AGENDA
Formal Session of the Board of Trustees Michigan Technological University
9:00 a.m. - May 3, 2019
Ballroom B – Memorial Union Building

I. Approval of Agenda

II. Opening Remarks
   A. Chair’s Comments
   B. President’s Comments

III. Committee Reports
   A. Academic Affairs Committee - Linda Kennedy
      - Provost’s Report - Dr. Jacqueline Huntoon, Provost and Vice President for Academic Affairs
      - Student Affairs Report - Dr. Bonnie Gorman, Dean of Students, Associate Provost for Student Affairs
   B. Audit and Finance Committee – Steve Tomaszewski
   C. Leadership Committee - Bill Johnson

IV. Consent Agenda
   A. Approval of Minutes
   B. Gifts
   C. Resignations, Retirements and Off Payroll
   D. Approval of External Auditor

V. Action/Discussion Items
   A. Employee Recognition
   B. Emeritus Rank
   C. Appointments, Not Involving Tenure and/or Promotion
   D. Appointments, Involving Tenure and/or Promotion
   E. Promotions
   F. Revision to Board Policy 6.1. Faculty Definitions
   G. Proposal for a Master’s in Engineering Management Degree
   H. Proposal for a Master’s of Science in Mechatronics Degree
   I. Proposal for a Bachelor’s of Science in Cybersecurity Degree
   J. Approval of a Department of Manufacturing and Mechanical Engineering Technology
   K. FY20 General Fund Operating Budget
   L. Appointment of Treasurer
   M. Election of Chair and Vice Chair

VI. Reports
   A. Undergraduate Student Government Report – Melanie Thomas, President
   B. Graduate Student Government Report- Apurva Baruah, President
   C. University Senate Report - Dr. Mike Mullins, President
   D. School of Business Presentation
VII. Informational Items
   A. Analysis of Investments
   B. University Issued Bond Balances
   C. Research and Sponsored Programs Report
   D. Advancement and Alumni Engagement Report
   E. Recent Media Coverage

VIII. Other Business

IX. Public Comments

X. Adjournment
I. APPROVAL OF AGENDA

RECOMMENDATION: That the Board of Trustees approves the agenda of the formal session of May 3, 2019 as distributed to the Board.
II. OPENING REMARKS

A. Chair’s Comments

B. President’s Comments
III. COMMITTEE REPORTS

A. Academic Affairs Committee - Linda Kennedy
   - Provost’s Report – Dr. Jacqueline Huntoon, Provost and Vice President for Academic Affairs
   - Student Affairs Report – Dr. Bonnie Gorman, Dean of Students and Associate Provost for Student Affairs

B. Audit and Finance Committee - Steve Tomaszewski

C. Leadership Committee - Bill Johnson
Tenure, Promotion, and Reappointment

3 Promotions from **Lecturer to Senior Lecturer**
- Andrew Galerneau – Chemistry
- Jonathan Leinonen – School of Business & Economics
- Leo Ureel – Computer Science

3 Promotions from **Senior Lecturer to Principal Lecturer**
- Amy Hamlin – Engineering Fundamentals
- Amber Kemppainen – Engineering Fundamentals
- Norma Veurink – Engineering Fundamentals
Tenure and Promotion

21 Recommendations for Promotions from Assistant Professor without Tenure to Associate Professor with Tenure

1 Recommendation for Associate Professor without Tenure to Associate Professor with Tenure

7 Recommendations for Promotions from Associate Professor with Tenure to Full Professor with Tenure
Kudos to Faculty Considered for Tenure and/or Promotion

From Penn State:  
It appears to me that Dr. X’s varied background makes them highly and uniquely qualified to meet the diverse needs of the students at Michigan Technological University. They are an asset to Michigan Tech and to our profession and have a bright future as a leader and innovator in our field.”

From Michigan State University:  
“... is a strong researcher with a passion for using their knowledge and skills to improve the world – through their research, service, and outreach activities.”

From The Ohio State University:  
“...is already regarded one of the world’s authorities on the...”

Michigan Tech
Kudos Continued

From Yale:
“...has been recognized as a next generation leader of our field who has a very distinguishable research identity.”

From University of Massachusetts:
“...is indeed the very symbolic character for creative and innovative research among the young faculty in the nation as well as the world.”

From University of California:
“MTU is lucky to count among its faculty such a brilliant professor and dedicated teacher.”
Kudos Continued

From Arizona State University:
“I feel that Dr. X is likely to serve as a role model for women in engineering.”

From University of South Dakota:
“Both the quantity of their scholarship and the quality indicate a level of scholarly productivity that exceeds any standard for tenure I have personally experienced in my career.”

From Virginia Tech:
“Their rate of journal article productivity continues to increase at a phenomenal rate, clearly placing them amongst the very top researchers in their field of study.”
School of Technology Future Plans

• Computer Network and System Administration (BS), Cybersecurity Minor (TCYM), Medical Informatics (MS)

Moving to the new computing unit

• Construction Management (BS)

Jointly managed through the School of Business & Economics & the Department of Civil & Environmental Engineering

• Mechanical Engineering Technology (BS), Minor in Manufacturing Systems (TMS) plus the School of Technology Machine Shop

Moving to the College of Engineering as a new department with planned name: Manufacturing and Mechanical Engineering Technology (name to be finalized)

• Electrical Engineering Technology (BS), Minor in Data Acquisition and Industrial Control (TDAC), and proposed Master of Science in Mechatronics

Moving to the new computing unit

• Surveying Engineering (BS), Surveying Minor (TSUM), Integrated Geospatial Technology (MS)

Moving to the Department of Civil & Environmental Engineering

Transitions to be complete by July 1, 2019
**COLLEGE OF COMPUTING**

**TEACHING**
- CoE
  - Computer Engineering
- CSA
  - Cybersecurity
- SBE
  - Robotics & Mechatronics
  - Human Factors
  - Data Science
- SFRES
  - Computational Science & Engineering
  - X + Computer Science

**RESEARCH**
- Institute of Computing & Cybersystems (ICC)
- Researchers
  - Computer Systems
  - Cybersecurity
  - Cyber-Physical Systems
  - Human Factors
- Michigan Tech Institutes & Centers
  - National & International Collaborators
  - Data Science
  - Computational Science & Engineering
  - Convergence Computing

**DEGREE PROGRAMS**
- Computer Science (CS)
- Software Engineering (SE)
- Computer Network & System Administration (CSNA)
- Health Informatics (HI)
- Mechatronics, Electrical, and Robotics Engineering Technology (MERET)*

**SERVICE**
- General Education Learning Center
- High-Performance Computing Support

**COMPUTATIONAL THINKING FOR THE MODERN CONNECTED WORLD**

*EET will transition to MERET (Mechatronics, Electrical, and Robotics Engineering Technology)
Tech Forward

Develop
solutions to natural resource, water, and energy problems.

Build
innovative autonomous and intelligent systems.

Create
technological solutions to enhance human health and quality of life.

Prepare
culturally receptive leaders for a diverse world.

Redefine
education for the next generation.
Formal Session of the Board of Trustees - III. Committee Reports
Preparing Students – Skills and Qualities

• Communication
• Computational Thinking
• Critical Thinking
• Leadership
• Networking
• Systems Thinking
• Teaming
• Adaptable
• Comfortable with Ambiguity

• Confident
• Good Community/Global Citizen
• Hands-on/Can-do Approach
• Resilient/Tenacious
• Self-Motivated
• Self-Aware
• Willing to take Responsible Risks
Preparing Students - Education

• Early real-world experiences
• Exposure to a variety of careers
• Focus on sustainability
• Interdisciplinary
Tech Forward Initiatives

- Sustainability and Resilience: David Shonnard
- Data Revolution and Sensing: Dan Fuhrmann
- Advanced Materials and Manufacturing: Greg Odegard
- Policy, Ethics, and Culture: Jennifer Daryl Slack
- Natural Resources, Water, and Energy: Andrew Burton
- Autonomous and Intelligent Systems: Jeff Naber
- Health and Quality of Life: Caryn Heldt
- Education for the 21st Century: Lorelle Meadows
- Diversity and Inclusion: Kellie Raffaelli
Thank you
Our Accomplishments
Our Community

Bonnie Gorman
Dean of Students and
Associate Provost

Board of Trustees
May 3, 2019
Commencement Celebration

1059

756 Bachelors
271 Masters
32 PhDs

Formal Session of the Board of Trustees - III. Committee Reports
Commencement Speaker Finalists

Monica Brechting
Mechanical Engineering

Eva Heydrich
Chemical Engineering

Nick Olson
Chemical Engineering

Dominique Aleo
Biological Sciences

Eva Heydrich
Chemical Engineering

Liesl Flannery
Chemical Engineering
Graduate Student Colloquium

Karina Eyre
Civil and Environmental Engineering
Graduate Student Leader

Miles Penhale
Mechanical Engineering
Graduate Student Scholar

85 participants
32 scholarship
35 teaching
3 service
Undergraduate Research Symposium

Ceily Fessel Doan
Environmental Engineering
Comparison of Nannochloropsis and Chlorelle Vulgaris Algae to Energy Efficiency in the Rio Grande Watershed

Jacob LeBarre
Chemical Engineering
Improvement of Virus Purification Method using Cation Exchange Chromatography

Kaylee Meyers
Biomedical Engineering
Nitric Oxide Releasing Composite Hydrogels for Tendon Repair Via Matrix Metalloproteinase Controlled Pathways

61 participants
Student Leadership Awards

Jack Hendrick
Biomedical Engineering
President’s Award for Leadership

Tessa Steenwinkel
Biological Sciences
Provost’s Award for Scholarship

Elise Cheney-Makens
Biochemistry and Molecular Biology
Dean of Students Award for Service

Ron Kyllonen
Mechanical Engineering
Percy Julian Award

227 nominations

24 department scholars
Fraternity and Sorority Life Awards

Trevor Peffley
Major
Fraternity Man of the Year

Greta Colford
Major
Sorority Woman of the Year

12,000 hours of service
11,000 statue hours
$28,000 donated
Staff and Faculty Recognition

Jessie Stapleton  
Director of Student Activities,  
National Association of Campus Activities (NACA) 2019 Outstanding Advisor for the Northern Plains Region

Tammy Monette  
Custodian, Wadsworth Hall  
Excellence in Service from the American College Personnel Association

Joel Isaacson  
Associate Athletic Director  
Clair M Donovan Award for Service

Melissa Baird  
Assistant Professor, Social Sciences  
Graduate School Mentor
Teaching Excellence Award Finalists

Ann Maclean
Andrew Burton
Andrew Barnard
Molly Cavaleri
Lisa Johnson de Gordillo
Sheila Milligan
Jeffrey Wall
Heather Newston
Christopher Webster
Thomas Werner
IV. CONSENT AGENDA

These are routine matters that generally do not require discussion or debate. Any Board member can remove any consent item from the agenda by request. They will be considered as one resolution.

A. Approval of Minutes
B. Gifts
C. Resignations, Retirements and Off Payroll
D. Approval of External Auditor
IV-A. APPROVAL OF MINUTES

RECOMMENDATION: That the Board of Trustees approves the minutes of the formal session of March 1, 2019 as distributed to the Board.
IV-B. GIFTS

Attached is a fiscal year to date comparative report of gifts to Michigan Technological University and the Michigan Tech Fund.

RECOMMENDATION: That the Board of Trustees acknowledges the gifts to Michigan Technological University.
Gifts
IV-C. RESIGNATIONS, RETIREMENTS AND OFF PAYROLL

Attached is a report of resignations, retirements and off payroll which have been approved by the President and are included for his convenience in recommending acceptance by the Board.

