ANNUAL REPORT

for the

Institute of Materials Processing

University Research Center

Fiscal Year 2019

submitted to

The Vice President of Research
Michigan Technological University

Attn: Kathleen Halvorsen
Interim Associate Vice President for Research Development

submitted by

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0. SUMMARY OF FY19 ACTIVITIES

The Institute of Materials Processing (IMP) exists to provide and manage a suite of major materials processing capabilities to the university community, and supports research, instruction, outreach, and entrepreneurship. Significant in FY 19 were substantial investments in the safety and workplace quality infrastructure; specifically, the installation of a newly designed ventilation system in the metal foundry, and the installation of now-required eye-wash and shower facilities in IMP-managed laboratories. IMP also continued its support of faculty research by providing cost share towards the use fees in facilities which serve to characterize materials (e.g., ACMAL, mechanical testing) that have been produced using IMP-managed facilities, and in support of competitive proposals for new capabilities. IMP hosted a variety of instructional laboratories across campus (MSE, ME, MMET, VPA), and also provided in-kind support (supplies and staff support) for five MMET and one EET capstone senior design projects that also served to improve functionality in the IMP labs.

1. MISSION STATEMENT

It is the IMP mission to effectively manage and promote a unique suite of materials processing facilities such that they will be functional and available to provide a competitive advantage for faculty-led research, to support instructional and outreach activities, and to enable a “maker-culture” for creativity, prototyping, and entrepreneurship. Towards enhancing Michigan Tech’s portfolio of materials processing capabilities, IMP is also motivated to assist and support other faculty and units in the establishment of new capabilities and functionalities.

2. IRAD FUND USE

Table I is a reconciliation the IMP IRAD account (E35426) for FY19. As noted above, the largest expense was in support of facility upgrades to the ventilation in the metal foundry (a capital project outlay coordinated by University Facilities and contracted to Byron Mechanical), and for the necessary installation of laboratory eye-wash and showers in five IMP-managed laboratories (installed and plumbed by University Facilities). Supplies and technical support for five MMET and one EET capstone senior design projects that provided facility improvements and capability upgrades.

3. ACCOMPLISHMENTS

- Renovation and completion of the enhanced foundry ventilation system
- Installation of eye wash and showers, with associated water mixing plumbing
- In-kind (supplies and technical staff support) sponsorship of five MMET capstone projects
  - Design and Fabrication of Waste Sand Bin
  - Refurbishment of Muller Sand Mixer
  - Design and Installation of a Furnace Fume Rig
  - Design and Fabrication of a Mechatronics-based Manufacturing Line
  - Design and Fabrication of a Mobile Melt De-gasser
- In-kind (supplies and technical staff support) sponsorship of an EET capstone project
  - Design and Programming of a Robotic Additive Manufacturing Process
- Approximately 210 instances of use fee cost sharing in support of faculty research
- Cost share of environmental control and measurement system for the environmentally-clean glove boxes in the particulate processing lab.

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TABLE I.
Institute of Materials Processing FY19 IRAD budget reconciliation.

<table>
<thead>
<tr>
<th>Item</th>
<th>Amount</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carryforward from FY18</td>
<td>$37,147.29</td>
<td></td>
</tr>
<tr>
<td>IRAD distributions</td>
<td>$119,348.38</td>
<td></td>
</tr>
<tr>
<td>Facility upgrades</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foundry ventilation</td>
<td>$(40,120.00)</td>
<td>Engineering by Robert Sinto Group in 2018, capital project coordinated by University Facilities; contracted to Byron Heating and Air.</td>
</tr>
<tr>
<td>Facilities Group (MTU)</td>
<td>$(5,817.73 )</td>
<td>Installation of safety eye-wash and showers in IMP labs</td>
</tr>
<tr>
<td>Supplies</td>
<td>$(1,356.86 )</td>
<td>Supplies in support of the above</td>
</tr>
<tr>
<td>Use charge cost share</td>
<td>$(9,874.80 )</td>
<td>Cost share of ACMAL use fees</td>
</tr>
<tr>
<td>Labor / salaries</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical staff</td>
<td>$(18,929.60)</td>
<td>Maintenance, facility oversight, support of MMET senior project</td>
</tr>
<tr>
<td>Students</td>
<td>$(4,825.10 )</td>
<td>Student helpers in IMP labs</td>
</tr>
<tr>
<td>Fringe</td>
<td>$(6,236.79 )</td>
<td></td>
</tr>
<tr>
<td>Supplies</td>
<td>$(13,592.24)</td>
<td>Miscellaneous supplies in support of MMET (5) and EET (1) senior projects; facility upgrades, facility maintenance.</td>
</tr>
<tr>
<td>Travel</td>
<td>$(563.23 )</td>
<td>Technical staff attends a training session in Southfield, MI</td>
</tr>
<tr>
<td>REF cost share commitment</td>
<td>$(8,000 )</td>
<td>IMP cost share of a REF proposal to upgrade facilities in the powder processing lab</td>
</tr>
<tr>
<td>Administrative fees</td>
<td>$(2,424.60 )</td>
<td></td>
</tr>
<tr>
<td>FY20 Carryforward</td>
<td>$44,754.72</td>
<td></td>
</tr>
</tbody>
</table>

