

MAINE STATE LEGISLATURE

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MAINE ECONOMIC IMPROVEMENT FUND



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



Annual Report FY18 • Presented to Maine State Legislature



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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 these Strategic Outcomes. These metrics were approved at the end of FY14 and are applied to all FY18 MEIF activity and included in this annual report. By statute, MEIF-funded activity is restricted to Maine's seven statutorily established R&D sectors.

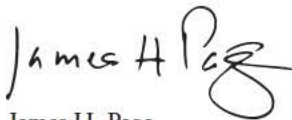
In FY18, the state's \$17.35 million MEIF investment was leveraged at a rate of 3.6:1 by our UMS campuses for an additional \$62.35 million in federal and private-sector grants and contracts in the seven sectors.

- MEIF funds and the external grants and contracts it leverages funded the work of 481 researchers and technicians, and 878 graduate and undergraduate students.
- These grants and contracts provided more than \$2.5 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 over 500 companies and individuals.

As required in the statute that created MEIF, included with this FY18 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,



James H. Page
Chancellor
University of Maine System

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 solve 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 money also supports equipment purchases or facilities renovations to make the universities more competitive for federal grants, expanding opportunities to support Maine companies, and involve students in 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 76.4 percent to the University of Maine, 19.1 percent to the University of Southern Maine, 1.4 percent 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 481 faculty and staff, and over 878 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.

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 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 those 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

Derived from UMS BOT Research and Economic Development 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 FY13 baseline was a calculated percentage of total activity. Table 1 below shows the actual FY13 baseline at slightly less at \$44.29 million.

Table 1

| FY18 Total Grants and Contracts (ALL Activity Inclusive) | Number of Awards | Total Award Value |
|---|-------------------------|--------------------------|
| Total Proposals Submitted | 1,205 | \$210,434,244 |
| Total Proposals Awarded | 1,018 | \$93,979,641 |

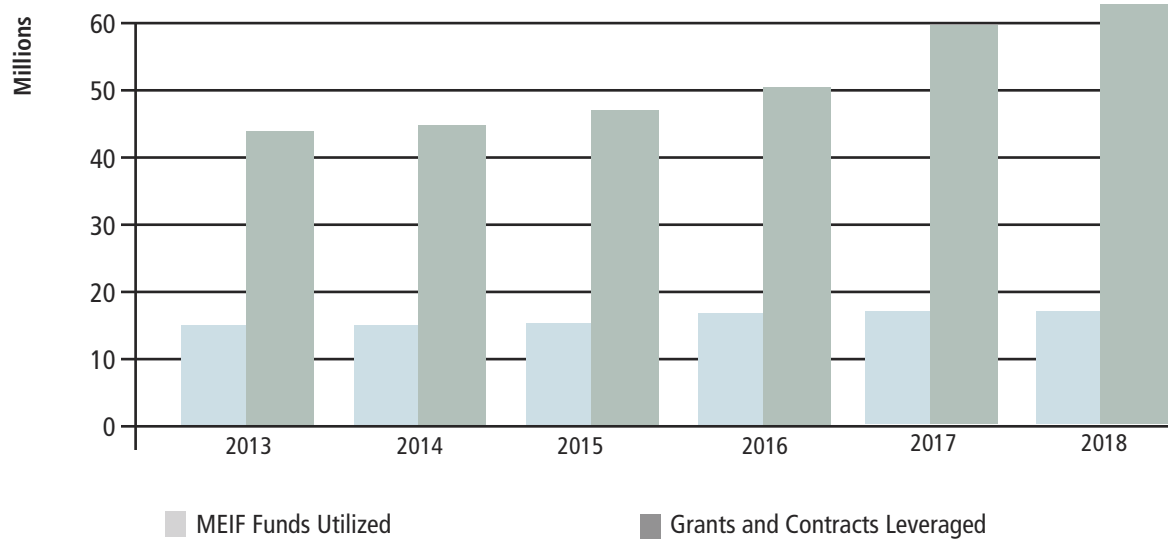
Grants and Contracts

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

FY17–18 Increase 4%

Strategic Outcomes, Goals and Metrics

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



In summary, the MEIF Target 1 for increasing external grants and contracts leveraged through MEIF investments saw an increase of 5 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 FY10 through FY12. This is largely related to changes in the economy and the federal and private sectors partners that are beginning to increase post-

recession funding for R&D. 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 |
|--|-----------|----------|-----------|-----------|-----------|-----------|
| Revenue from Commercialization | \$121,250 | \$96,726 | \$150,094 | \$127,949 | \$186,148 | \$561,423 |
| Number of Patents Filed | 15 | 32 | 22 | 35 | 12 | 14 |
| Number of Patents Issued | 16 | 12 | 9 | 8 | 6 | 5 |
| Number of License Agreements and License Options | 6 | 6 | 16 | 8 | 7 | 9 |

FY17–18 Revenue Increase 202%

In summary, revenue from the licensing of intellectual property has shown an overall increase since FY2013 in an upward trend in FY2018. Commercialization in Maine relies on private companies licensing UMS intellectual property to secure private investment to advance technology, products, and services into markets. General trends in venture capital and private equity investments are slowly rebounding in Maine and companies are starting to see new equity investments. Patents take four to five years from 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 been slower to rebound post-recession and timelines from lab to market can take five to ten years. UMS is focusing additional effort to accelerate the 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 FY13 baseline of \$3.15 million to \$6.75 million by FY17, and the number of business and industry contracts in the MEIF sectors increased from a baseline of 407 in FY13 to 450 in FY17. The number of business and industry contracts is included in the total grant and contract count in Table 1.

Table 3

Figure 2 UMS Industry Partnerships FY10 through FY18

| MEIF TARGET 3 — Business and Industry Contracts | FY2013 | FY2014 | FY2015 | FY2016 | FY2017 | FY2018 |
|---|-------------|-------------|-------------|-------------|-------------|-------------|
| Revenue from Business and Industrial Contracts | \$4,156,184 | \$4,371,999 | \$5,759,572 | \$4,836,138 | \$5,035,394 | \$5,009,399 |
| Number of Business and Industrial Contracts | 407 | 500 | 624 | 519 | 565 | 520 |