RECOMMENDATION: That the Board of Trustees accepts the resignations, retirements and confirms the off payroll determinations.
# BOARD OF TRUSTEES OFF-PAYROLL REPORT  
(February 10, 2019 – April 13, 2019)

## RETIRED

<table>
<thead>
<tr>
<th>Name</th>
<th>Class</th>
<th>Department</th>
<th>Title</th>
<th>Most Recent Hire Date</th>
<th>Term Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dube, Kelly</td>
<td>Staff</td>
<td>Financial Services &amp; Operations</td>
<td>Senior Accountant</td>
<td>06/05/1989</td>
<td>03/22/2019</td>
</tr>
<tr>
<td>Gaddis, Michael</td>
<td>Staff</td>
<td>Human Resources</td>
<td>Administrative Aide 7</td>
<td>08/07/2006</td>
<td>03/31/2019</td>
</tr>
<tr>
<td>Quinn, Anita</td>
<td>Staff</td>
<td>Provost Senior Vice President for</td>
<td>Policy &amp; Planning Analyst</td>
<td>04/10/1985</td>
<td>03/01/2019</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Academic Affairs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rothenberger, Jane</td>
<td>Staff</td>
<td>Residential Dining</td>
<td>Food Service Helper</td>
<td>12/22/2003</td>
<td>04/05/2019</td>
</tr>
</tbody>
</table>

## OFF-PAYROLL

<table>
<thead>
<tr>
<th>Name</th>
<th>Class</th>
<th>Department</th>
<th>Title</th>
<th>Most Recent Hire Date</th>
<th>Term Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anderson, Niina</td>
<td>Staff</td>
<td>Residential Dining</td>
<td>Food Service Helper</td>
<td>08/27/2018</td>
<td>02/13/2019</td>
</tr>
<tr>
<td>Babcock, Heather</td>
<td>Staff</td>
<td>Student Affairs Information Systems</td>
<td>Business Systems Analyst</td>
<td>03/30/2015</td>
<td>03/15/2019</td>
</tr>
<tr>
<td>Banach, David</td>
<td>Staff</td>
<td>Michigan Tech Research Institute (MTRI)</td>
<td>Research Scientist I - Geo Research Scientist</td>
<td>09/12/2011</td>
<td>04/05/2019</td>
</tr>
<tr>
<td>Codere, Rebecca</td>
<td>Staff</td>
<td>Alumni Engagement</td>
<td>Administrative Aide 8</td>
<td>09/25/2017</td>
<td>04/05/2019</td>
</tr>
<tr>
<td>Hill, Zachary</td>
<td>Staff</td>
<td>General Athletics</td>
<td>Director of Hockey Operations</td>
<td>08/13/2018</td>
<td>03/15/2019</td>
</tr>
<tr>
<td>Hoffman, Angela</td>
<td>Staff</td>
<td>Waino Wahtera Center Student Success</td>
<td>Assistant Director, Orientation Programs</td>
<td>11/09/2015</td>
<td>03/02/2019</td>
</tr>
<tr>
<td>Klutts, Judy</td>
<td>Staff</td>
<td>Residential Dining</td>
<td>Manager, Dining Services</td>
<td>11/18/1997</td>
<td>03/14/2019</td>
</tr>
<tr>
<td>Sever, Joseph</td>
<td>Staff</td>
<td>Facilities Management</td>
<td>Custodian</td>
<td>03/03/2015</td>
<td>03/26/2019</td>
</tr>
<tr>
<td>Staehler, Allyse</td>
<td>Staff</td>
<td>Van Pelt and Opie Library</td>
<td>Library Assistant 4</td>
<td>07/16/2018</td>
<td>03/22/2019</td>
</tr>
<tr>
<td>Stefano, Christopher</td>
<td>Staff</td>
<td>AE Seaman Mineral Museum</td>
<td>Associate Curator</td>
<td>10/01/2013</td>
<td>04/01/2019</td>
</tr>
<tr>
<td>Thompson, Joseph</td>
<td>Staff</td>
<td>Pavlis Honors College</td>
<td>Associate Director, Industry Engagement</td>
<td>06/10/2015</td>
<td>03/08/2019</td>
</tr>
<tr>
<td>Williams, Sarah</td>
<td>Staff</td>
<td>Advancement</td>
<td>Advancement &amp; Alumni Marketing Specialist</td>
<td>01/30/2017</td>
<td>01/24/2019</td>
</tr>
</tbody>
</table>
IV-D. APPROVAL OF EXTERNAL AUDITOR

The University's external auditors (certified public accountants) perform interim audit work prior to the close of our June 30 fiscal year, therefore, it is desirable that they be appointed prior to the end of the fiscal year.

RECOMMENDATION: That the Board of Trustees authorizes the Treasurer to engage the certified public accounting firm Andrews Hooper Pavlik, PLC to conduct the following audits for the fiscal year ending June 30, 2019:

1. The annual examination of the University's Financial Statements and Supplemental Information (all funds).

2. The annual examination of federal awards and federal student financial assistance programs, including Pell Grants, Education Opportunity Grants, Perkins Loans, College Work Study Programs and Part B Loans.

3. The financial audit of the University's intercollegiate athletics programs, as mandated by the National Collegiate Athletics Association.

V. ACTION/DISCUSSION ITEMS

A. Employee Recognition
B. Emeritus Rank
C. Appointments, Not Involving Tenure and/or Promotion
D. Appointments, Involving Tenure and/or Promotion
E. Promotions
F. Revision to Board Policy 6.1. Faculty Definitions
G. Proposal for a Master’s in Engineering Management Degree
H. Proposal for a Master of Science Degree in Mechatronics
I. Proposal for a Bachelor’s of Science in Cybersecurity Degree
J. Approval of a Department of Manufacturing and Mechanical Engineering Technology
K. FY20 General Fund Operating Budget
L. Appointment of Treasurer
M. Election of Chair and Vice Chair
V-A. EMPLOYEE RECOGNITION

For our employees that have worked for Michigan Tech for 35 or more years and in recognition of their distinguished service and outstanding contributions to Michigan Tech, the Board would like to honor them with a resolution of appreciation.

RECOMMENDATION: That the Board of Trustees adopts the Resolution of Appreciation for the following individual:

1.) Sheri Thomas – 35 years of service
V-B. EMERITUS RANK

Recommendation for the granting of faculty emerita/emeritus status originates within the retiree’s academic department and proceeds through the respective college and school. Once approved, the recommendation is presented to the Provost, and if successful, to the President of the University for presentation to the Board of Trustees.

RECOMMENDATION: That the Board of Trustees approves the following emeritus appointments:

- Dr. John Beard, Professor Emeritus
  Mechanical Engineering-Engineering Mechanics
- Dr. David Hand, Professor Emeritus
  Civil and Environmental Engineering
- Dr. David Nitz, Professor Emeritus
  Physics
TO: Michigan Technological University Board of Trustees  
FROM: William W. Predebon, Ph.D., J.S. Endowed Department Chair  
DATE: February 18, 2019  
SUBJECT: Recommendation for Emeritus Status of Professor John E. Beard, Ph.D.

The faculty of the Department of Mechanical Engineering-Engineering Mechanics voted on January 31, 2019 to request that the following recommendation be presented to the Michigan Technological University Board of Trustees for action to name John E. Beard to Professor Emeritus.

Professor Beard began his employment with Michigan Technological University as an Associate Professor without tenure on January 1, 1992. He was appointed to the rank of Associate Professor with tenure on September 3, 1996.

During his tenure at Michigan Tech, Professor Beard was awarded the Winter/Spring 2008 semester General Motors Technical Education Program (TEP) Outstanding Distance Learning Faculty Award recognizing his excellent level of instruction in delivering the “Product Realization II” course. He was awarded the NSF Future Truck Faculty Advisor of the Year Award in 2002. He was also a recipient of the W.R. Shapton Award, MTU SAE Student Chapter, 1995, and the 1993 SAE Ralph R. Teetor Award. In 2011 he was nominated for the Frederick D. Williams Instructional Innovation Award.

Professor Beard served as the Faculty Advisor for the MTU FutureCar and FutureTruck Competitions and the Challenge X Competitions. He was also a Faculty Advisor for Hero’s Alliance, a Faculty Mentor for the FIRST Robotics Competition - Team 857 since 2016, and was a Faculty Advisor for ME-EM Senior Capstone Design Teams.

His service to the University includes serving on a Scientific Misconduct committee in 1995, as a committee member of the University Textbook Strategy Study Group, and as a member of the Faculty Advisory Board for the EcoCAR Competition. Over the years he has been a member of several ME-EM departmental committees including faculty and staff searches, the Faculty Peer Evaluation Committee, the Safety Committee, and the Curriculum and Curriculum Revision Committees.

Professor Beard is active in national and international service organizations as a member of the Society of Automotive Engineers (SAE), Sigma Xi, and the American Society of Mechanical Engineers (ASME).

Approved:  

[Signatures and dates]  

2/19/2019  
2/19/19  
04 Mar 2019  
3/19/19
TO: Michigan Technological University Board of Trustees
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Professor Beard is active in national and international service organizations as a member of the Society of Automotive Engineers (SAE), Sigma Xi, and the American Society of Mechanical Engineers (ASME).

Approved:

[Signatures]

[Date] 2/19/2019
[Date] 2/19/19
[Date] 04 Mar 2019
[Date] 3/19/19

R.L. Smith Building | 1400 Townsend Drive, Houghton, MI 49931-1295
906-487-2551 | F. 906-487-2822 | mtu.edu/mechanical

Michigan Tech is an EOE which includes protected veterans and individuals with disabilities.
OFFICE MEMO

TO: Michigan Technological University Board of Trustees

FROM: Audra Morse, Professor and Department Chair, Civil and Environmental Engineering

DATE: February 15, 2019

SUBJECT: Recommendation for Emeritus Status – Dr. David Hand

The Department of Civil and Environmental Engineering Promotion, Tenure, and Policy committee voted on February 14 to recommend Emeritus status for David Hand. I request that the Michigan Technological University Board of Trustees name Dr. David Hand as Professor Emeritus upon his retirement on May 31, 2019.

Some of the highlights of his 37-year career at Michigan Tech include having a very active research program where he was involved with 56 research projects (32 as PI) totaling over $10 M. He authored and co-authored over 130 technical publications including co-authoring 8 textbooks, 2 patents and 8 copyrighted software programs. He received the ASCE Rudolf Hering Medal, awarded to the author of the paper which contains the most valuable contribution to the increase of knowledge in, and to the advancement of, the environmental branch of the engineering profession. He is a Board Certified Environmental Engineering Member of the American Academy of Environmental Engineers. Dr. Hand was also very involved in teaching and developed the pilot-scale Environmental Engineering Process Lab. In 2006, he was the recipient of the Association of Environmental Engineering and Science Professors Outstanding Teaching Award. David Hand served six years as Department Chair and during this time he was involved in securing the largest Michigan Tech legacy gift ever received by the university.

Approved

Audra Morse
Department Chair/School Dean

2-15-19

Date

JCD

College Dean

2/20/19

Date

Provost and Vice President for Academic Affairs

4 May 2019

Date

President

3/14/19

Date

Revised 9/21/16
V-C. APPOINTMENTS, NOT INVOLVING TENURE AND/OR PROMOTION

The departments, with the support of the college or school, have requested that the individuals listed herein be granted faculty appointments. The administration has reviewed these faculty appointments and supports the recommendations of the departments.

RECOMMENDATION: That the Board of Trustees approves the appointments listed herein. The appointments do not include tenure or promotion.
TO: Richard Koubek, President
FROM: Jacqueline E. Huntoon, Provost and Senior Vice President for Academic Affairs
DATE: April 15, 2019
SUBJECT: Tenure-Track Faculty Appointment Recommendations

In accordance with Board of Trustees Policy 2.2, Duties and Powers of the President, I am submitting the following faculty appointment recommendations for your review and subsequent approval by the Board of Trustees at their meeting on May 3, 2019.

Appointment without Tenure for Two Years
Effective August 19, 2019

Gordon Paterson  Assistant Professor  Biological Sciences
Stephen Techtmann  Assistant Professor  Biological Sciences
Christo Christov  Associate Professor  Chemistry
Kathryn Perrine  Assistant Professor  Chemistry
Kevin Trewartha  Assistant Professor  Cognitive & Learning Sciences
Bo Chen  Assistant Professor  Computer Science
Jianhui Yue  Assistant Professor  Computer Science
Oren Abeles  Assistant Professor  Humanities
Sarah Bell  Assistant Professor  Humanities
Lesley Alexandra Morrison  Assistant Professor  Humanities
Xiao Zhang  Assistant Professor  Mathematical Sciences
Issei Nakamura  Assistant Professor  Physics
Angela Carter  Assistant Professor  Social Sciences
Kent Cyr  Assistant Professor  Visual & Performing Arts

Sangyoon Han  Assistant Professor  Biomedical Engineering
Smitha Rao  Assistant Professor  Biomedical Engineering
Daniel Dowden  Assistant Professor  Civil & Environmental Engineering
Stephen Morse  Assistant Professor  Civil & Environmental Engineering
Jeremy Bos  Assistant Professor  Electrical & Computer Engineering
Roohollah Askari  Assistant Professor  Geological & Mining Eng. & Sciences
Erik Herbert  Assistant Professor  Materials Science & Engineering
Parisa Abadi  Assistant Professor  Mechanical Eng. – Eng. Mechanics
Hassan Masoud  Assistant Professor  Mechanical Eng. – Eng. Mechanics
Appointment without Tenure for Two Years (continued)
Effective August 19, 2019

Peng Guo  Assistant Professor  School of Business & Economics
Ulrich Schmetzle  Assistant Professor  School of Business & Economics
Jeffrey Wall  Assistant Professor  School of Business & Economics
Fengting Liu  Associate Professor  School of Forest Res. & Env. Science

Appointment without Tenure for One Year
Effective August 19, 2019

Marina Tanasova  Assistant Professor  Chemistry
Latika Gupta  Assistant Professor  School of Business & Economics

Formal notification of these decisions were sent to each individual on Monday, April 1, 2019.

APPROVED:

[Signature]

Richard Koubek, President

[Date]
V-D. APPOINTMENTS, INVOLVING TENURE AND/OR PROMOTION

The policy for granting tenure and/or promotion to faculty members requires that the process begin with deliberations in the candidate's department and proceed through the respective colleges and schools. Once approved, it is presented to the Provost, and if successful, to the President of the University. The candidates listed herein have met all the requirements and are being recommended for tenure and/or promotion.

RECOMMENDATION: That the Board of Trustees approves the appointments involving tenure and/or promotion listed herein.
TO: Richard Koubek, President
FROM: Jacqueline E. Huntoon, Provost & Senior Vice President for Academic Affairs
DATE: April 16, 2019
SUBJECT: Tenure with Promotion Recommendations

In accordance with Board of Trustees Policy 6.4, Academic Tenure and Promotion, the following faculty members have been recommended for promotion with tenure. I have reviewed and support these recommendations and request that the Board of Trustees be asked to approve them at their May 3, 2019 meeting. If approved, the promotions will be effective August 19, 2019.

