626	102,726		
Total State Funding	\$17,350,000	\$(1,045,990)	\$ -	\$(1,045,990)	\$ -	\$16,304,010	\$22,891,387	\$2,579,500	\$19,016,565	\$(2,712,555)		

<sup>1</sup> Includes year-end equipment carry-over funds (equipment ordered, not received, and not paid).

<sup>2</sup> UM Cost Sharing.

<sup>3</sup> Inter-unit R&D funding transfers related to FY2019 MMA and Small Campus Initiative (SCI) awards.



Center for Additive Metals Manufacturing at the Advanced Manufacturing Center

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