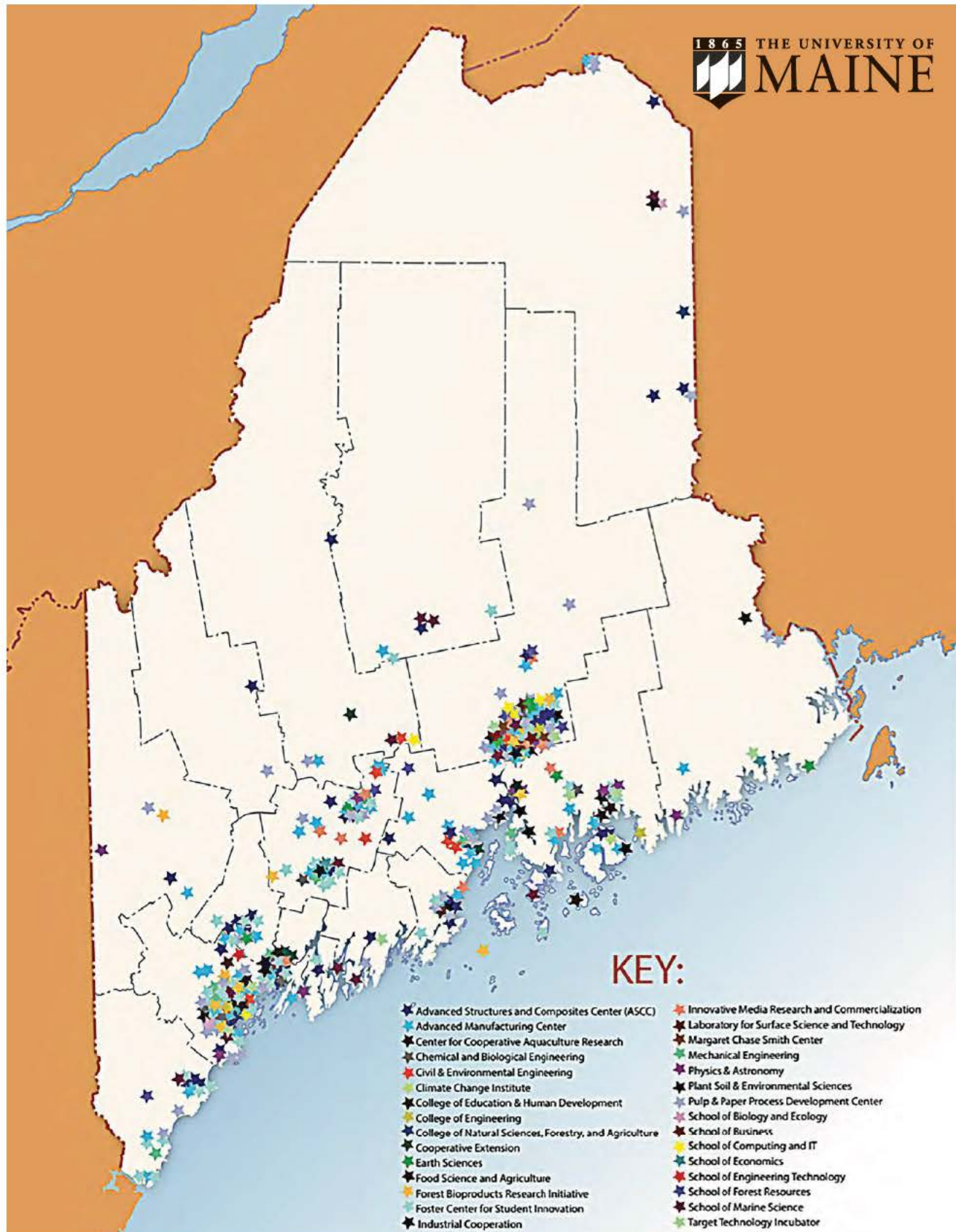
FY17–18 Revenue Change -.99%

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.

Strategic Outcomes, Goals and Metrics

Figure 2 UMS Industry Partnerships FY10–18



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 support 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. Nonstudent 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 \$307 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 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 with federal and private-sector grants and contracts.

Developing Workforce and Creating Jobs

Annually, 481 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, 878 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

| MEIF Target 4 — Workforce Development | FY18 Wages Paid from MEIF | FY18 Wages Paid from External Grants/Contracts | Totals |
|--|----------------------------------|---|---------------|
| Number of Faculty and Staff Supported (FTE = Full-Time Equivalent) | 176.21 | 305.43 | 481.64 |
| Number of Graduate Students Supported (Headcount) | 20 | 248 | 268 |
| Number of Undergraduate Students Supported (Headcount) | 119 | 491 | 610 |

Table 4-B

| Graduate and Undergraduate Student Costs Paid from Grants and Contracts | FY2014 | FY2015 | FY2016 | FY2017 | FY2018 |
|--|--------------------|--------------------|--------------------|--------------------|--------------------|
| Student Salaries and Wages from Grants and Contracts | \$4,877,650 | \$4,603,696 | \$5,255,861 | \$5,498,777 | \$4,853,956 |
| Student Tuition Paid by Grants and Contracts | 857,781 | 835,961 | 956,963 | 935,494 | 373,118 |
| Student Fellowships Paid by Grants and Contracts | 199,400 | 552,944 | 197,744 | 233,111 | 214,000 |
| Student Health Insurance Paid by Grants and Contracts | 282,848 | 62,967 | 247,960 | 214,951 | 795,339 |
| Total Soft Money Student Support | \$6,217,679 | \$6,055,568 | \$6,658,528 | \$6,882,333 | \$6,236,413 |

FY17–18 Change -0.91%

MEIF Success Stories

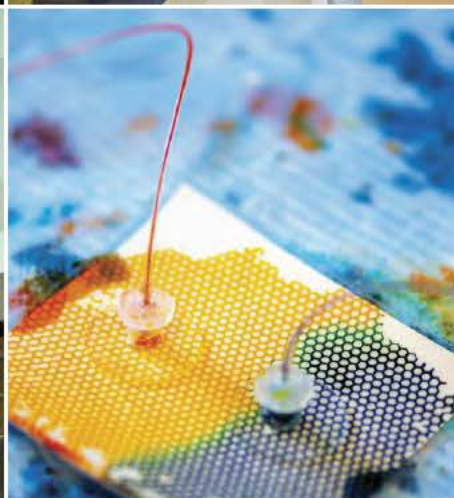
MIRTA: Out of the lab and into the public

At the University of Maine System, faculty and students collaborate to make significant discoveries that solve meaningful problems to improve lives and create jobs. And now the Maine Innovation, Research and Technology Accelerator (MIRTA), a new university technology accelerator program, provides the resources and expertise to allow researchers to move their inventions out of the lab and into commercial use with public benefit.

Earlier this year, five inventions created by UMaine faculty-led teams were the first to benefit from the program. All projects are tied to Maine businesses or industries critical to the future of the state. At the end of their program, all five teams had clear commercialization plans to move forward, from starting a company to licensing and collaborating with business partners.

Healthy Hives (MIRTA)

In a single year, the successful pollination of crops by honeybees is reflected in the foods found in nearly every average American meal. In particular, the \$28 million wild Maine blueberry crop (2016) was dependent on pollination by commercial honeybees. But in 2014–15, bee losses in Maine reached 60 percent due to colony collapse, a global problem not yet fully understood. To learn more about bee colony health and prevent collapses through early intervention, a noninvasive beehive activity monitor was invented to record the insects' movements. Armed with the customer and market knowledge gained through MIRTA activities, Healthy Hives inventor Nuri Emanetoglu plans to launch a startup company in late 2018, with companies in Ellsworth and Portland expected to collaborate on manufacturing.