Promotion from Assistant Professor without Tenure to Associate Professor with Tenure

John Durocher          Biological Sciences
Ebenecer Tumban       Biological Sciences
Kelly Steelman        Cognitive & Learning Science
Keith Verlanen         Computer Science
Abraham Romney      Humanities
Marcelino Viera-Ramos  Humanities
Steven Elmer          Kinesiology & Integrated Physiology
Zhiying Shan          Kinesiology & Integrated Physiology
William Keith          Mathematical Sciences
Melissa Baird       Social Sciences
Mark Rouleau          Social Sciences
Michael Christianson  Visual & Performing Arts

Zhen Liu             Civil & Environmental Engineering
Daisuke Minakata    Civil & Environmental Engineering
Kuilin Zhang        Civil & Environmental Engineering
Pengfei Xue          Civil & Environmental Engineering
Lucía Gauchia       Electrical & Computer Engineering
Zhaochui Wang       Electrical & Computer Engineering
Andrew Barnard    Mechanical Eng. – Eng. Mechanics

Emanuel Marcos Castro-Oliveira School of Business & Economics
Scott Wagner         School of Technology

APPROVED:

Richard Koubek, President

Date
V-E. PROMOTIONS

The policy for promotions of faculty members requires that the process starts with deliberations in the candidate’s department and proceed through the respective colleges and schools. Once approved, it is presented to the Provost, and if successful, to the President of the University. The candidates listed herein have met all the requirements and have been approved for promotion.

RECOMMENDATION: That the Board of Trustees approves the promotions listed herein.
TO: Richard Koubek
FROM: Jacqueline E. Huntoon, Provost & Senior Vice President for Academic Affairs
DATE: April 16, 2019
SUBJECT: Promotion Recommendations

In accordance with Board of Trustees Policy 6.4, Academic Tenure and Promotion, the following faculty members have been recommended for promotion. I have reviewed and support these recommendations and request that the Board of Trustees be asked to approve them at their May 3, 2019 meeting. If approved, the promotions will be effective August 19, 2019.

Promotion from Associate Professor without Tenure to Associate Professor with Tenure

Youngchul Ra Mechanical Eng. – Eng. Mechanics

Promotion from Associate Professor with Tenure to Professor with Tenure

Melissa Keranen Mathematical Sciences
Zhongfu Xu Mathematical Sciences
Qingli Dai Civil & Environmental Engineering
Paul Sanders Materials Science & Engineering
Robert Hutchinson School of Business & Economics
Audrey Mayer School of Forest Resources & Env. Sci.
Yu Cai School of Technology

APPROVED:

Richard Koubek, President

Date 4/19/19
V-F. REVISION TO BOARD POLICY 6.1. FACULTY DEFINITIONS

It is being recommended that this policy be revised to redefine the ranks associated with affiliated and adjunct faculty at Michigan Technological University.

RECOMMENDATION: That the Board of Trustees amends Board Policy 6.1. Faculty Definitions as presented.
REVISION TO BOARD POLICY 6.1. FACULTY DEFINITIONS

It is being recommended that this policy be revised to redefine the ranks associated with non-tenure-track faculty to include librarians and archivists at Michigan Technological University.

RECOMMENDATION: That the Board of Trustees amends Board Policy 6.1 Faculty Definitions as presented.

PROPOSED REVISION TO BOARD OF TRUSTEES POLICY 6.01

RED = ADD
STRIKETHROUGH = DELETE

6.1 Faculty Definitions

The faculty comprises two groups: "tenured and tenure-track faculty" and "non-tenure-track faculty". The "tenured and tenure-track faculty" comprises individuals holding the rank of assistant professor, associate professor, or professor. The "non-tenure-track faculty" comprises individuals holding the rank of instructor, lecturer, senior lecturer, principal lecturer, librarian, senior librarian, principal librarian, archivist, senior archivist, principal archivist, professor of practice, visiting (assistant/associate/professor) faculty, adjunct (professor, associate professor, assistant professor, instructor, lecturer, senior lecturer, principal lecturer, librarian, senior librarian, principal librarian, archivist, senior archivist, principal archivist, professor of practice) faculty, affiliated (professor, associate professor, assistant professor, instructor, lecturer, senior lecturer, principal lecturer, librarian, senior librarian, principal librarian, archivist, senior archivist, principal archivist, professor of practice) faculty, research (assistant/associate/professor) faculty, ROTC faculty, or emeritus faculty.

"Learned professions" shall mean those professions (or members thereof) skilled in a calling or vocation requiring advanced knowledge as evidenced by a specific degree from a recognized College or University.

"Engaged in teaching" shall be interpreted to mean that the person is to teach during each academic semester of the normal academic year.

"Appointed by the Dean of the Graduate School" shall imply appointment to the Graduate Faculty as defined by the Graduate Council. Such appointment is limited to those with advanced degrees or equivalent experience, as well as interest and experience in research or teaching on the graduate level.
"Equivalent experience" shall be determined by the President of the University.

The Faculty of the University

The President shall hire the faculty of the University which shall consist of the Undergraduate and Graduate Faculties.

Each faculty member shall qualify for one or more of the following defined faculties.

1. The Undergraduate Faculty consists of the members of the learned professions who are engaged in teaching for a degree in one of the learned professions and/or direct supervision thereof.
2. The Graduate Faculty consists of members of the faculty who have been appointed by the Dean of the Graduate School to be members of the Graduate Faculty.

Administrative officials of the University and members of staff, may be accorded membership of the faculties and such membership shall be within a specific department or school of the University.

This policy shall be administered in accordance with procedures recommended by the Senate and approved by the Provost and Senior Vice President for Academic Affairs.

THE AMENDED POLICY SHALL READ AS FOLLOWS:

6.1 Faculty Definitions

The faculty comprises two groups: "tenured and tenure-track faculty" and "non-tenure-track faculty". The "tenured and tenure-track faculty" comprises individuals holding the rank of assistant professor, associate professor, or professor. The "non-tenure-track faculty" comprises individuals holding the rank of instructor, lecturer, senior lecturer, principal lecturer, librarian, senior librarian, principal librarian, archivist, senior archivist, principal archivist, professor of practice, visiting (assistant/associate/professor) faculty, adjunct (professor, associate professor, assistant professor, instructor, lecturer, senior lecturer, principal lecturer, librarian, senior librarian, principal librarian, archivist, senior archivist, principal archivist, professor of practice) faculty, affiliated (professor, associate professor, assistant professor, instructor, lecturer, senior lecturer, principal lecturer, librarian, senior librarian, principal librarian, archivist, senior archivist, principal archivist, professor of practice, research assistant/associate/professor, emeritus) faculty, research (assistant/associate/professor) faculty, ROTC faculty, or emeritus faculty.

"Learned professions" shall mean those professions (or members thereof) skilled in a calling or vocation requiring advanced knowledge as evidenced by a specific degree from a recognized College or University.
"Engaged in teaching" shall be interpreted to mean that the person is to teach during each academic semester of the normal academic year.

"Appointed by the Dean of the Graduate School" shall imply appointment to the Graduate Faculty as defined by the Graduate Council. Such appointment is limited to those with advanced degrees or equivalent experience, as well as interest and experience in research or teaching on the graduate level.

"Equivalent experience" shall be determined by the President of the University.

**The Faculty of the University**

The President shall hire the faculty of the University which shall consist of the Undergraduate and Graduate Faculties.

Each faculty member shall qualify for one or more of the following defined faculties.

1. The Undergraduate Faculty consists of the members of the learned professions who are engaged in teaching for a degree in one of the learned professions and/or direct supervision thereof.
2. The Graduate Faculty consists of members of the faculty who have been appointed by the Dean of the Graduate School to be members of the Graduate Faculty.

Administrative officials of the University and members of staff, may be accorded membership of the faculties and such membership shall be within a specific department or school of the University.

This policy shall be administered in accordance with procedures recommended by the Senate and approved by the Provost and Senior Vice President for Academic Affairs.
V-G. PROPOSAL FOR A MASTER'S IN ENGINEERING MANAGEMENT DEGREE

The faculty of the School of Business and Economics at Michigan Technological University seek to establish a Master’s in Engineering Management (MEM) degree. This technical/business (hybrid) degree program focuses on the managerial knowledge, business literacy, and other relevant skills critical for successful operations in various engineering/technology-intensive industries. The curriculum enables students to enhance their technical depth with technical electives while adding vital management competency and awareness. The current Master’s in Business Administration degree, by definition, provides broad coverage across the spectrum of business disciplines without the opportunity to specialize in a focused technical domain.

The proposal has been approved by the University Senate and the University administration. The University is seeking Board of Trustees approval to advance the proposal to the State Academic Affairs Officers.

RECOMMENDATION: That the Board of Trustees approves the Master’s in Engineering Management degree.
Proposal 24-19
(Voting Units: Academic)

Proposal for a New Graduate Degree Program
“Masters in Engineering Management (MEM)”

Introduction

The School of Business and Economics currently offers a Master’s in Business Administration graduate degree that does not include an opportunity for students to specialize in a technical domain. The School of Business and Economics proposes a new graduate degree program: Masters in Engineering Management (MEM hereafter). We propose a technical/business (hybrid) degree program that focuses on the managerial knowledge, business literacy and other relevant skills critical for successful operations in various engineering/technology-intensive industries.

1. January 14, 2019

2. Contact

Soonkwan Hong
Associate Professor of Marketing
School of Business and Economics
shong2@mtu.edu

3. Approval

(Not applicable)

4. General description and Characteristics

The recent success of the B.S. in Engineering Management (undergraduate enrollment growth to 80 students from its introduction in 2013) and the support from various departments at the College of Engineering and College of Sciences and Arts encourage the school to offer this degree program at the master’s level. Given the large engineering and science population at Michigan Tech, the program would be of great necessity and appeal to the University community. The intent of this degree is to add the business acumen to the technical foundation provided in STEM undergraduate programs to help create accelerate graduates’ career trajectories. The most significant difference between the MEM and the MBA graduate programs is the addition of a significant number of technical courses compared to a more general management curriculum of our traditional MBA degree. The MEM should be considered a specialized graduate degree.
The MEM can also incorporate the “stacking” of credentials. Credentials can be earned for completing the business component or the technical component of the degree program. Completion of the different components leads to awarding of the MEM degree. This stacking concept is not detailed in this proposal as it is outside the direct proposal for the introduction of this degree program.

In addition, the university strategic plan underscores the significance of developing interdisciplinary degrees and research endeavors. Stakeholders, including but not limited to alumni, members of various advisory boards, and industry leaders, echo that such a program will add value to the University as well as the School of Business and Economics (SBE). The program will provide opportunities for our engineering graduates to learn how to evaluate and manage innovation and technology in harmony with current business practices.

Student performance will be assessed using the accepted learning objectives and rubrics developed by the SBE faculty for AACSB accreditation. Each business core course will be assessed on a regular schedule. The current learning objectives are:

**Goal 1: Decision Making**

Objective 1a: Identify key problems, risks and opportunities in complex business scenarios.

Criterion
1) Students can identify key problems in complex business scenarios.
2) Students can identify key risks in complex business scenarios.
3) Students can identify key opportunities in complex business scenarios.

Objective 1b: Evaluate multiple alternatives to make appropriate executive-level recommendations.

Criterion
1) Students consider multiple alternatives when making recommendations.
2) Students make appropriate recommendations.
3) Students’ recommendations are executive-level.

**Goal 2: Managerial Competences**

Objective 2a: Generate unique and differentiated alternatives to offer business solutions under uncertainty.

Criterion
1) Students suggest alternatives that are unique.
2) Students suggest alternatives that are differentiated from competitors.
Objective 2b: Recommend appropriate technologies in business solutions.

Criterion
1) Students suggest technologies that are appropriate.
2) Students suggest technologies that integrate with business solutions.

Objective 2c: Demonstrate ethical leadership by influencing globally aware, socially and environmentally responsible behaviors.

Criterion
1) Students demonstrate globally aware leadership behaviors.
2) Students demonstrate socially responsible leadership behaviors.
3) Students demonstrate environmentally responsible leadership behaviors.

Goal 3: Professional Communication

Objective 3a: Written communication is logical, concise, and comprehensive.

Criterion
1) Written communication has a logically flow from premises to conclusions.
2) Written communications are concise, minimizing repetition and extraneous information.
3) Written communications are comprehensive, without gaps of missing information.

Objective 3b: Oral presentation is persuasive and audience-tailored.

Criterion
1) Student presentations are persuasive.
2) Student presentations are tailored to their audiences.

Goal 4: Disciplinary Knowledge

Objective 4a: Demonstrate knowledge necessary for a MEM graduate.

Criterion
1) Student have acquired disciplinary knowledge in finance.
2) Student have acquired disciplinary knowledge in accounting
3) Student have acquired disciplinary knowledge in operations management and project management.
4) Student have acquired disciplinary knowledge in technology and innovation domains.