4. SPACE AND FACILITIES REQUIREMENTS
No additional needs required.

5. FUTURE PLANS / GOALS

• Support the installation and development of new, emerging facilities in additive manufacturing, including submission of a REF proposal to procure a high resolution control protocol capability
• Continued in-kind (supplies and technical staff support) sponsorship of five MMET capstone projects
• Continued in-kind (supplies and technical staff support) sponsorship of an EET capstone project
• Continued support of characterization use fee cost sharing in support of faculty research
Introduction

Abstract

The Institute for Material Processing (IMP) provides, maintains, and encourages partnerships for the use of facilities supporting synthesis, processing, and the manufacture of a wide range of engineering materials and product prototypes. IMP’s maintained capabilities include several melt processing variants, various deformation-processing strategies, particulate (powder)-based methods, and emerging capabilities in metal-based additive manufacturing. The facilities support a wide range of university activities, including production of advanced and experimental materials for faculty-led research, advanced process development, support of instructional labs, interdisciplinary collaboration, and outreach. When coupled with the University’s core Microfabrication Facility (MFF) and the Advanced Characterization and Morphological Analysis Laboratories (ACMAL), Michigan Tech’s suite of material processing and complementing characterization facilities represent an impressive breadth of capabilities enabling advanced in-house experimentation, discovery, and development at a level and scale that is unique among universities nationally and internationally.

History of IMP

The Institute of Mineral Research (IMR) was founded in 1955 to assist the mining industries in the State of Michigan as a state-funded, dedicated research institute with a non-academic staff of research scientists and engineers. IMR was the initial occupant of Benedict Labs, adjacent to the Minerals and Materials Building. In 1988, the Institute was renamed as the Institute of Materials Processing (IMP), in recognition of its expanded role that included other materials industries, notably steel making, ceramic and composite processing, and near net-shape manufacturing. In 2010, IMP merged with the Institute of Engineered Materials (IEM), further broadening its scope to include processing-engineered functional materials.

Research

Capabilities

- Melt Processing (metals)
  - Induction melting (Fe, Al- alloys)
  - Vacuum induction melting (Al, Mg, Cu- alloys)
  - Resistance melting (Cu, Al- alloys)
  - Investment casting (Al, Cu- alloys)
- Melt-spinning (rapidly solidified metals)
- Arc melting (e.g., refractory metals)
  - plus supporting molding, pattern-making, analysis, and finishing facilities

Deformation processing (metals)

- Brakes 550 ton extrusion press
- FENN B-in rolling mill
- FENN rotary swager
- Wire-drawing
  - plus supporting heat treatment and finishing facilities

Particulate (powder) processing (metals, ceramics)

- ASEA Mini-hot isostatic press (metals, ceramics)
- AWS vacuum hot press (metals, ceramics)
- Cold isostatic press (metals)
- Dale 150-ton unidirectional press (metals, ceramics)
  - plus supporting powder blending and preparation, canning, environmental glove boxes, sintering and heat treatment, and characterization facilities

Metallic 3D printing (Additive Manufacturing)

- Low-cost, wire-fed GMAW process development
- Laser fusion process development (REF pendign)

Instruction & Outreach

- MSE 2110 Intro to MSE II
- MSE 4310 Principles of Metal Casting
- MEEM 3600 Intro to Manufacturing
- MET 3500 Manufacturing Processes
- FA 3335 Traditional Sculpture
- Advanced Metalworks Enterprise (AME)
- Finlandia University Sculpture class
- Summer Youth Program (SYP)
  - Materials Science and Engineering Exploration
  - Engineering Scholars Program (ESP)
  - Women in Engineering (WE)
  - Junior Women in Engineering (JWE)

Entrepreneurship & Creativity

MakerMSE™ provides a path for students to propose, design, and create products for sale, commission, or to simply establish a capability or methodology for future use.

Examples include:

- Retro Michigan Tech bookends (cast)
- Upper peninsula bottle openers (extruded)
- Etched bird strike-resistant glass (laser etching)
- Departmental/University plaques (cast)
- Name plates (cast)
- Hancock *Hay Bulldog* (segmented casting)