Geospatial Innovations Supporting Landscape Management in Maine (MIRTA)

The Maine forest industry contributes \$8.5 billion annually to the gross domestic product and supports 33,000 jobs. This industry has a long, rich history in Maine, and continues to have significant economic impact in the state. To keep this industry strong and the resources sustainable, forest managers require ongoing, accurate data collection. Currently in Maine, a lack of broad-scale geospatial information about forest and landscape conditions is a barrier to planning and prioritization for large private landowners. The Intelligent Geosolutions mapping approach is gathering this critical information using machine learning algorithms. University of Maine inventors Erin Simons-Legaard, Kasey Legaard and Aaron Weiskittel have created a cost-effective high-resolution, near-real time mapping system about timber and nontimber resources. Those forest attributes can include tree species biomass and relative abundance, forest types, wildlife habitat suitability, disturbance history and canopy change.

Beverage Contamination Detector (MIRTA)

Across the country, demand for beer and wine is on the rise. There are more than 6,000 wineries in the United States — a number that's growing by more than 6 percent a year. In Maine, the number of breweries has jumped 30 percent in the past year to more than 120. To meet the ever-increasing market demand, wineries and breweries need a faster, more cost-effective means of identifying spoilage than the current costly yeast tests that take days to return results and require specialized equipment. A portable device for point-of-use beverage spoilage yeast testing has been developed by University of Maine inventors Laurie Connell and Corey Hirn. The technology delivers on-site microbe detection using RNA-related probes to return results in 15 minutes, compared to the industry standard method that takes five days. They will be partnering with Beacon Analytical in Saco to develop kits that could be used by commercial beer and wine producers throughout the US. Current beta versions of the instrument and test kits are undergoing testing at commercial facilities in 2019, with commercial products expected to be available to the industry as early 2020.

Point-of-Care Diagnostics, Simplified (MIRTA)

The need is ever-increasing for handheld point-of-care biomedical diagnostic testing devices, such as those used in blood and urine testing, in the health care and pharmaceuticals arenas. These types of tests enable providers to detect diseases earlier and provide diagnostic testing to underserved populations. Despite the numerous benefits these devices bring to the health care community, they are costly to produce. Can the devices be made more cost-effective and environmentally friendly, eliminating the use of plastics and glass? In collaboration with Sappi North America in Westbrook, Maine, a UMaine research team is developing new methods of using patterned release paper in biotechnical applications. The team is led by University of Maine inventors Caitlin Howell, Amber Boutiette and Matthew Talbot in collaboration with Amy Blakeley of Sappi. The goal is to develop low-cost, paper-based devices that leverage the existing patented patterning technology and microfluidics engineering in disposable, biodegradable devices that could ultimately increase accessibility to health-related diagnostic testing worldwide.

Making Peripheral Neuropathy Right (MIRTA)

Neuropathy, the death of peripheral nerves, is a health condition that can result in pain and loss of mobility and, in some cases, can lead to amputation. Causes range from diabetes and aging to certain viruses and exposure to some chemicals. It is estimated that, in the U.S. alone, approximately 30 million people are affected and one out of every four Americans will be affected by it. How can peripheral neuropathy be detected and diagnosed as early as possible to avoid extreme measures like amputation? A University of Maine research team led by Kristy Townsend and Rosemary Smith has developed a microneedle medical device for early detection and diagnosis of small-fiber neuropathy. The device also has the ability to deliver noninvasive, pain-free treatment on and below the skin. The flexible microneedle array is capable of nerve conduction measurements and drug delivery, and has the potential to stimulate nerve regrowth.

■ UMaine wins \$14.2M DOT award to form Transportation Infrastructure Durability Center

The U.S. Department of Transportation (U.S. DOT) has selected the University of Maine to lead the creation of a highly competitive University Transportation Center (UTC) called the Transportation Infrastructure Durability Center (TIDC). TIDC aims to save federal and state taxpayer dollars by extending the life of transportation assets, including bridges, roads, and rail.

The U.S. DOT will provide as much as \$14.2 million over five years for the UMaine-led coalition that includes the University of Rhode Island, University of Connecticut, University of Massachusetts Lowell, University of Vermont, and Western New England University. For many years this center has resided with the Massachusetts Institute of Technology, but because of the University of Maine's nationally recognized expertise in the use of composite materials in infrastructure, leveraged with the strengths of several partners, it now has the opportunity to house this important resource.

Working with state DOTs, the new TIDC seeks to identify new materials and technologies that maximize the impact of transportation infrastructure investments. TIDC will harness the experience of 28 faculty researchers and train 280 student researchers from all New England states. It will focus on real infrastructure needs identified by DOT partners and prioritize extending the life of existing transportation assets to ensure cost-effectiveness.

■ \$400,000 Award to Develop Computer Model that Simulates Irregular Voice Conditions

University of Maine assistant professor of mechanical engineering, Qian Xue, is leading the development of a computer model that can provide an accurate, real-time simulation of irregular voice conditions.

Xue recently was awarded \$406,984 from the National Institute on Deafness and Other Communication Disorders (NIDCD), part of the National Institutes of Health, for the project. The overall objective of the project is to develop a high-fidelity computer model for simulating mucosal wave on vocal fold and voice outcomes in various irregular vocal conditions.

Xue says the proposed model could further the understanding of the relationship between vocal fold biomechanics, mucosal wave patterns and the resulting voice. This will help improve the diagnosis and treatment of a variety of medical conditions.

■ UMaine develops new potato variety for gourmet, specialty markets

The University of Maine, in partnership with the Maine Potato Board, has released a new gourmet potato variety, Pinto Gold. The potato is a high-yielding, yellow-fleshed specialty variety with excellent roasting and eating quality, according to Gregory Porter, who leads UMaine's potato breeding program at Aroostook Farm in Presque Isle.

Pinto Gold is the fourth potato variety released by UMaine and the Maine Potato Board since 2014. They previously released Easton, Sebec, and Caribou Russet. The partners license new varieties to seed growers and commercial farmers, and revenue from licensing is reinvested into the potato breeding program.

Although Pinto Gold will likely never be produced on thousands of acres in the state, Porter says, he believes it will be beneficial for small-scale growers, restaurants, home cooks and gardeners.

"They're pretty, unique, and the tastiest roasting potatoes you could ever have," he says.



■ Soil professors awarded \$498,000 to study phosphate interactions in agroecosystems

Research led by two University of Maine professors aims to provide a greater understanding of how soils collect and hold phosphate, an important fertilizer component, to increase the sustainability of agriculture in the United States.

At the University of Maine, Tsutomu Ohno, a professor of soil chemistry, and M. Susan Erich, a professor of plant and soil chemistry, were awarded a \$498,000 grant from the United States Department of Agriculture's National Institute of Food and Agriculture to complete a three-year study to provide the foundational knowledge to design management practices that significantly increase phosphorus use efficiency in agroecosystems and to understand soil carbon stabilization.

"Fertilizer use and other technologies have increased food production in the U.S. which has increased food security for many, but has come at the cost of adverse environmental impacts and decreasing sustainability of U.S. agriculture," Ohno says.

■ Tajvidi awarded \$250,000 to develop next-generation CNF floor, wall products

Mehdi Tajvidi knows that big things can come in small packages.

He works with cellulose nanofibrils (CNF) — the natural structural building units of wood that are 1/100,000th the width of a human hair. CNF can be produced from any wood species and from the lower value residual byproducts from Maine's sawmills and pulp and paper mills.

The University of Maine assistant professor of renewable nanomaterials describes CNF as magical. The renewable biodegradable material has superior properties, he says, including exceptional strength and ability to bond.