The program uses existing and regularly offered courses. The SBE expects the list of electives to evolve as new courses are developed. It will be a 30-credit course-based master’s program; therefore, the designation of Masters in Engineering Management is appropriate.
The SBE Graduate Programs Committee started the curriculum identification process by determining the requisite skills and knowledge for a MEM graduate. From that abstract, high-level view, specific courses were identified to ensure that their contents align with the profile from an academic perspective. After reviewing over 40 similar graduate programs from other universities, five business courses were identified as key requirements for all students in the MEM. These courses span accounting, finance, operations, project management, and management of technology and innovation domains.

Students will have the flexibility to enroll in more business courses or technical courses via a set of focused electives. The program director will advise MEM students to encourage a coherent combination of electives suited to a particular domain.

Finally, a set of technical electives will augment the anticipated strong STEM background of the target student population. The proposed program balances business knowledge with an expansion of technical competency of students from various undergraduate backgrounds in engineering and science, which is not readily possible with the current Tech MBA® program. The SBE Dean and SBE Associate Dean met with Department Chairs and the College of Engineering Associate Deans from various units across campus over the summer 2018 to obtain feedback on the MEM proposal. These representatives provided guidance on courses to include (and to delete) based on relevance to the intended expertise of MEM graduates and course availability. The program director will advise MEM students to encourage a coherent combination of technical electives suited to individual career goals.

5. Title of the program: Masters in Engineering Management (MEM)

6. Rationale

(a) We are creating this specialized graduate degree for the following reasons:

i. To give students the opportunity to pursue a career requiring a foundation in both engineering and business. The curriculum enables students to enhance their technical depth with technical electives while adding vital management competency and awareness.

ii. To introduce technical graduates (e.g. engineering undergraduates) to a subset of current business principles and processes while assessing the commercial ramifications of their technical design solutions. Their engineering skill set is augmented with essential business expertise, including knowledge of organizational behavior, cost management, and leadership skills. Thereby, future graduates of the MEM program are prepared to manage people, lead scientific or engineering operations, head complex technical projects, or pursue entrepreneurial endeavors within a high-technology context. We anticipate graduates will secure more challenging entry-level jobs employing their technical skills. The ultimate objective is, however, to provide an opportunity for graduates to rapidly
transition into upper level management positions employing their business skills.

iii. To aid students with technical majors in broadening and diversifying career opportunities that were previously unavailable to purely technical graduates. Discussions with alumni often reflect regret at the missed opportunity to study business earlier in their careers. With business credentials on their resumes, engineering graduates will differentiate themselves from their peer group.

(b) In addition, the MEM program will contribute to the SBE’s vision to produce tech-savvy business graduates and business-savvy tech graduates. The MEM program takes advantage of a business school embedded in a technological university. While the Bureau of Labor Statistics does not track Engineering Management as a separate category, the related job title of Industrial Engineers can provide relevant information. According to the Bureau of Labor Statistics, this career field is growing faster than the national average (10% growth rate) over the next decade. Furthermore, the number of jobs in this field is very large compared to other engineering fields. We anticipate strong career placement for MEM graduates.

7. Discussion of related programs within the institution and at other institutions

The Tech MBA® courses currently offered by the School of Business and Economics will provide a foundation for the proposed program where engineering and science students are exposed to business aspects of engineering, technology, and innovation.

By definition, a MBA degree provides broad coverage across the spectrum of business disciplines. An MBA is widely considered to be a generalized graduate program with equal representation of the primary core functions (and theoretical foundations) applied in most business schools. The MBA is more attractive for a career that requires overall business knowledge. Indeed, our prior Tech MBA® program required 10 business courses, whereas the MEM degree requires only a portion of the Tech MBA® courses.

By definition, a M.S. degree is a focused, deeper and more precise degree program. In this case, the MEM is focused on technical knowledge and abilities combined with the primary business content required for expertise in management of operations within technical industries. Students will be able to extend their technical education through graduate courses in the various engineering and science disciplines. This degree requires a strong background in a technical domain through the electives selected. Students will be encouraged to choose courses that present a logical connection, appealing to recruiters in a well-defined industry or area. Graduates will more likely remain in supervisory levels within a technical unit as a career path. In other words, the proposed program balances business knowledge with the technical competency of students from various undergraduate backgrounds in engineering and science, which is not the intent of the current Tech MBA® program.
The following institutions in the State of Michigan offer programs that are primarily engineering-centric, and generally lack core business components:

- Lawrence Technological University - Master of Engineering Management,
- University Detroit Mercy - Master of Science in Technical Management,
- University Michigan Dearborn – Master of Science in Engineering Management,
- Western Michigan University - Master of Science in Engineering Management,
- Wayne State University – Master of Science in Engineering Management, and
- Eastern Michigan University - Master of Science in Engineering Management.

Michigan State University also offers a Master of Science program in Operations and Engineering Management, but the curriculum is primarily business focused.

The proposed program will be hosted in the School of Business and Economics with a focus on providing students with a unique opportunity to further develop their skill sets in their respective engineering and science fields as well as expand required knowledge in business, innovation, and technology management. Class projects will provide opportunities for MEM students to interact with MBA students on a regular basis.

8. Projected enrollment

The enrollment is projected to be 20 students in the first year, with a gradually increasing enrollment of +5% each year until the program plateaus with an estimated 40 students admitted annually.

9. Curriculum design

The proposed program is a 30-credit course-based degree.

**Business Requirements (15 credits)**

1. BA 5300: Financial Reporting & Control
2. BA 5400 Financial Risk Management & Decision Making (Prereq: BA 5300)
3. BA 5610: Operations Management
4. MGT 4600: Management of Technology and Innovation
5. ENG/OSM 4300: Project Management
   OR BA5650 Project Management
Focused Electives (6 credits)
1 BA 5200: Information Systems Management & Data Analysis
2 BA 5700: Managing Behavior in Organizations
3 BA 5800: Marketing, Technology & Globalization
4 CEE 5350: Life Cycle Engineering
5 MEEM 4650: Quality Engineering OR
   OSM 4650: Six Sigma Fundamentals OR
   MEEM 5650: Advanced Quality Engineering
6 MGT 3800: Entrepreneurship

Prerequisites
MA 3710: Engineering Statistics (or any other statistics course)
(CEE 3710 Stats for Civil Engineering)

Technical Electives (9 credits)*

Civil & Environmental Engineering
1 CEE 5710: Modeling and Simulation Applications
2 CEE 5404: Transportation Planning
3 CEE 5417: Transportation Design
4 CEE 5501: Environmental Process Engineering
5 CEE 5730: Probabilistic Analysis and Reliability
6 CEE 5760: Optimization Methods in Civil/Env. Engineering
7 EC 3400: Economic Decision Analysis

Chemical Engineering
1 CM 3310: Process Control
2 CM 5100: Applied Mathematics for Chemical Engineering
3 CM 5300: Advanced Transport Phenomena
4 CM 5400: Advanced Reactive Systems Analysis
5 EC 3400: Economic Decision Analysis

Computer Science
1 CS 3712 Software Quality Assurance
2 CS 4712 Data Mining
3 CS 5471 Computer Security
4 CS 5841 Machine Learning
5 EC 3400: Economic Decision Analysis
**Electrical & Computer Engineering**

1. EE 3261: Control Systems
2. EE 5300: Mathematical & Computational Methods in Engineering
3. EE 5451: Cyber Risk Assessment Critical Inference
4. EE 5500: Probability and Stochastic Processes
5. EE 5511: Information Theory
6. EE 5521: Detection Estimation
7. EE 5821: Computational Intelligence
8. EE 5230: Power Systems Operations

**Mechanical Engineering**

1. MEEM 3600: Introduction to Manufacturing
2. MEEM 5680: Optimization I
3. EC 3400: Economic Decision Analysis

* This list of technical electives is an example; other courses are open for consideration. Students will need to satisfy the course prerequisites in selection of their technical electives.

10. New course descriptions

There will be no new courses added for the program.

11. Model schedule (Business courses only)

<table>
<thead>
<tr>
<th>Business requirements</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MGT 4600: Management of Technology and Innovation</td>
<td>BA 5610: Operations Management</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OSM 4300: Project Management</td>
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<table>
<thead>
<tr>
<th>Focused electives</th>
<th>Fall</th>
<th>Spring</th>
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<tbody>
<tr>
<td></td>
<td>Focused Elective 1</td>
<td>Focused Elective 2</td>
</tr>
<tr>
<td></td>
<td>Technical Elective 1</td>
<td>Technical Elective 3</td>
</tr>
<tr>
<td></td>
<td>Technical Elective 2</td>
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</tr>
</tbody>
</table>

Reference the MTU course catalog for the semesters in which the focused and technical electives are offered.
12. Library and other learning sources

The library and other learning resources will be identical to those for current students.

13. Faculty resumes

http://www.mtu.edu/business/people-groups/faculty/robert-hutchinson/
http://www.mtu.edu/business/people-groups/faculty/manish-srivastava/
http://www.mtu.edu/business/people-groups/faculty/howard-qi/
http://www.mtu.edu/business/people-groups/faculty/ulrich-schmelzle/

14. Description of available/needed equipment

No new or specific equipment needed for the program.

15. Program costs

The proposed program leverages the Tech MBA® program and other courses currently offered by engineering and science programs. Therefore, no specific additional cost will be incurred from the program. Administrative costs will be covered by the School of Business and Economics.

16. Space

No new space is needed. The Graduate Computing Lab in the Academic Office Building will be available for MEM student use.

17. Accreditation requirements

Michigan Tech is accredited by the Higher Learning Commission (HLC)(https://www.mtu.edu/provost/accreditation/hlcommission/). Individual programs may, in addition, seek and receive professional accreditation (https://www.mtu.edu/provost/accreditation/professional/).

This program will be reviewed and accredited by AACSB (Association to Advance Collegiate Schools of Business).

18. Planned implementation date

Fall 2019

19. Program specific policies, regulations, and rules

(Not applicable)
Introduced to the Senate:
Approved by the Senate:
Approved by Administration:
Approved by Board of Trustees:
V-H. PROPOSAL FOR A MASTER’S OF SCIENCE IN MECHATRONICS DEGREE

The faculty of the School of Technology at Michigan Technological University seek to establish a Master’s of Science (MS) degree program in Mechatronics. This interdisciplinary degree is an outcome of a joint effort between the Electrical Engineering Technology (EET) and Mechanical Engineering Technology (MET) programs in the School of Technology, as well as the Departments of Electrical and Computer Engineering (ECE) and Mechanical Engineering – Engineering Mechanics (ME-EM) in the College of Engineering.

Mechatronics is the synergistic integration of electrical and mechanical engineering, robotics, computational hardware, and software in the design of products and processes. Mechatronics is an essential foundation for the expected growth in automation and manufacturing. There is a demand for graduate education in mechatronics as the landscape of engineering programs has changed in the past decade, shifting from traditional degrees leading directly to closely aligned positions in industry, to preparing individuals with advanced technical competencies capable of engaging in interdisciplinary research and industry applications. The proposed multidisciplinary degree will fill the need for applied researchers and for entrepreneurs to revitalize the US and global economies in the areas of advanced manufacturing and automation. Graduates will be equipped with multidisciplinary skills in electrical, mechanical, computer, and software engineering. The increased connectivity of smart, connected machinery has resulted in a complete transformation in the technologies used to create new industrial, commercial, and consumer products. The industry-driven curriculum will address the need for a skilled advanced manufacturing workforce and accelerate the development of a digitally-savvy workforce for emerging manufacturing technologies. It will focus on core technical skills, advanced technical design skills, and core technical implementation/instrumentation skills that are used in the design and manufacturing of control systems and devices used in consumer products, aerospace and military applications, and automotive and other advanced manufacturing industries. This degree program is responsive to advice from industrial advisory board members, other industry contacts, and student interest surveys to meet industry needs and to develop career pathways. The new degree will be hosted at the new computing college and function as a convergence program with the College of Engineering.

The proposal has been approved by the University Senate and the University administration. The University is seeking Board of Trustees approval to advance the proposal to the State Academic Affairs Officers.