Tajvidi has been awarded \$250,000 from P3Nano — a public-private partnership founded by the U.S. Endowment for Forestry and Communities and the U.S. Forest Service — to develop next-generation CNF building materials.

Tajvidi is developing and testing an alternative to traditional drywall made of plaster, other materials, and additives. His version, which is made with CNF and wood particles, is lighter and a better insulator. Tajvidi plans to make the core fire resistant, as well. In addition he's partnering with G-O Logic to create a lightweight interior wall covering system that's easy to mold into various shapes. G-O Logic is a Belfast, Maine firm that makes advanced building products for the high-performance construction market.

FiberLean Technologies, a global producer of products that combine CNF and minerals, has contributed \$10,000 cash and \$10,000 in-kind support toward implementation of the wall-covering product.

Maine mills could be modified to handle production, says Tajvidi, who adds that he has numerous other ideas of how to utilize the magic of CNF in a variety of other products.

■ University of Maine's Laboratory for Surface Science and Technology (LASST) receives \$2.5 million from U.S. Department of Energy to improve technology in power plants

A University of Maine research project focused on improving sensor technologies used in coal-based power plants has received a \$2.5 million grant from the National Energy Technology Laboratory (NETL) through the Department of Energy's Office of Fossil Energy.

The goal of the project is to develop new advanced sensor instrumentation that can provide improved condition-based maintenance in existing coal power plants, thus serving to reliably reduce the costs of operation and maintenance, increase efficiency and safety, and significantly reduce the pollutant emissions, according to the DOE.

The technology aims to monitor temperature and equipment degradation at both the fire-side and steam-side of boilers and other critical components. The work carried out under this DOE funding will focus on technology transfer and development of new materials and packaging for wireless harsh-environment sensors applications in coal-fired power plants. The award builds on the ongoing work on UMaine's patented wireless high temperature sensors for extreme environments.

■ Suds to Shrimp

The Suds to Shrimp Project began during the summer of 2018. The project, directed by the University of Southern Maine's (USM) Environmental Science and Policy (ESP) Department, seeks to create 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.

This project will develop a grave-to-cradle approach for sustainable food production by using waste beer grains to grow prawns, tilapia, and vegetables in a multi-species aquaponics system. The project is being incorporated into the ESP Research and Analytical Methods class as a first step in broadening the knowledge base in Maine as well as offering an excellent opportunity for students and faculty to conduct experiments with their community partners that move toward creating the first source of larval prawns in Maine.

Over the next year, the project will demonstrate methods to overcoming economic barriers to the development of Maine's aquaponic industry and workforce by:

1. Raising prawns in production with tilapia in aquaculture systems
2. Developing a business model that sells an aquaponic service to restaurants
3. Training future growers to establish and maintain sustainable polyculture aquaponics operations

Alliance for Maine's Marine Economy invests over \$14 million in infrastructure projects to increase jobs



The Alliance for Maine's Marine Economy, a consortium of Maine-based marine businesses, research institutions, and educational organizations, is investing in infrastructure and technologies with \$7 million in voter-approved bond funds, matched by more than \$7 million from Alliance members.

Coordinated by the University of Maine, the Alliance is dedicated to ensuring that Maine seafood, fishing, and aquaculture industries, and the natural ecosystems on which they depend, are healthy and benefit Maine people. These strategic investments support and diversify traditional fisheries, aquaculture, and other marine-dependent industries.

The bond money and public/private matching funds total over \$14 million supported capital investments in public institutions and private businesses that will benefit the entire marine sector by facilitating business development, accelerating product innovation, assessing and preventing risks to resource health, forecasting changes in product supply, and improving the value of Maine's seafood resources. These investments include new processing capabilities at seafood businesses in York, Cumberland, Lincoln, Knox, Hancock, and Washington counties, and new R&D and commercialization facilities in Lincoln, Penobscot, and Washington counties.

Maine's marine businesses will benefit from resources, technical assistance, information, educational opportunities, business training, and capital that will allow them to grow and thrive in the face of an ever-changing ocean ecosystem and globalized economy.

The Alliance is a developing initiative focused on emerging opportunities and challenges related to a productive and profitable marine economy. In the long term, the Alliance is committed to stimulating Maine's marine economy at all levels. Alliance partners have identified projects and contracts aimed at attracting at least another \$50 million in additional private sector and federal grant dollars over the next 10 years.

■ UMaine designated one of eight US Department of Energy combined heat and power centers

The U.S. Department of Energy (DOE) has selected the University of Maine to lead one of eight regional partnerships dedicated to the promotion, technical support, and deployment of cost-effective and highly efficient combined heat and power (CHP) technologies throughout the nation. UMaine, in partnership with the University of New Hampshire and Watson Strategy Group, will oversee the CHP Technical Assistance Partnership (TAP) center in the northeast region, including Maine, New Hampshire, Vermont, Rhode Island, Massachusetts, and Connecticut.

The UMaine-led Northeast Combined Heat and Power Center (NECHPC), as well as the seven other CHP TAP program centers nationwide, are supported by \$25 million of DOE funding. The NECHPC will receive more than \$2 million of that total.

Combined heat and power (CHP) — also known as cogeneration — is an efficient and clean approach to generating both electric power and heat from a single fuel source, like biomass or natural gas. Furthermore, heat and power can be produced onsite, reducing the need to purchase electricity from the distribution grid, greatly increasing energy security and resiliency.

Traditional electric and thermal energy generation systems can be very inefficient. In many situations, electricity is purchased from the distribution grid, and additional fuel is used to heat a boiler or furnace to provide heat to a facility or a manufacturing process.

However, over half of the fuel energy consumed to generate electricity at a large power plant is exhausted as heat energy and often underutilized, even wasted.

CHP systems capture the “extra” thermal energy created in power generation and use it to provide heat in any required application — from staving off cold temperatures in apartment buildings and hospitals, to heating large amounts of water for industrial or food processing purposes. The team is meeting with companies and facilities throughout Maine to help applicants measure their baseline loads and evaluate modern solutions to improve their bottom lines.

■ Projects aim to bolster seaweed, blue mussel production

Aquaculture companies in Maine are at the forefront of efforts to culture high-quality seafood products. While the industry has grown in the last five years, those seeking to further expand face serious challenges.

Two awards from National Oceanic and Atmospheric Administration (NOAA) will support research projects designed to overcome the challenges and increase aquaculture production.

A NOAA grant of \$908,015 to the University of Maine will support research into sustainable post-harvest processing of aquacultured seaweed and development of value-added products. Balunkeswar Nayak, assistant professor of food processing in the University of Maine School of Food and Agriculture, will lead the research. Interest in seaweed aquaculture is increasing in the U.S. for many reasons, including the demand for natural and local food. Maine is home to the first commercial kelp farm in the nation and has emerged as an industry leader.

A second award of \$249,238 to University of Maine Machias professor Brian Beal and the Downeast Institute for Applied Marine Research and Education will support study of large-scale culture of blue mussel seed or spat (larval or juvenile shellfish provided to commercial aquaculturists for grow-out). Demand for mussels in the Northeast exceeds the current domestic supply. In 2015, 9 million pounds of live mussels were imported from farms in Canada, especially Prince Edward Island. This represents about half of the U.S. market, and demand is projected to increase by nearly a third in the next decade.

These new efforts build on previous NOAA Sea Grant investments to support domestic aquaculture efforts. Between February 2016 and January 2017, Sea Grant reported \$90 million in national economic impacts, including support of 900 businesses and 1,800 jobs from aquaculture investment.

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.

■ Creation of Maine Mass Timber Commercialization Center

The University of Maine System will be examining how to build structures using engineered wood composites and Maine timber. This is made possible by a \$454,532 US EDA grant that created the Maine Mass Timber Commercialization Center.

The center's mission is to work with key stakeholders across the state to revitalize and diversify the forest economy through the development and advancement of new technologies and manufacturing opportunities such as Composite Laminated Timber (CLT).

"Maine's forest products industry helps drive local economies throughout our state. By establishing the Maine Mass Timber Commercialization Center, UMaine and its forest industry partners are furthering important work to discover innovative ways to develop new forest products from our natural resources," Collins and King said in a joint statement. "This grant will help strengthen Maine's forest economy, support jobs in our rural communities and further diversify the industry. The possibilities are endless with the introduction of new technology and ingenuity."

Forest Sector Focus: Maine Forest Economy Growth Initiative



FORMaine is one of the most comprehensive economic development efforts in the history of Maine. With the closure of six pulp and paper mills in Maine in just a two-year period, Maine has seen the economic disaster from the businesses and jobs lost in those communities. This situation led the Maine Forest Products Council, the Maine Professional Loggers Association, the Maine Woodland Owners, the Maine Development Foundation, and the University of Maine to form a unique collaboration between the private companies, trade associations, and the public sector to develop a Vision and Roadmap for Maine's Forest Economy. Several US Economic Development Administration (EDA), US Department of Agriculture (USDA), and U.S. Department of Energy (DOE) grants have been awarded in Maine and to UMaine to specifically focus on industry support, forest species supply and modeling, emerging technology commercialization, workforce assessment, community and stakeholder engagement, and business attraction and recruitment. FORMaine is run by an industry-led executive committee and seven subcommittees that include private sector companies, trade associations, land owners, state agencies, the University of Maine, and communities.

Partners in the formation of this statewide project include UMaine and USM. UMS faculty and staff participate in all of the committees and expertise is sought in all facets of the programs. UMS faculty and staff serve as PIs/Co-PIs on multiple grants funding different elements of the vision and roadmap for Maine's forest economy. In addition, EDA also funded a roadmap for Maine's Bioproducts Sector to advance biobased manufacturing, marketing Maine's biobased assets to investors in new technologies and processes, and providing technical assistance to Maine forest products manufacturers and users in the implementation of new biobased technologies. Biobased materials include bio-plastics, bio-chemicals and bio-fuels that are traditionally derived from petroleum. Markets for bio-based alternatives are growing throughout Europe and North America placing Maine in an important geographic market at a time where Maine has abundant, under-utilized wood-based feed stocks.

■ New Lab Provides Hands-On Experience Students through Cutting-Edge Research

The University of Maine Alford Advanced Manufacturing Laboratory for Structural Thermoplastics was created to advance research and development of a new class of structural composite materials — the latest generation of tough, lightweight structural thermoplastics. The automotive, transportation, and building industries are the most common areas where these materials are used today. The goal is to develop new automated, advanced manufacturing techniques that reduce cycle time and cost, and can then be transferred into industry.

The materials that students and faculty are working with also have applications in the marine and aerospace industries. They can be adapted to exterior or interior uses, and can be engineered for a variety of specifications, such as withstanding weather and ultraviolet radiation in outdoor applications, or limiting smoke and toxicity in the event of fires in indoor applications. They also can be adapted to different manufacturing processes. The ultimate goal is to find new ways to use this new class of thermoplastic composites in industrial applications.

One student working on this project is Justin Baron from Madawaska, ME. Justin has gained considerable hands-on experience through his position within the lab as he focuses on tape layup — placing layers of fiber composites at various angles to gain strength.

■ Sleep monitoring invention that could help detect early symptoms of Alzheimer's receives \$1 million NIH award

A home-based sleep monitoring invention developed by University of Maine researchers that has the potential to help detect early symptoms of mild cognitive impairment and Alzheimer's disease in elders has received a \$1 million Small Business Innovation Research Award (SBIR) from the National Institute of Health's Institute on Aging.

The two-year NIH Phase II award to start-up company Activas Diagnostics, LLC, founded by UMaine professors Marie Hayes and Ali Abedi, focuses on bringing the company's SleepMove product — a fitted mattress undersheet instrumented with 16 hybrid wireless sensors — to market as a new approach to diagnostics and monitoring in early stage neurological diseases, including Alzheimer's disease.

Activas Diagnostics' SleepMove technology allows for home-based, nonintrusive recording that integrates wireless sensing technology, signal processing, and statistical inference software to identify two novel biomarkers of sleep disorder that complement standard actigraphy, and new level of accuracy for out-patient sleep recording.

Adults living independently will perform a seven-day sleep study and overnight memory testing to evaluate sleep-wake and respiratory status during sleep. The funding will focus on proof of concept — through clinical testing and device development to validate the SleepMove device's predictive power — and execute early stage commercialization plan.

The goal is to move the technology into clinical trials and establish approval from the U.S. Food and Drug Administration.



■ Research and Workforce Development of Maine's Microalgal Industry

The purpose of this research project was to engage biology students in carrying out growth optimization and ecophysiological measurements on various strains of the microalgae, *Nannochloropsis*, to determine the growth conditions under which any of the strains would produce the most lipids that could be used for biofuels.

Five students from the University of Southern Maine were trained in basic lab techniques, as well as microalgal culturing. Engaging students in research leads to developing a trained and educated workforce. One student has gone on to work in a biotechnology company in Maine; two students are attending graduate studies in pharmacy and dentistry; and another student, while still an undergraduate biology major, was awarded the Tom Knight Memorial Scholarship for his exceptional dedication to research and academics.

■ New England and Iceland Cluster/MBA Program

Five teams of USM MBA students worked with entrepreneurs at the New England Ocean Cluster (NEOC) and Soli DG to examine market feasibility, conduct market opportunity analyses, and develop market plans for new building materials products and a cold storage facility on the Portland Waterfront. Students presented the following five ideas to local entrepreneurs to be judged on the most impactful business plan and best overall business presentation:

1. Lobster chitosan processing
2. Reusing seashell and glass waste products
3. New USA consumer herring products
4. Direct waterfront-to-restaurant seafood distribution channels
5. Portland Waterfront cold storage needs (winning team)

The winning team (Cold Storage) of four MBA students travelled with Professors Bob Heiser, Patricia Griffin, and Jimmy Xu to Iceland in October 2017 to meet Icelandic entrepreneurs and academics. The MBA team presented their project ideas to individual businesses in Reykjavik, as well as to a group of academics at Reykjavik University. The MBA team also visited local Icelandic seafood entrepreneurs, particularly members of the Icelandic Ocean Cluster House.