RECOMMENDATION: That the Board of Trustees approves the Master’s of Science in Mechatronics degree.
PROPOSAL FOR A MASTER OF SCIENCE IN
MECHATRONICS

Proposal 30-19

(Voting Units: Academic)

Submitted by the School of Technology

Task Force Committee:
Chair: Aleksandr Sergeyev* – Electrical Engineering Technology, School of Technology
Trever Hassel - Electrical and Computer Engineering Department
Kevin Johnson – Mechanical Engineering Technology, School of Technology
Mo Rastgaar – Department of Mechanical Engineering – Engineering Mechanics
Yu Cai – Computer Network and System Administration, School of Technology

*Primary Points of Contact:
Aleksandr Sergeyev avsergue@mtu.edu and Adrienne Minerick, Dean, School of Technology, minerick@mtu.edu

1. GENERAL DESCRIPTION AND CHARACTERISTICS OF PROGRAM

This proposal recommends the establishment of a Master of Science in Mechatronics (and Controls System Integration) at Michigan Tech. Mechatronics is the synergistic integration of electrical and mechanical engineering, robotics, computational hardware and software in the design of products and processes. Mechatronics is an essential foundation for the expected growth in automation and manufacturing. Figure 1 (source: https://en.wikipedia.org/wiki/Mechatronics) depicts the mix of various science and engineering disciplines that are part of Mechatronics and outlines related job opportunities for degree recipients. There is a demand for graduate education in Mechatronics as the landscape of engineering programs has changed in the past decade, shifting from traditional degrees leading directly to closely aligned positions in industry, to preparing individuals with advanced technical competencies capable of engaging in interdisciplinary research and industry applications. The proposed multidisciplinary degree will fill the need for applied researchers and for entrepreneurs to revitalize the US and global economies in the areas of advanced manufacturing and automation. Graduates will be equipped with multidisciplinary skills in electrical, mechanical, computer, and software engineering. The increased connectivity of smart machinery has resulted in a complete transformation in the technologies used to create new industrial, commercial, and consumer products. The movement towards smart, connected technologies is transforming the manufacturing industry. Emerging technologies will help manufacturers provide advanced automation, improved communication and
monitoring, self-diagnosis in real time, and bring data-driven analyses to realize new heights of productivity. The industry-driven curriculum developed for the proposed program will address the need for a skilled advanced manufacturing workforce and accelerate the development of a digitally-savvy workforce for emerging manufacturing technologies. It will focus on core technical skills, advanced technical design skills, and core technical implementation/instrumentation skills that are used in the design and manufacturing of control systems and devices used in consumer products, aerospace and military applications, and automotive and other advanced manufacturing industries. This degree program is responsive to advice from industrial advisory board members and other industry contacts to meet industry needs and to develop career pathways. This proposed degree program has the potential to increase enrollments in each of the four feeder BS programs that bridge into the MS in Mechatronics: Electrical Engineering Technology (EET), Electrical and Computer Engineering (ECE), Mechanical Engineering Technology (MET), and Mechanical Engineering - Engineering Mechanics (ME-EM).

Figure 2 depicts the overview of the proposed model of Master of Science degree in Mechatronics at Michigan Tech.

Figure 2 depicts the overview of the proposed MS degree in Mechatronics; each pathway will be discussed beginning at the top and moving clockwise around the figure. The MS degree has been designed to be flexible and accessible to students originating from various disciplines and academic pathways. Students from Michigan Tech pursuing their bachelor's degree will be able to enroll in an accelerated MS degree in Mechatronics and will be available to qualified Michigan Tech undergraduate students who apply in their junior or senior year. Students will be able to apply up to six credits of approved coursework from their BS towards the MS degree in Mechatronics. In addition, up to six (6) credits may be taken under Senior
Rule (in which courses approved for graduate study are taken while students are undergraduates, but the course credits are reserved for the graduate transcript and cannot be used to satisfy undergraduate degree requirements). Depending on the students’ preparation (i.e. the number of prerequisites needed for graduate level courses, the number of graduate classes taken during their BS degree, courses transferred using Senior Rule), the graduation time for the students pursuing coursework option can vary between 1 and 2 years. For students who elect the research or industry internship option, the graduation time will be minimum of 1.5 years. Students who have earned BS degrees prior to being accepted into the MS Mechatronics program will not be eligible for Senior Rule and thus the Accelerated Master’s program but will be able to enroll in the stand-alone 2-year MS in Mechatronics program as shown in Figure 2.

The School of Technology has established and maintains several articulation agreements with regional community colleges. The 2+2+(1-2) degree path will provide these community college students pursuing an associate degree with the opportunity to first obtain a bachelor’s degree in electrical or mechanical engineering technology at Michigan Tech and then move into the accelerated MS graduate degree in Mechatronics. These students will be able to follow all pathways enabled above for traditional EET and MET students.

The proposed degree also targets industry representatives who may or may not be able to be full-time students. Discussions with alums suggest there is considerable interest in this Mechatronics degree from those presently working in industry; therefore, online courses will be made available in the second year after program approval and development (potential for partnership with Keypath) for the required masters-level courses. To accommodate the distance, laboratory components will be taught in a week-long format on campus in a condensed fashion at a time that is most convenient for the students. This hybrid (online lectures and in-person hands-on training) approach will not only attract industry representatives but will also provide additional flexibility to the students currently enrolled in the degree.

International students and the students from the other universities will be able to enroll in the MS degree of Mechatronics based upon their earned BS degree, admittance by the graduate school, and approval of the graduate advisor. The approval will be based on comparing the individuals’ transcripts with the current requirements for similar courses at Michigan Tech. Given the breadth of possible applications, this will be an iterative optimization with the Graduate School to identify which students to admit into the program. Per graduate school policy, students will be able to take graduate courses at another university and apply to have credits transferred to the MS Mechatronics program. Students will be able to transfer in up to 1/3 of the non-research credits required. The Mechatronics program director will be in charge of approving any allowable credits. Students must earn a ‘B’ or better in the course they are requesting to transfer.

The proposed MS degree will be very flexible, offering three options to complete graduation requirements: a coursework with internship path; a research option with thesis, and a report. The research option will allow students to work with MET, EET, ECE, and ME-EM faculty members at Michigan Tech on various applied research projects, with the goal of enhancing their knowledge in practical applications. The option most desirable by both students and industry (see survey below), is an internship with industry. Students electing internship option will be able to participate in at least one internship opportunity and acquiring up to at most of 3 credits for a single opportunity with the maximum of up to 6 credits with multiple opportunities. The number of credits awarded for a particular internship
opportunity will be decided by the graduate faculty advising to the students. The acquired credits will be counted towards coursework with internship pathway graduation option.

The graduate learning objectives (GLOs) for the coursework, thesis, and report pathways of the proposed Master of Science Degree in Mechatronics are listed below. Topic Areas are outlined in Figure 5.

**Graduate Learning Objectives**

- Demonstrate core proficiency of the hybrid subject matter
- Develop a deeper understanding of the discipline through an appropriate activity.
  - Make a contribution to the discipline. (Thesis option)
  - Expanding student knowledge of the discipline. (Report option)
  - Expanding student knowledge of the field through coursework or coursework with internship
- Demonstrate professional skills
  - Effective written communication skills
  - Effective oral communication skills
- Practice responsible conduct of the profession

**2. RATIONALE AND SURVEY RESULTS**

Modern industrial processes rely on sensor technology to carry out precise functions, from touchscreen tablets and phones to robotic assembly machines. Advanced manufacturing incorporates complicated electromechanical systems with advanced control systems to increase production quality and throughputs. Mechatronics is the science of receiving, processing, and transmitting sensory data, resulting in advanced control of external devices. Industry has a great demand for engineers with overlapping expertise in the fields of electrical, mechanical, computer, robotic and control engineering. The physical systems currently used in industry are electromechanical with advanced controls. To operate, troubleshoot, and develop new systems, the “ideal” engineer needs knowledge about electrical, mechanical, and computer fields. A Mechatronics degree prepares graduates with expertise in all of these fields.

As part of the initial assessment of the need for a new type of Master of Science degree in Mechatronics, the task force committee surveyed both students at Michigan Tech (in MET, EET, ECE, and ME-EM) and industry representatives. The student survey targeted currently enrolled engineering students and intended to collect feedback on their perceptions of a new degree: Master of Science in Mechatronics. The survey offered three options to fulfill degree requirements: a) a traditional course-only option; b) a research/project with thesis option; and c) an internship with industry with thesis option. Given the opportunity for the students to extend by 2 years their undergraduate degree to obtain a Master of Science in Mechatronics, the participants were surveyed on two questions: “1) Would you consider this opportunity?; and 2) Which option for the degree completion requirement would you prefer?” Based on 273 responses received in less than a two-week window, the statistical data shown in Figure 3, was compiled.

The industry survey was conducted via an alumni list of recent graduates from the SoT and was open for two weeks. Similar to the student survey, industry representatives were introduced to the proposed initiative and various options for fulfillment of the degree requirements, followed by two questions: “1)
Given the opportunity to hire a graduate with a Mechatronics degree, would this person receive priority over a traditional Electrical or Mechanical Engineering Technology graduate?; and 2) As an employer, which option for the degree completion requirement would you prefer?" Surveyed companies represent a very broad range of industrial sectors: automotive, automation and controls, robotics, additive manufacturing, mechatronics, material handling, energy services, power, steel, computer hardware, industrial machinery, hydraulics, mining, heavy equipment manufacturing, and others. A total of 105 responses were received and the statistical data, shown in Figure 4, was compiled.

Analysis of both data sets clearly indicates that there is a great interest in a Master of Science degree in Mechatronics. Students understand the need for advanced education and are ready to consider a graduate degree, and there is great demand and an immediate need in industry for highly qualified graduates with the proposed degree. 77% of student participants indicated an interest in enrolling in a MS degree in Mechatronics. It is interesting to note that the most preferable degree completion option (at a rate of 47%) is through the internship with industry and thesis option while 41% of students would still prefer to obtain the degree via the coursework option. Based on data collected from a broad spectrum of industry, it is clear that there is a strong (a rate of 80%) preference for graduates with a degree in Mechatronics, as opposed to Electrical or Mechanical engineering technology graduates. Industry prefers a graduate with electrical, mechanical, and computer skills in one package. This type of graduate will enable more productive work in complex industrial solutions and will be well-oriented to communicate with other specialists from various disciplines. Industry responses also show that the internship graduation path is preferred, at a rate of 72%. Industry values graduates who, while still in school, experience real-world, application-based challenges. Graduates with industrial experience and hands-on education are ready to immediately implement their skills and contribute to the company mission.
3. RELATED PROGRAMS

Mechatronics is a very common degree in Europe and Asia; well-known programs are located in Germany, Spain, Czech Republic, France, Russia, Portugal, Canada, Vietnam, China, and Taiwan. However, only a limited number of mechatronics degrees, and especially master’s programs, exist in the United States. University of Michigan offers a Master of Science in Robotics with a focus on the research and development of human-robot interactions, bio-inspired compliant systems, robotics, and nanomanipulation. Georgia Tech is also ranked among the best universities in the US for people interested in studying mechanical engineering. Georgia Tech has several laboratories specially created for fields such as precision machining, robotic mechanisms, and advanced intelligent mechatronics. Various courses are available, including robotics and mechatronics. Massachusetts Institute of Technology specializes in applications for robotics, looking for advances such as making humanoid robots, designing mechatronic systems, and implementing robots as tools for real-time computation tasks. The School of Engineering at Stanford University offers a Master of Science degree in Engineering that focuses on the development of solutions using robotic tools. Carnegie Mellon’s robotics Master of Science program looks to spread robotics research and solutions across different fields and departments of research and work. The Master’s Degree in Robotics offered by Oregon State University remains one of the best and most straightforward options for professional engineers looking to specialize in a program that is versatile and well-reputed. The University of Pennsylvania offers a Master of Science Degree in Robotics and stands out as the one with a high-quality student community, since it attracts multitalented groups of people who have applied robotics to solve different problems. The proposed, interdisciplinary, MS degree in Mechatronics will serve domestic and international students. Currently enrolled students at Michigan Tech in bachelor’s degrees electing to advance their degree will be able to enter the accelerated MS degree in Mechatronics. Currently, opportunities for engineering technology students to extend their BS degree are very limited. There are approximately 29 relevant Master of Science in Technology programs worldwide; very few are in the U.S. The Department of Technology at the University of Northern Iowa offers a Master of Science in Technology, but without a specialization in Mechatronics. The College of Technology at Purdue University Northwest offers a Master of Science in Technology with a concentration in Mechatronics Engineering Technology. It is perhaps the closest in nature to the proposed Master of Science degree in Mechatronics at Michigan Tech; however, it lacks flexibility in degree completion requirements.

4. PROJECTED ENROLLMENT

Based on initial assessment conducted using the students’ survey on the relevance of MS degree in Mechatronics 210 out of 273 students would enroll in the proposed degree. Using an initial conservative rate of 20%, we estimate the Graduate Program to have approximately 40 degree-seeking students over the first three years with an anticipated steady-state enrollment of 40-60 students including international and students from the other universities. Upon program development and availability of the online courses, we expect 80% of the degree-seeking students in the program to be traditional students and the remainder to be industry representatives enrolled through distance learning with intense on-site training. Responsive to the nature of student engagement in the first few years, we will launch a marketing campaign and examine partnering with Keypath to take the online components to a higher level of professional delivery. The School of Technology already carries the status of a FANUC authorized and
certified training center in industrial robotics and offers four industrial certificates of completion: “Roboguide: Robotic Workcell Assembly” (8 hours), “Robot Operations” (16 hours), “Handling Toll Operation and Programming” (32 hours), and “IR-Vision 2D” (32 hour). Enrollments over the past three years have been in the upper twenties; we expect this trend to continue and potentially guide additional industry students into the MS in Mechatronics. Non-degree seeking students or industry representatives could take courses that can be applied to professional credentials. The details of a proposed graduate certificate are addressed in a separate proposal.

Also, according to the latest U.S. Bureau of Labor Statistics, the number of jobs for Mechatronics Engineers is expected to experience moderate growth, specifically in Michigan and Wisconsin, which needs to be supported by new specialists as shown in the table below. Michigan Tech is strategically located in close proximity to the largest automotive companies that have expressed they are in need of Mechatronics specialists. We expect that the expected growth in jobs for Mechatronics Engineers will have direct and positive impact on the enrollment in the proposed MS Degree in Mechatronics.

We strongly believe that the unique structure of the proposed graduate program curriculum and the availability of online course delivery will attract both traditional, non-traditional degree seeking, and non-degree seeking students.