In Portland, Maine, the Cold Storage team's economic analysis was reviewed by NEOC's waterfront client Americold, which was extremely well received by NEOC and its clients. The analysis was used to justify economic development and zoning approvals on Portland's waterfront.

USM's School of Business and Professor Bilodeau also conducted a competition with USM undergraduate entrepreneurial students. The undergraduates examined a range of ideas regarding seafood processing, waste recovery, and shipping logistics. The winning undergraduate student and Professor Bilodeau traveled to Iceland to conduct company visits and present entrepreneurial ideas at RU, as well as several Icelandic small farming and aquaculture startup companies.

■ Samstarf – USM and Iceland Academic Public Health Collaboration

The Samstarf Initiative built public health and healthcare capacity in the areas of workforce training, international health, health services research, and academic course development. Public health graduate students from Maine engaged in public health and health care research and fieldwork with Icelandic preceptors and Icelandic public health PhD candidates involved in health services research work in Maine. Faculty from the University of Southern Maine (USM) developed and piloted e-Learning opportunities for Icelandic public health students, faculty public health officials, and healthcare professionals. These activities are intended to support the growing business, cultural, and academic relationships between Icelandic universities, government agencies, industry, and the State of Maine.



Project staff traveled to Reykjavik and Akureyri, Iceland to meet with university, government, and embassy officials to advance the work of the Samstarf Initiative and attended the Arctic Circle Assembly. Multiple student exchanges took place with USM students visiting Iceland for internships and field experiences and UNAK students and faculty taking USM courses. The efforts of the project led USM and UNAK to sign a Memorandum of Understanding (MOU) for a partnership to develop collaboration in both academic and research activities.

The Samstarf Initiative was successful in increasing international public health and health care experiences that are important to Maine's economic development with Northern Atlantic countries.

■ Maine Regulatory Training and Ethics Center

The Maine Regulatory Training and Ethics Center (MeRTEC) was founded to develop regulatory compliance professional development training and certification that will allow graduates to provide consultation to businesses about maintaining compliance to regulations in a cost-effective manner, regardless of the field or sector.

The partnership with the University of Maine School of Law resulted in co-designing and delivering a professional certificate program to help non-lawyer professionals across Maine in businesses, nonprofits, and government agencies navigate the regulatory minefield in areas such as finance, health care, environment, and energy. There is also an undergraduate certificate and minor in Regulatory Ethics housed at Lewiston Auburn College.

MeRTEC hosts the annual conference called the Three I's, Biosecurity & Research Integrity Conference each spring. This year they have partnered with the Massachusetts Society for Medical Research (MSMR). The national conference aims to deliver an exceptional educational and training opportunity that will facilitate meaningful dialogue as well as interactive, interdisciplinary learning and networking.

■ Downeast Institute Creates Regional Business Incubator and Research Hub

The Downeast Institute (DEI) serves as the Marine Science Field Station for the University of Maine at Machias, providing diverse opportunities for students, researchers, and industry members. DEI has enabled UMM to complete MEIF-funded applied research on soft-shell clams and a number of new candidates for shellfish aquaculture. Local entrepreneurs in downeast Maine can use this research space to develop and test new ideas about marine-based products or processes. So far this project has facilitated five new research projects, and has resulted in seven collaborations with businesses. Three new species have been introduced to the aquaculture sector, and one production site has been added to the region.

The Downeast region has great potential for growth in the marine economy, including commercial fisheries and aquaculture. The \$5.2 million expansion of the Downeast Institute's shellfish hatchery and lab facility, creating a business incubation and research "hub" for the region, was made possible by its unique partnership with the University of Maine at Machias. The 2018 project included \$100,000 MEIF money used for equipment.

Funds were used to purchase equipment that will build the research capacity of the only marine research facility and business incubation space of its kind northeast of Bar Harbor. Additional building improvements include 8,250 square-foot wet and dry labs, a 2,500 square-foot expansion of the current shellfish production and research center, and business incubation space. Conference and office space were also included to accommodate additional researchers and support collaboration.



■ Students' biomedical engineering spinoff company receives VentureWell funding

A group of University of Maine biomedical engineering graduate students have been selected by nonprofit VentureWell to receive funding and training to develop their medical simulation startup. As part of their senior capstone project advised by assistant professors Caitlin Howell and Karissa Tilbury, the students developed a cost-efficient, realistic simulator to train medical professionals in diagnosing and responding to critical respiratory situations.

The students are receiving a \$5,000 grant to help build their spinoff company, Zephyrus Simulation, LLC. The funding comes from VentureWell's E-Team Student Grant Program. VentureWell announced Dec. 4 it has awarded 18 student teams more than \$200,000 in its winter 2018 cohort.

The students — Patrick Breeding of East Granby, Connecticut; Banton Heithoff of Oldwick, New Jersey; Amber Boutiette of Skowhegan, Maine; and Madeline Mazjanis of Portland, Maine. Like Breeding, Boutiette and Mazjanis are now pursuing master's degrees in biomedical engineering at UMaine. Heithoff is now a researcher at IDEXX in Westbrook, Maine.

The capstone project won the undergraduate Innovation Award at UMaine's 2017 Student Symposium. In October 2017, Zephyrus Simulation, based in UMaine's Foster Center for Student Innovation, won \$500 in the Big Gig pitch event for innovators and entrepreneurs. The company went on to win the \$5,000 grand prize offered by Big Gig, a partnership of municipalities, universities, and organizations in the greater Bangor region that works with local entrepreneurs to spur economic growth.

Zephyrus Simulation is pursuing a patent for the prototype, and also has received grants from the Libra Future Fund and Maine Technology Institute.

■ UMaine lake monitoring project bolstered with NSF funding

Maine lakes are home to a diversity of fish and wildlife and contribute approximately \$4 billion to the state's economy. They provide economic, social, recreational, and aesthetic benefits to the people of Maine and millions of visitors annually.

The National Science Foundation has awarded a one-year, \$100,000 grant for continuing a University of Maine citizen-science project aimed at protecting lake water quality in the state. The grant will help extend the project, which began in 2015 with funding from UMaine's Senator George J. Mitchell Center for Sustainability Solutions, into 2018 and beyond.

The initial project focused on 24 Maine lakes in an effort to develop a lake vulnerability index through a blend of biophysical measurements and social science techniques. The index is meant to help predict which lakes are most susceptible to deterioration in water quality via chemical, physical and biological measurements, and identifying — through surveys and interviews — the underlying factors that encourage successful citizen science collaborations.