5. SCHEDULING PLANS

The classes will be taught on the Michigan Tech campus and via a staged rollout approach, the required courses will be online followed by a majority of the topic area courses (see Figure 5). Some of the courses that are part of the proposed curriculum already have online versions. The new courses that will be developed as part of this initiative will include online content as well. This type of blended learning course meets the needs of distance and on-campus traditional students. Distance education students from industry will be able to complete theoretical portion of courses online, followed by intense on-site training. The courses not currently selected for online delivery are more suitable for on-campus students who intend to write a thesis.
6. CURRICULUM DESIGN

The Mechatronics Graduate Program requires a minimum of 30 credits of coursework and thesis/report for the MS degree. Table 1 outlines options and requirements for the proposed Master of Science degree in Mechatronics.

<table>
<thead>
<tr>
<th>Option</th>
<th>Minimum Course credits</th>
<th>Research credits</th>
<th>Internship credits (included in course credits)</th>
<th>Minimum Total Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coursework</td>
<td>30</td>
<td></td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>Internship path</td>
<td>30</td>
<td></td>
<td>1-6</td>
<td>30</td>
</tr>
<tr>
<td>Thesis</td>
<td>20-24</td>
<td>6-10</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>Report</td>
<td>24-28</td>
<td>2-6</td>
<td></td>
<td>30</td>
</tr>
</tbody>
</table>

Table 1: MS Degree Requirements

Figure 5 depicts the curriculum Model for the proposed MS degree in Mechatronics. The model was designed to be flexible enough to accommodate students enrolling from various disciplines: EET, EE, MET, ME-EM, and others (subject to adequate preparation). All majors are required to take EET5144 Real Time robotics and EET5373 Advanced Programmable Logic Controllers. Knowledge of robotic systems and the ability to smartly program robots are absolutely necessary skills for Mechatronics graduates. Job descriptions from Tesla, Ford, Fanuc, GM, and many other companies dealing with automation, all call for a specific knowledge of Fanuc robots and Programmable Logic Controllers. This has been a deciding factor for requiring all majors to be enrolled in EET5144 and EET5373. The prerequisites are designed to allow students from EET, EE, MET, and ME-EM to be able to enroll in these courses.

In addition, the students need to select at least one course from each of the topics (1-4) containing courses related to key identified knowledge areas for the Mechatronics degree. These topics are Cybersecurity of Industrial Systems, Autonomous Robotic Platforms, Controls of Industrial Systems, and Signal Processing of Electromechanical Systems. Availability of similar-in-nature courses in each Topic area that are offered by different majors will avoid foreseeing conflicts with course prerequisites.

It is expected, and will be required, that students coming from an electrical engineering background will complement their knowledge with mechanical engineering concepts by enrolling in at least one course outside of their discipline, and vice versa for the students with mechanical engineering backgrounds. This will be made possible by supplementing the required courses with various technical elective courses needed to qualify as prerequisites. The degree requirements followed Figure 5 provide more specific information on disciplinary breadth necessities. The specific degree paths, as well as flowchart options, have been developed for all participating majors and available along with the Master of Science Degree plan in Appendix A.

Note: The flowcharts shown in Appendix A are only examples and some of the courses may be substituted with different ones upon the degree evolution.
Formal Session of the Board of Trustees - V. Action/Discussion Items

**Required for all Majors**

- EET 5144 Real Time Robotics
- EET 5373 Advanced PLC
- EET 5400 Industrial Safety

Add at least 1 course from each of the Topics (1-4)

At least one course from Topics (1-3) must be selected from out discipline

**Topic 1: Autonomous Robotic Platforms**

- EE 5531 Introduction to Robotics
- MEEM 5705 Introduction to Robotics and Mechatronics
- EET 5147 Industrial Robotic Vision System
- MET 5800 Dynamics and Kinematics of Robotic Platforms

**Topic 2: Controls of Industrial Systems**

- EE 4262 Digital and Non-Linear Control
- EE/MEEM 5750 Model-Based Embedded Control System Design
- MEEM 4775 Analysis and Design of Feedback Control Systems
- EET 5311 Advanced Circuits and Controls
- MET 5801 Controls of Dynamic Systems
- MET 5802 Vibrations of Mechanical Systems

**Topic 3: Signal Processing of Electromechanical Systems**

- EE 4252 Digital Signal Processing and Applications
- MEEM 5700 Dynamic Measurements/Signal Analysis
- EET 5142/4142 Digital Signal and Image Processing Applications

**Topic 4: Cyber Security of Industrial Systems**

- SAT 3812 Cybersecurity I
- EE 4723 Network Security
- EE 5455/MEEM 5300 Cybersecurity of Industrial Control Systems
- EE/MEEM 5315 Cyber Security of Auto Systems

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Figure 5 Curriculum Model for MS Degree in Mechatronics
Degree Requirements

Required courses (8)
- EET 5144 Real Time Robotics (4)
- EET 5373 Advanced PLC (3)
- EET 5400 Industrial Safety (1)

Selected Electrical and Mechanical Electives – Pick one from each group (12-15)
Coursework is subject to a limitation of 12 credits at the 3000-4000 level

Disciplinary Breadth Requirement
Choose a minimum of 3 credits with an EE or EET prefix AND
Choose a minimum of 3 credits with an MET or MEEM prefix
from the following 3 groups. Courses that are cross-listed between EE/EET and MET/MEEM cannot be used to satisfy this requirement.

Autonomous Robotic Platforms (3-4)
- EE 5531 Introduction to Robotics (3)
- MEEM 5705 Introduction to Robotics and Mechatronics (4)
- EET 5147 Industrial Robotic Vision System (4)
- MET 5800 Dynamics and Kinematics of Robotics Platforms (3)

Controls of Industrial Systems (3-4)
- EE 4262 Digital and Non-Linear Control (3)
- EE/MEEM 5750 Model-Based Embedded Control System Design (3)
- MEEM 4775 Analysis and Design of Feedback Control Systems (4)
- EET 5311 Advanced Circuits and Controls (4)
- MET 5801 Controls of Dynamic Systems (3)
- MET 5802 Vibrations of Mechanical Systems (3)

Signal Processing of Electromechanical Systems (3-4)
- EE 4252 Digital Signal Processing and Applications (3)
- EET 5142/4142 Digital Signal and Image Processing (4)
- MEEM 5700 Dynamic Measurements/Signal Analysis (4)

Selected Electives in Cyber Security of Industrial Processes (3)
- EE 4723 Network Security (3)
- EE 5455/MEEM 5300 Cybersecurity of Industrial Control Systems (3)
- MEEM 5315 Cyber Security of Auto Systems (3)
- SAT 3812 Cybersecurity I (3)

Internship pathway (0-6)
- EET 5995 Mechatronics Internship (Repeatable 1-6)

Electives (0-10)
Remaining courses are subject to advisor approval and the limitation of a maximum of 12 credits at the 3000-4000 level. Example courses are shown below.

Possible Elective Courses by Major
- EET 5144/4144 Real Time Robotics
- EET 5147/4147 Industrial Robotic Vision System
Description of the required courses for MS Degree in Mechatronics:

**Required for All Majors:**

EET 5144 Real Time Robotics

- Covers the components of a robot system, safety, concepts of a work-cell system, geometry, path control, automation sensors, programming techniques, hardware, and software.
EET 5373 Advanced PLC

- Using Allen Bradley Control Logix and SLC500 programmable controllers, course covers structured programming, Sequential Function Charts, networking, proportional integral differential control, data acquisition and interfacing. The course requires proposing, executing and defending the graduate level, and related to the course material, project.
- Credits: 3.0
- Lec-Rec-Lab: (0-2-3) Semesters Offered: Spring
- Restrictions: Must be enrolled in one of the following Level(s): Graduate Pre-Requisite(s): EET 3373

EET 5400 Industrial Safety

- Course covers safety training and background on safe operation of pneumatic, electrical and fluid power system. Recitation component includes lab and facility tours to observe properly and improperly installed/operated systems. The course will survey federal regulations and processes to assess safety and usage impacts, understand responsibilities as equipment designers and operators, and provide practice learning to write Standard Operating Procedures. Provides the technical and cultural background necessary to design, operate and manage a safe manufacturing facility.
- Credits: 1.0
- Lec-Rec-Lab: (0-1-0)
- Restrictions: None

**Topic 1: Autonomous Robotic Platforms**

EE 5531 Introduction to Robotics

- Introduction to autonomous systems and robotics with focus on automated ground vehicles. Project based course using distributed computing to solve problems related to motion planning, perception, and localization. Requires experience with Linux operating systems variants, version control systems, and C++ or Python.
- Credits: 3.0
- Lec-Rec-Lab: (2-0-3)
- Semesters Offered: Spring
- Restrictions: Permission of department required; Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following College(s): College of Engineering
MEEM 5705 Introduction to Robotics and Mechatronics

- Cross-discipline system integration of sensors, actuators, and microprocessors to achieve high-level design requirements, including robotic systems. A variety of sensor and actuation types are introduced, from both a practical and a mathematical perspective. Embedded microprocessor applications are developed using the C programming language. A final project is required including analysis, design, and experimental demonstration. Cannot receive credit for both MEEM4705 and MEEMS705.
- Credits: 4.0
- Lec-Rec-Lab: (0-3-3)
- Semesters Offered: Fall, Spring
- Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Mechanical Engineering, Mechanical Eng-Eng Mechanics, Engineering Mechanics
- Pre-Requisite(s): MEEM 3750

EET 5147 Industrial Robotic Vision System

- Procedures for setting up, teaching, testing, and modifying robot vision systems widely used in industrial automation. Introduces advanced Teach Pendant Programming to develop complex scenarios for integrating robots into industrial cells. Final project must demonstrate proficiency in setting up and programming an advanced robotic vision scenario.
- Credits: 4.0
- Lec-Rec-Lab: (0-3-3) Semesters Offered: Fall, Summer
- Restrictions: Must be enrolled in one of the following Level(s): Graduate Pre-Requisite(s): EET 4144 or EET 5144

MET 5800 Dynamics and Kinematics of Robotics Platforms

- This course covers the dynamics and kinematics of rigid bodies as the foundation for analyzing motion of robots. Robotic kinematics is reviewed by analyzing the motion of the robot. The dynamics is reviewed by analyzing the relation between the joint actuator torques and resulting motion.
- Credits: 3.0
- Lec-Rec-Lab: (0-2-3)
- Semesters Offered: Fall
- Pre-Requisite(s): MET3130

**Topic 2: Controls of Industrial Systems**

EE 4262 Digital and Non-Linear Control

- Introduction to state space analysis and design (state feedback, observers, and observer feedback); digital control system design and analysis (Z-transforms, difference equations, the discrete-time state model, and digital implementation of controllers); introduction to nonlinear systems (equilibrium states, linearization, phase plane analysis, and describing function analysis); and experiments with physical systems.
- Credits: 3.0
- Lec-Rec-Lab: (2-0-2)

Proposal 30-19

March 27, 2019
EE/MEEM 5750 Model-Based Embedded Control System Design

- This course introduces embedded control system design using model-based approach. Course topics include model-based embedded control system design, discrete-event control, sensors, actuators, electronic control unit, digital controller design, and communications protocols. Prior knowledge of hybrid electric vehicles is highly recommended.
- Credits: 3.0
- Lec-Rec-Lab: (0-2-2)
- Semesters Offered: Spring
- Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following College(s): College of Engineering; Must be enrolled in one of the following Major(s): Mechanical Engineering, Mechanical Eng-Eng Mechanics, Engineering Mechanics
- Pre-Requisite(s): EE 3261

MEEM 4775 Analysis and Design of Feedback Control Systems

- This course covers topics of control systems design. Course includes a review for modeling of dynamical systems, stability, and root locus design. Also covers control systems design in the frequency domain, fundamentals of digital control and nonlinear systems.
- Credits: 4.0
- Lec-Rec-Lab: (0-3-2)
- Semesters Offered: Fall
- Restrictions: Must be enrolled in one of the following Major(s): Mechanical Engineering, Mechanical Eng-Eng Mechanics, Engineering Mechanics
- Pre-Requisite(s): MEEM 3750

EET 5311 Advanced Circuits and Controls

- Graduate-level students are expected to demonstrate ability in modeling/simulation techniques of linear systems. Topics include: Fourier and Laplace transforms, signal comparison techniques and transfer functions. Control techniques addressed will include feedback, cascade, feedforward, multivariable and model-based methods.
- Credits: 4.0
- Lec-Rec-Lab: (0-3-3) Semesters Offered: Fall
- Restrictions: Must be enrolled in one of the following Level(s): Graduate Pre-Requisite(s): EET 3131 or EET 4253

MET 5801 Controls of Dynamic Systems

- This course covers the modeling, analysis, and control of dynamic systems. It uses the controlling equations for the control of mechanical and electrical systems. Theory is verified with simulation and lab testing.
- Credits: 3.0
- Lec-Rec-Lab: (0-2-3)
- Semesters Offered: Spring
- Pre-Requisite(s): MET4800
MET 5802 Vibrations of Mechanical Systems

- This course deals with the modeling and analysis of mixed physical systems. Introduction to modeling and oscillatory response analysis for discrete and continuous mechanical and structural systems. Time and frequency domain analysis of linear system vibrations. Vibration of multi-degree-of-freedom systems. Free vibration eigenvalue problem. Un-damped system response and viscously damped systems. Vibration of continuous systems with modes of vibration.
- Credits: 3.0
- Lec-Rec-Lab: (0-2-3)
- Semesters Offered: Fall
- Pre-Requisite(s): MET2130

**Topic 3: Signal Processing of Electromechanical Systems**

EE 4252 Digital Signal Processing and Applications

- Digital signal processing techniques with emphasis on applications. Includes sampling, the Z-transform, digital filters and discrete Fourier transforms. Emphasizes techniques for design and analysis of digital filters. Special topics may include the FFT, windowing techniques, quantization effects, physical limitations, image processing basics, image enhancement, image restoration and image coding.
- Credits: 3.0
- Lec-Rec-Lab: (3-0-0)
- Semesters Offered: Fall
- Co-Requisite(s): EE 4259
- Pre-Requisite(s): EE 3160

EET 5142/4142 Digital Signal and Image Processing

- Provides students with digital signal and image processing techniques with emphasis on applications. Covers concepts of sampling, digital filters and discrete Fourier transforms, image processing, enhancement, and restoration. The course requires proposing, executing and defending the graduate level, and related to the course material, project.
- Credits: 4.0
- Lec-Rec-Lab: (0-3-3) Semesters Offered: Spring
- Restrictions: Must be enrolled in one of the following Level(s): Graduate Pre-Requisite(s): EET 4311 or EET 3367 and EET 4141

MEEM 5700 Dynamic Measurements/Signal Analysis

- Assessment of measurement system requirements: transducers, conditioners, and displays of dynamic measurements. Time-, frequency-, probabilistic-, and correlative-domain approaches to dynamic signal analysis: sampled data, discrete Fourier transforms, digital filtering, estimation errors, system identification, calibration, recording. Introduction to wavelet analysis. All concepts reinforced in laboratory and simulation exercises.
- Credits: 4.0
- Lec-Rec-Lab: (0-3-3)
- Semesters Offered: Fall, Summer
• Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following College(s): College of Engineering

**Topic 4: Cyber Security of Industrial Processes**

EE 4723 Network Security

- Learn fundamental of cryptography and its application to network security. Understand network security threats, security services, and countermeasures. Acquire background knowledge on well-known network security protocols. Address open research issues in network security.
- Credits: 3.0
- Lec-Rec-Lab: (3-0-0)
- Semesters Offered: Fall, Spring
- Pre-Requisite(s): EE 4272 or CS 4461

EE 5455/MEEM 5300 Cybersecurity of Industrial Control Systems

- General introduction to cybersecurity of industrial control systems and critical infrastructures. Topics include NIST and DHS publications, threat analysis, vulnerability analysis, red teaming, intrusion detection systems, industrial networks, industrial malware, and selected case studies.
- Credits: 3.0
- Lec-Rec-Lab: (0-3-0)
- Semesters Offered: On Demand
- Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Mechanical Engineering, Mechanical Eng-Eng Mechanics, Engineering Mechanics
- Pre-Requisite(s): MEEM 4700 or MEEM 4775 or EE 3261 or EET4311

MEEM 5315 Cyber Security of Auto Systems

- Modern automotive control and communications systems from a cyber-security perspective. Topics include: V2X communications, vehicle attack surfaces and vulnerabilities, in-vehicle networks, threat analysis and vulnerabilities, security mechanisms and architectures, security requirements analysis, hardware security modules, and standards.
- Credits: 3.0
- Lec-Rec-Lab: (0-3-0)
- Semesters Offered: Spring
- Prerequisite: MEEM5300
- Restrictions: Graduate Student in EME, MEEM, EEE, ECP, or CSS

SAT 3812 Cybersecurity I

- The evolution of information security into cybersecurity and its relationship to nations, organizations, society, and individuals. Exposure to multiple cybersecurity technologies, processes, and procedures; analyzing threats, vulnerabilities and risks present; and developing appropriate strategies to mitigate potential cybersecurity issues. Applied lab to develop cybersecurity offensive attributes and learn how to prevent and/or mitigate threats.
- Credits: 3.0
- Lec-Rec-Lab: (0-2-2)
• Semesters Offered: Fall, Summer  
• Restrictions: Must be enrolled in one of the following Class(es): Junior, Senior  
• Pre-Requisite(s): SAT 1200 or CS 1111 or CS 1121 or CS 1131 or CS 1142 or MIS 2100 or EET 2241

**Internship Course**

EET5995

• Empirical experiences in an approved internship site. Provides practical experience in one or more work settings, assisting the upper level student in making an appropriate career choice. Internships must be approved by the department internship coordinator and work minimum of 150 hours for each credit earned.

• Credits: variable up to 3; Repeatable to a Max of 6  
• Semesters Offered: Fall, Spring, Summer  
• Restrictions: Permission of department required; Must be enrolled in one of the following Major(s): MS Degree in Mechatronics  
• Pre-Requisite(s): None

**Industry-Driven Curriculum**

As can be seen from the industry survey responses, there is high demand for graduates with an advanced degree in Mechatronics. Technology evolves every day, and industry is a first responder to these changes. This rapid evolution should be frequently reflected in the curriculum by updating course topics to leverage current technologies. Due to the interdisciplinary nature and hands-on approach of the Mechatronics field of study, it is crucially important that we as an educational institution seek feedback from industry. The EET, ECE, MET, ME-EM and Computer Network and System Administration (CNSA) programs at Michigan Tech already have Industrial Advisory Boards (IABs) that provide continuous feedback for the undergraduate curriculum. One of the program goals is to form an IAB for the new Master of Science degree in Mechatronics. The task force committee for the proposed Mechatronics degree has already identified and received commitments from the following leading automotive and automation corporations: Tesla, Ford, General Motors, Fanuc Robotics, and Kaufman Engineered Systems.

Tesla, the leading automotive company in the production of advanced electrical vehicles, has identified an urgent need for mechatronics specialists with a controls background. Tesla has committed to collaborate with Michigan Tech in the advanced mechatronics curriculum development by being part of the new IAB mechatronics committee and advising on emerging changes in technology. Tesla has also expressed an interest in hiring future highly qualified mechatronics graduates prepared by this new MS degree program.

Fanuc Robotics is a leading industrial robot manufacturing company in the U.S and abroad. Fanuc is represented in 5 continents and > 22 countries with more than 100,000 robots installed in the US and 250,000 robots worldwide. The extensive presence of Fanuc robots in industry requires well-trained and certified specialists with a mechatronics background. Fanuc has a long record of commitment of positively impacting undergraduate education at Michigan Tech and has committed to act on the new IAB for the mechatronics degree by advising on curriculum development and modifications in order to stay tuned
with current industry needs. Fanuc has a strong record of hiring Michigan Tech students and has expressed an even stronger interest for graduates with an advanced mechatronics degree.

Kaufman Engineered Systems (KES), is the largest in the U.S. integrator of Fanuc robotics solutions. For over 70 years, KES has been a pioneer in complete line automation. The company has a reputation for single-source convenience, responsive service, and unmatched equipment performance. KES has been a long proponent of Michigan Tech. They have demonstrated continuous support for the undergraduate robotic curriculum development in the EET program. KES has expressed a significant demand for mechatronics specialists with skills that are current and relevant to industry needs. KES has committed to serve on the Mechatronics IAB committee to promote the program and advise on curriculum development.

The Ford Motor Company has deep roots of collaboration with Michigan Tech. The relationship started in 1930 when Henry Ford developed Alberta village, where he established one of his sawmills. For many decades, Ford has supported Michigan Tech’s mission of providing the best possible educational practices for students. Ford’s engagement with Michigan Tech ranges from providing internships and full-time employment opportunities, sponsoring traditional and applied research, sponsoring and advising senior design and Enterprise projects, to supporting summer youth programs for middle and high school students. Ford has expressed a strong interest in the proposed Master’s Degree in Mechatronics, since mechatronics specialists are the best-fit engineers for the automotive sector. Not only has Ford committed to be an active member of the Mechatronics IAB, it has also expressed a solid commitment to interviewing and hiring Mechatronics program graduates.

The partnership between General Motors (GM) and Michigan Tech is called “Made for More.” Michigan Tech and General Motors share a long-standing partnership dating back to at least 1940, supporting a wide range of activities across campus including scholarships, Senior Design and Enterprise programs, student organizations, sponsored research, recruiting support, youth programs, diversity initiatives, and more. GM is excited about a new program in Mechatronics and an opportunity to have access to the pool of highly qualified graduates. GM has agreed to collaborate with Michigan Tech by serving as an external advisor, as part of the newly formed IAB, and to provide valuable industrial feedback on the Mechatronics curriculum development.

In addition to these committed corporations who will serve on the new IAB for the Master’s Degree in Mechatronics, we will also solicit additional feedback from the companies that are already part of our existing IABs for the related undergraduate programs.

7. COURSE DESCRIPTIONS

The actual program of study for each student will be developed in consultation with an advisor and will be based on individual educational goals. Table 2 provides an overview of the schedule of course offerings and the associated instructors. Each of the courses, with the exception of Special Topics, are offered annually with some of the courses being offered in each semester and during summer Tracks A and B. The teaching load for participating faculty members is based on two courses per semester, including current undergraduate teaching assignments. Summer courses will be offered for additional compensation and according to Michigan Tech policies.
## Table 2: Schedule of Course Offerings

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Pre-requisites</th>
<th>Credits</th>
<th>Fall</th>
<th>Spring</th>
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<tbody>
<tr>
<td>EET 5144 Real-Time Robotics Systems</td>
<td>EET1411 or EET2220 or PH2230 or EE2110 or EE 3010 or MEEM 3750 or MEEM4705</td>
<td>4</td>
<td>Sergeyev</td>
<td>Sergeyev</td>
</tr>
<tr>
<td>EET 5147 Industrial Robotic Vision Systems and Advanced Teach Pendant Programming</td>
<td>EET4144</td>
<td>4</td>
<td>Sergeyev</td>
<td>Sergeyev</td>
</tr>
<tr>
<td>EET 5373 Advanced PLC</td>
<td>EET3373</td>
<td>3</td>
<td>Hamouz</td>
<td>Hamouz</td>
</tr>
<tr>
<td>EET 5311 Advanced Circuits and Controls</td>
<td>EET3131 or EET4253</td>
<td>4</td>
<td>Hazaveh</td>
<td></td>
</tr>
<tr>
<td>EET 5142 Digital Signal and Image Processing <em>(new course)</em></td>
<td>EET5311 or EET3367 and EET4141</td>
<td>4</td>
<td></td>
<td>TBD</td>
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<tr>
<td>EET5995 <em>(new course)</em></td>
<td>None</td>
<td>Up to 6</td>
<td>Sergeyev</td>
<td>Sergeyev</td>
</tr>
<tr>
<td>EET5400 Industrial Safety <em>(new course)</em></td>
<td>None</td>
<td>1</td>
<td>TBD</td>
<td>TBD</td>
</tr>
<tr>
<td>MET 5800 Dynamics and Kinematics of Robotics Platforms <em>(new course)</em></td>
<td>MET2130</td>
<td>3</td>
<td>Labyak</td>
<td></td>
</tr>
<tr>
<td>MET 5801 Controls of Dynamic Systems <em>(new course)</em></td>
<td>MET5800/4800</td>
<td>3</td>
<td>Labyak</td>
<td></td>
</tr>
<tr>
<td>MET 5802 Vibrations of Mechanical Systems <em>(new course)</em></td>
<td>MET2130</td>
<td>3</td>
<td>Labyak</td>
<td></td>
</tr>
<tr>
<td>MET5378 Electrohydraulic Components and Systems <em>(new course)</em></td>
<td>MET4377</td>
<td>3</td>
<td>Johnson</td>
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<tr>
<td>MEEM 4775 Analysis and Design of Feedback Control Systems</td>
<td>MEEM 3750</td>
<td>4</td>
<td>Parker</td>
<td></td>
</tr>
<tr>
<td>MEEM 5705 Introduction to Robotics and Mechatronics</td>
<td>MEEM 4775</td>
<td>4</td>
<td>Sun</td>
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</tr>
<tr>
<td>ECE/MEEM 5750 Model-Based Embedded Control System Design</td>
<td>MEEM 4775</td>
<td>3</td>
<td>Chen</td>
<td></td>
</tr>
<tr>
<td>MEEM 5700 Dynamic Measurements/Signal Analysis</td>
<td>Enroll in Col. Of Eng.</td>
<td>4</td>
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<td></td>
</tr>
<tr>
<td>ECE 5455/MEEM 5300 Cybersecurity of Industrial Control Systems</td>
<td>MEEM 4775 or EE 3261</td>
<td>3</td>
<td>Goldsmith</td>
<td>Goldsmith</td>
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<tr>
<td>MEEM 5310 Cyber Security of Auto Systems</td>
<td>Graduate Student in EME, MEEM, EEE, ECP, or CSS</td>
<td>3</td>
<td>Goldsmith</td>
<td></td>
</tr>
</tbody>
</table>
8. LIBRARY AND OTHER LEARNING RESOURCES

Students will have access to all Library resources, Michigan Tech subscription based IEEEXplorer digital database, interlibrary loans, and degree specific subscription-based journals and conference proceedings.