Appendix 1 — University of Maine System Intellectual Property

Table A1-1

University of Maine System New Patent Applications Filed FY2018

| Title | Application Type | Filing Date | Inventor | Campus |
|---|-------------------|-------------|---|--------|
| MULTILINE RING ANCHOR | US – PROVISIONAL | 3/28/2018 | MELISSA LANDON | ORONO |
| POLYMERIC COMPOSITE MATERIALS AND METHODS OF MAKING THEM | US – CONTINUATION | 3/5/2018 | MICHAEL BILODEAU JONATHAN SPENDER | ORONO |
| IV INFUSION SYSTEM FOR STANDARDIZED PATIENT | US – PROVISIONAL | 1/29/2018 | SUSAN WHEATON | USM |
| METHODS FOR THE PRODUCTION OF HIGH SOLIDS NANOCELLULOSE | PCT | 11/22/2017 | MICHAEL BILODEAU JOHN SPENDER ADRIAAN VAN HEININGEN | ORONO |
| IMPROVED FILAMENTS FOR 3D PRINTING | US – PROVISIONAL | 11/16/2017 | DOUGLAS GARDNER JORDAN (ELLIOTT) SANDERS LU WANG | ORONO |
| METHODS OF CONTROLLING THE HYDROPHILICITY OF CELLULOSE | US | 11/13/2017 | MICHAEL BILODEAU JONATHAN SPENDER | ORONO |
| ELECTRICALLY CONTROLLABLE SURGICAL TOOLS | US | 10/19/2017 | ROBERT ECKER MOSHEN SHAHINPOOR | ORONO |
| ELECTRICALLY CONTROLLABLE SURGICAL TOOLS | PCT | 10/19/2017 | ROBERT ECKER MOSHEN SHAHINPOOR | ORONO |
| METHODS FOR THE PRODUCTION OF HIGH SOLIDS NANOCELLULOSE | US | 10/18/2017 | MICHAEL BILODEAU JOHN SPENDER ADRIAAN VAN HEININGEN | ORONO |
| PARASITE TREATMENT COMPOUND | US – PROVISIONAL | 9/19/2017 | DEBORAH BOUCHARD IAN BRICKNELL | ORONO |
| METHODS FOR BIOBASED DERIVATIZATION OF CELLULOSIC SURFACES | PCT | 8/31/2017 | MICHAEL BILODEAU JONATHAN SPENDER | ORONO |
| METHODS FOR BIOBASED DERIVATIZATION OF CELLULOSIC SURFACES | US | 8/31/2017 | MICHAEL BILODEAU JONATHAN SPENDER | ORONO |
| SOFT TISSUE IN--GROWTH OF POROUS, THREE--DIMENSIONALLY PRINTED, TRANSCUTANEOUS IMPLANTS OF VARYING MATERIAL AND PORE GEOMETRY | US | 8/1/2017 | IAN DICKEY ANNE LICHTENWALNER DAVID NEIVANDT KYLE SPIVAK | ORONO |

Table A1-2 **University of Maine System — Patents Issued FY2018**

| Title | Patent Number | Issued Date | Inventor | Campus |
|--|---------------|-------------|---|--------|
| POLYMERIC COMPOSITE MATERIALS AND METHODS OF MAKING THEM | 9,944,789 | 4/17/2018 | MICHAEL BILODEAU JONATHAN SPENDER | ORONO |
| ENERGY DENSIFICATION OF BIOMASS--DERIVED ORGANIC ACIDS (LEVULINIC ACID UPGRADING) | CA 2,778,453 | 4/3/2018 | ADRIAAN VAN HEININGEN M. CLAYTON WHEELER PETER VAN WALSUM THOMAS SCHWARTZ | ORONO |
| ATTACHMENT OF A DEVICE TO A SUBSTRATE FOR OPERATION IN UNDER VARIABLE CONDITIONS | 9,850,932 | 12/26/2017 | ALBERTO CANABAL GEORGE HARRIS MAURICIO PEREIRA DA CUNHA SCOTT MOULZOLF THOMAS MOONLIGHT | ORONO |
| RADIO--FREQUENCY IONIZATION OF CHEMICALS | 9,818,593 | 11/14/2017 | TOURADJ SOLOUKI | ORONO |
| BREACH DETECTION SYSTEM FOR CONTAINERS | 9,809,007 | 11/7/2017 | ANTHONY VISELLI BRUCE SEGEE HABIB DAGHER RYAN FISHER | ORONO |

Appendix 2 — Maine Economic Improvement Fund Financial History and Tables

Table A2-1

A History of Legislative Actions on Appropriating State Research Funds

The following is a summary of the actions of the 118th–127th (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 FY98 year-end state surplus for use in FY99.

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 FY99 \$4 million research appropriation that was funded from the FY98 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.

A History of Legislative Actions on Appropriating State Research Funds

continued

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 FY03 \$2 million Supplemental Appropriation by \$1 million.

July 1, 2002: Governor signed a Financial Order that curtailed the FY03 \$2 million Supplemental Appropriation by an additional \$1 million. This eliminated the FY03 increase of \$2 million for research, bringing the FY03 research and development appropriation back to the FY02 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 FY04. 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 FY05 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 FY07 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 FY08 and an additional \$1 million in FY09 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 FY09 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 (FY17/FY18).

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 LEGISLATURE20

| | <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 |
| Total | \$0 | \$0 | \$0 |

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 |
| Total | \$0 | \$0 | \$0 |

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 |
| Total | \$2,650,000 | \$0 | \$2,650,000 |

128th LEGISLATURE

| | <u>FY2017</u> | <u>FY2018</u> | <u>Total 2-Year</u> |
|------------------|---------------|---------------|---------------------|
| UMaine | \$0 | \$0 | \$0 |
| USM | 0 | 0 | 0 |
| S.C. Initiatives | 0 | 0 | 0 |
| Total | \$0 | \$0 | \$0 |

Total Yearly Research Appropriations for FY2018**FY2017 Appropriation**

| | |
|--------------|---------------------|
| UMaine | \$13,289,194 |
| USM | 3,290,306 |
| UMM | 250,000 |
| UMFK | 0 |
| UMF | 0 |
| UMA | 0 |
| UMPI | 0 |
| MMA | 520,500 |
| Total | \$17,350,000 |

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 FY18 Research Appropriation by Targeted Sector

| UMAINE Targeted Research Area | Source of R&D Funds | | | | Utilization of R&D Funds | | | | | Balance | |
|--|--------------------------|--|---|---|---------------------------------------|---|--------------------------------------|--|---|-----------------------------------|---|
| | FY2018 R&D Initial | Unused R&D Funds from Prior Years As Reported | Adjustment To Prior Years Unused R&D Funds | Adjusted Unused R&D Funds From Prior Years | FY2018 R&D Funding Transfers | FY2018 Total R&D Funds Available | FY2018 R&D Actual Expenditures | Transferred To Match Grants & Contracts | Transferred Between R&D Accounts | Total R&D Funds Utilized | Unused Funds Carried Forward To FY2019 ¹ |
| | Base Budget | As Reported | R&D Funds | Prior Years | | | | | | | |
| | | | | | | | | | | | |
| Adv. Technology Forestry & Agriculture | \$1,595,386 | \$(517,144) | \$(7) | \$(517,151) | \$ - | \$1,078,235 | \$2,868,058 | \$194,498 | \$(934,654) | \$2,127,902 | \$(1,049,667) |
| Aquaculture & Marine Science | 3,046,875 | (2,000,333) | - | (2,000,333) | - | 1,046,542 | 3,195,616 | 1,409,917 | (1,158,893) | 3,446,640 | (2,400,098) |
| Biotechnology | 995,565 | (724,475) | - | (724,475) | - | 271,090 | 1,798,943 | 100,310 | (492,620) | 1,406,633 | (1,135,543) |
| Composites | 2,064,300 | 1,334,271 | - | 1,334,271 | - | 3,398,571 | 2,253,318 | 61,248 | (944,196) | 1,370,370 | 2,028,201 |
| Environmental | 1,178,699 | (209,929) | - | (209,929) | - | 968,770 | 2,038,363 | 236,118 | (735,681) | 1,538,800 | (570,030) |
| Information Technology | 1,963,483 | (147,741) | (1,533) | (149,274) | - | 1,814,209 | 3,224,381 | 101,247 | (921,163) | 2,404,465 | (590,256) |
| Precision Manufacturing | 1,465,789 | 210,324 | - | 210,324 | - | 1,676,113 | 2,124,979 | 46,819 | (736,246) | 1,435,552 | 240,561 |
| Cross Sector | 979,097 | (703,635) | - | (703,635) | - | 275,462 | 802,387 | 76,979 | (181,454) | 697,912 | (422,450) |
| Total State Funding | \$ 13,289,194 | \$(2,758,662) | \$(1,540) | \$(2,760,202) | \$ - | \$ 10,528,992 | \$ 18,306,045 | \$ 2,227,136 | \$ (6,104,907) | \$ 14,428,274 | \$(3,899,282) |
| UM Cost Sharing Funding ² | 6,104,907 | - | - | - | - | 6,104,907 | - | - | 6,104,907 | 6,104,907 | - |
| Total Funding | \$ 19,394,101 | \$(2,758,662) | \$(1,540) | \$(2,760,202) | \$ - | \$ 16,633,899 | \$ 18,306,045 | \$ 2,227,136 | \$ - | \$ 20,533,181 | (3,899,282) |

¹ Includes year-end equipment carry-over funds (equipment ordered, not received and not paid).² Salary and benefits from university.³ 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 Targeted Research Area | Source of R&D Funds | | | | Utilization of R&D Funds | | | | | Balance | |
|------------------------------------|--------------------------|--|---|---|--|---|--------------------------------------|--|---|-----------------------------------|---|
| | FY2018 R&D Initial | Unused R&D Funds from Prior Years As Reported | Adjustment To Prior Years Unused R&D Funds | Adjusted Unused R&D Funds From Prior Years | FY2018 R&D Funding Transfers ³ | FY2018 Total R&D Funds Available | FY2018 R&D Actual Expenditures | Transferred To Match Grants & Contracts | Transferred Between R&D Accounts | Total R&D Funds Utilized | Unused Funds Carried Forward To FY2019 ^{1,2} |
| | Base Budget | As Reported | R&D Funds | Prior Years | | | | | | | |
| | | | | | | | | | | | |
| Forestry & Agriculture | \$ - | \$ 402,807 | \$ - | \$ 402,807 | \$ 1,107,845 | \$ 1,510,652 | \$ 1,008,644 | \$49,909 | \$ - | \$ 1,058,553 | \$ 452,099 |
| Aquaculture & Marine | - | 343,940 | - | 343,940 | 973,072 | 1,317,012 | 816,365 | - | - | 816,365 | 500,647 |
| Biotechnology | - | 13,737 | 57 | 13,794 | 274,450 | 288,244 | 273,972 | - | - | 273,972 | 14,272 |
| Composites | - | - | - | - | 4,400 | 4,400 | 3,311 | - | - | 3,311 | 1,089 |
| Environmental | - | 36,509 | - | 36,509 | 136,628 | 173,137 | 107,437 | - | - | 107,437 | 65,700 |
| Information Technology | - | 683,506 | - | 683,506 | 1,185,841 | 1,869,347 | 1,058,462 | 134,512 | - | 1,192,974 | 676,373 |
| Precision Manufacturing | - | - | - | - | 84,172 | 84,172 | 83,616 | - | - | 3,616 | 556 |
| Cross Sector | - | 47 | (57) | (10) | 865,664 | 865,654 | 839,547 | - | - | 839,547 | 26,107 |
| Unassigned — reallocated by System | 3,290,306 | 1,629,317 | - | 1,629,317 | (4,632,072) | 287,551 | - | - | - | - | 287,551 |
| Total State Funding | \$ 3,290,306 | \$ 3,109,863 | \$ - | \$ 3,109,863 | \$ - | \$ 6,400,169 | \$ 4,191,354 | \$ 184,421 | \$ - | \$ 4,375,775 | \$ 2,024,394 |

¹ Includes year-end equipment carry-over funds (equipment ordered, not received, and not paid).² 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 FY19 are committed but not yet allocated to multi year projects.³ 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

FY2018 Utilization of FY18 Research Appropriation by Campus

| | Source of R&D Funds | | | | Utilization of R&D Funds | | | | | Balance | |
|---------------------|---------------------|---------------|------------------------|---------------|--------------------------|--------------|--------------|-------------|---------------|--------------|------------------------|
| | FY2017 | Unused R&D | Adjustment | Adjusted | FY2017 | FY2017 | | Transferred | Transferred | Total | Unused |
| | R&D | Funds from | To Prior | Unused R&D | R&D | Total | FY2017 | To Match | Between | R&D | Funds |
| | Initial | Prior Years | Years Unused | Funds From | Funding | R&D Funds | R&D Actual | Grants & | R&D | Funds | Carried |
| | Base Budget | As Reported | R&D Funds ⁴ | Prior Years | Transfers ³ | Available | Expenditures | Contracts | Accounts | Utilized | To FY2018 ¹ |
| UMAINE | \$13,289,194 | \$(2,758,662) | \$(1,540) | \$(2,760,202) | \$ - | \$10,528,992 | \$18,306,045 | \$2,227,136 | \$(6,104,907) | \$14,428,274 | \$(3,899,282) |
| USM | 3,290,306 | 3,109,863 | - | 3,109,863 | - | 6,400,169 | 4,191,354 | 184,421 | - | 4,375,775 | 2,024,394 |
| UMM | 250,000 | 222,656 | - | 222,656 | 300,000 | 772,656 | 529,556 | - | - | 529,556 | 243,100 |
| UMFK | - | 24,394 | - | 24,394 | 182,500 | 206,894 | 29,862 | - | - | 29,862 | 177,032 |
| UMPI | - | 119,989 | - | 119,989 | 182,500 | 302,489 | 43,918 | - | - | 43,918 | 258,571 |
| UMA | - | 19,867 | - | 9,867 | - | 19,867 | 12,579 | - | - | 12,579 | 7,288 |
| UMF | - | 57,568 | - | 57,568 | - | 57,568 | 33,932 | - | - | 33,932 | 23,636 |
| UMS | 520,500 | 158,353 | - | 158,353 | (665,000) | 13,853 | - | - | - | - | 13,853 |
| MMA | - | 121,440 | - | 121,440 | - | 121,440 | 16,022 | - | - | 16,022 | 105,418 |
| Total State Funding | \$17,350,000 | \$1,075,468 | \$(1,540) | \$1,073,928 | \$ - | \$18,423,928 | \$23,163,268 | \$2,411,557 | \$(6,104,907) | \$19,469,918 | \$(1,045,990) |

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

2 UM Cost Sharing.

3 Inter-unit R&D funding transfers related to FY2018 MMA and Small Campus Initiative (SCI) awards.

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