Since this Master of Science Degree in Mechatronics builds from foundations in EET, MET, ME-EM, and ECE, additional library and learning resources are expected to be minimal.

9. ADDITIONAL FEES

A university online learning fee of $38/per credit will be required for on-line courses. Laboratory courses are expected to have $50 lab fees and will be adjusted in the future as usage and infrastructure needs are better understood.

10. FACULTY RESUMES

Key faculty members for this graduate program are listed below:

**Graduate Program Director in Mechatronics: Dr. Sergeyev,**
[https://www.mtu.edu/technology/about/faculty/sergeyev/index.html](https://www.mtu.edu/technology/about/faculty/sergeyev/index.html)

Dr. Hamouz, [http://www.mtu.edu/technology/about/faculty/](http://www.mtu.edu/technology/about/faculty/)

Dr. Hazaveh, [http://www.mtu.edu/technology/about/faculty/](http://www.mtu.edu/technology/about/faculty/)

Dr. Labyak, [http://www.mtu.edu/technology/about/faculty/](http://www.mtu.edu/technology/about/faculty/)

Mr. Johnson, [http://www.mtu.edu/technology/about/faculty/](http://www.mtu.edu/technology/about/faculty/)

Dr. Parker, [https://www.mtu.edu/mechanical/people/faculty/parker/](https://www.mtu.edu/mechanical/people/faculty/parker/)

Dr. Ye Sun [https://www.mtu.edu/mechanical/people/faculty/sun/index.html](https://www.mtu.edu/mechanical/people/faculty/sun/index.html)

Dr. Chen, [https://www.mtu.edu/mechanical/people/faculty/chen/](https://www.mtu.edu/mechanical/people/faculty/chen/)

Dr. Coldsmith, [https://www.mtu.edu/mechanical/people/scholars-instructors/goldsmith/index.html](https://www.mtu.edu/mechanical/people/scholars-instructors/goldsmith/index.html)
Key staff members for this graduate program are listed below

**Keypath Lead:** Dean, SoT: Dr. Minerick, [https://www.mtu.edu/technology/about/staff/minerick/](https://www.mtu.edu/technology/about/staff/minerick/)

MEEM Department Chair: Dr. Predebon, [https://www.mtu.edu/mechanical/people/faculty/predebon/index.html](https://www.mtu.edu/mechanical/people/faculty/predebon/index.html)

ECE Department Chair: Dr. Fuhrmann, [https://www.mtu.edu/ece/department/faculty/fulltime/fuhrmann/index.html](https://www.mtu.edu/ece/department/faculty/fulltime/fuhrmann/index.html)

ECE Academic Advisors: Hassell, P.E. and J. Donahue, [https://www.mtu.edu/ece/department/staff/](https://www.mtu.edu/ece/department/staff/)

SoT Academic Advisor: D. Jarvey, [https://www.mtu.edu/technology/resources/undergraduate/advising/](https://www.mtu.edu/technology/resources/undergraduate/advising/)

MEEM Academic Advisors: T. Stein and R. Towles, [https://www.mtu.edu/mechanical/people/staff/](https://www.mtu.edu/mechanical/people/staff/)

11. **DESCRIPTION OF EQUIPMENT**

The School of Technology, ECE and ME departments are well equipped with various laboratory and research instruments to deliver the proposed courses. Some of the equipment and lab resources sharing between EET and ECE as well as ME and MET programs are expected upon mutual agreement. The two courses, Advanced PLC Programming and Real-Time Robotics required for all majors, will be taught in the School of Technology using state-of-the-art laboratory equipment. The SoT robotics lab is equipped with four FANUC LR-Mate 200iC industrial robots retrofitted with advanced FANUC vision system: three of the robots have been assembled as an industrial robotic workcell, shown in Figure 6, and incorporated with the conveyor, various sensors and actuators. The individual control of the robots can be achieved via manual mode utilizing teach pendants. The production mode of all three robots is accomplished via PLC as a master controller and initializing handshaking protocol between the robots. The forth robot is incorporated with four mechatronics stations, Shown in Figure 7.
Each mechatronics station is equipped with Allen Bradley ControlLogix PLC enabling individual control for the station’s components, as well as handshaking control between all the stations while acting as an assembly line. The SoT PLC lab, shared with ECE department, is equipped with nine the latest Amatrol 990PAB53 Portable PLC Learning Systems, shown in Figure 8 (a) and one process control system, shown in Figure 8 (b).

This equipment allows teaching modern PLC systems as they are used in the industry today. Students learn both basic and advanced applications using the powerful Allen Bradley Compact Logix 5300 PLC, a Panel View Plus terminal, and networks throughout the curriculum. The 990PAB53 System comes with a mobile carrying case, workstation mounting panel, master control relay circuit, Allen Bradley Compact Logix 5300 Programmable Controller, RS Linx and RS Logix 5000 software, a Panel View Plus terminal, an Ethernet Switch, I/O Simulator, five application circuits. Learners will study industry relevant skills, including how to operate and program PLC systems for a wide range of real-world applications. The 990PAB53 Learning System enhances learning by featuring a wide array of real-world applications to allow students to actually see their programs control real systems. In addition to a discrete I/O simulator with discrete switches and indicators, the 990PAB53 includes application circuits and components for thermostatic temperature control, analog temperature control, reversing constant speed motor control, variable speed motor control with feedback, and stepper motor homing and commissioning. These circuits include basic and advanced applications starting with discrete I/O projects and extending to projects involving analog I/O. In addition to all the features mentioned above, the portable
system has outstanding capabilities of fault insertion of software and hardware levels and features 35+
electrical faults. The fault insertion capability provides students with unique, real world like opportunity
to troubleshoot the industrial equipment in academic settings.

Availability of the state-of-the-art industrial equipment are important to enable the teaching of critical
skills that are very relevant to current industry needs. Currently, laboratory equipment associated with
teaching introductory and advance concepts of Programmable Logic Controllers is adequate for a class of
50 students with three laboratory sections. Robotics equipment that is used in Real-Time Robotics and
Robotic Vision courses can accommodate a class of 36 students with three laboratory sections. Upon the
growth of the program enrollment and subject to available profit, additional equipment will be acquired
to support larger classes and provide valuable hands-on training with adequate equipment to student’s
ratio. The Dean of the School of Technology is currently communicating with potential industrial partners,
donors, and friends to bolster the equipment availability.

### 12. PROGRAM COSTS

<table>
<thead>
<tr>
<th>PROGRAM REVENUE</th>
<th>Year</th>
<th>Year</th>
<th>Year</th>
<th>Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enrollment (MS students)</td>
<td>25</td>
<td>30</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>Tuition revenue (MS students-15 credits/year at $1,143/credit)</td>
<td>$428,625</td>
<td>$514,350</td>
<td>$685,800</td>
<td>$857,250</td>
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<tr>
<td>Tuition revenue (@ 6 certification courses/year/ minimum 3 students in the course with 20% increase every year)</td>
<td>$27,000</td>
<td>$32,400</td>
<td>$38,880</td>
<td>$46,656</td>
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<tr>
<td>Total tuition revenue</td>
<td>$455,625</td>
<td>$546,750</td>
<td>$724,680</td>
<td>$818,181</td>
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</table>

### ADDITIONAL PROGRAM EXPENSES

<table>
<thead>
<tr>
<th>Expense Description</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program Director (in addition to the faculty salary)</td>
<td>$9,000</td>
<td>$9,360</td>
<td>$9,734</td>
<td>$10,124</td>
</tr>
<tr>
<td>Professor of Practice /Assistant Professor for EET Yr 1 and MET Yr 2. Subject to enrollment</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Salary ($75,000, startup $100,000)</td>
<td>$175,000</td>
<td>$253,750</td>
<td>$161,438</td>
<td>$169,510</td>
</tr>
<tr>
<td>Graduate Assistantships (3 GTAs or GRAs/year) at $33,141/student increased by 4% per year.</td>
<td>$99,423</td>
<td>$103,400</td>
<td>$107,536</td>
<td>$111,837</td>
</tr>
<tr>
<td>Total annual expenses</td>
<td>$283,423</td>
<td>$366,510</td>
<td>$278,708</td>
<td>$291,471</td>
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</table>

### REVENUE – EXPENSES

<table>
<thead>
<tr>
<th></th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>REVENUE – EXPENSES</td>
<td>$172,202</td>
<td>$180,240</td>
<td>$445,972</td>
<td>$526,710</td>
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</tbody>
</table>

### One-time Startup Costs:

<table>
<thead>
<tr>
<th>Expense Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marketing &amp; Recruiting</td>
<td>$10,000</td>
</tr>
</tbody>
</table>
Courses development $48,000
Total One Time Costs: $58,000

The anticipated revenue and expenses, based on projected enrollment for the first four years, are presented below. Enrollment is expected to reach steady-state by year four. Non-degree seeking students are individuals who are registered to take courses, possibly to obtain their Robotic certificates, but are not enrolled in the Mechatronics Graduate program.

Note: Upon the growth in enrollment, additional laboratory equipment will be acquired to adequately support larger classes. The first priority for the laboratory expansion will be given to Fanuc Industrial Robots, mechatronics and PLC training stations. The revenue funds will be used for additional laboratory acquisition.

13. SPACE

The School of Technology has graduate offices located in EERC #228 (seats approximately 8 graduate students). Additional office space for graduate students will be required. Faculty offices and one research lab has also been secured in the EERC.

Lab repurposing involves ongoing coordination between the School of Technology and the Department of Electrical and Computer Engineering. Currently, EERC 418 is undergoing renovations and plans are underway for this to be used for undergraduate EET and ECE students as well as assist with Master’s in Mechatronics training. Collaborative research space with ECE as well as ME-EM will be needed for the research projects and will progress via faculty advisor need-based decisions.

14. POLICIES, REGULATIONS AND RULES

Admission Requirements: This graduate program is open to excellent candidates who a bachelor’s degree with sufficient technical and engineering related backgrounds. We anticipate our graduate student population to have undergraduate degrees in technical areas of electrical engineering technology, electrical and computer engineering, mechanical engineering-engineering mechanics, and mechanical engineering technology. Graduate applications will be reviewed following Graduate School policies.

15. RECOMMENDED TEST SCORES FOR ADMISSION ARE AS FOLLOWS:

Bachelor’s degree-seeking students with GPAs above 3.0 will be encouraged into the program.

These scores serve as general guidelines for admission. The Admissions Committee, in making its final decision, will consider the combination of professional knowledge, academic excellence, letters of recommendation, and the Student statements.

16. ACCREDITATION REQUIREMENTS

No Professional Accreditation is required
17. **INTERNAL STATUS OF THE PROPOSAL**

Approved by: Dean’s Council  
Date: (needed in Nov 2018)

Approved by: Graduate Faculty Council  
Date: (needed by February 2019)

Approved by: University Senate (Curriculum Policy Committee)  
Date: (needed by March 2019)

18. **PLANNED IMPLEMENTATION DATE**

Deployment of the first courses is expected in fall semester of 2019. This is possible because the proposed degree program relies heavily upon existing courses. Please refer back to Table 2 on pages 17 and 18 for details.
## Appendix A: Master and Major Specific Degree Plans

<table>
<thead>
<tr>
<th>Fall</th>
<th>Spring</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>EET 5144 Real-Time Robotics Systems</td>
<td>EET 5373 Advanced PLC</td>
<td>EET 5144 Real-Time Robotics Systems</td>
<td>EET 5373 Advanced PLC</td>
</tr>
<tr>
<td>EET 4311 Advanced Circuits and Controls</td>
<td>EET 5147 Robotic Vision Systems</td>
<td>EET 4311 Advanced Circuits and Controls</td>
<td>EET 5147 Robotic Vision Systems</td>
</tr>
<tr>
<td>MET 5800 Dynamics and Kinematics of Robotics Platforms</td>
<td>MET 5800 Dynamics and Kinematics of Robotics Platforms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MET 5801 Controls of Dynamic Systems</td>
<td>MET 5801 Controls of Dynamic Systems</td>
<td>MET 5801 Controls of Dynamic Systems</td>
<td>MET 5801 Controls of Dynamic Systems</td>
</tr>
<tr>
<td>MET 5802 Vibrations of Mechanical Systems</td>
<td>MET 5802 Vibrations of Mechanical Systems</td>
<td>MET 5802 Vibrations of Mechanical Systems</td>
<td>MET 5802 Vibrations of Mechanical Systems</td>
</tr>
<tr>
<td>MET4378 Electrohydraulic Components and Systems</td>
<td>MET4378 Electrohydraulic Components and Systems</td>
<td>MET4378 Electrohydraulic Components and Systems</td>
<td>MET4378 Electrohydraulic Components and Systems</td>
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<tr>
<td>MEEM 5475 Introduction to Robotics</td>
<td>EE 4262 Digital and Non-Linear Control</td>
<td>MEEM 5475 Introduction to Robotics</td>
<td>EE 4262 Digital and Non-Linear Control</td>
</tr>
<tr>
<td>EE 4252 Digital Signal Processing and Applications</td>
<td>Research EET/EE/MET 5990 MEEM 5999</td>
<td>EE 4252 Digital Signal Processing and Applications</td>
<td>Research EET/EE/MET 5990 MEEM 5999</td>
</tr>
<tr>
<td>EE 4723 Network Security</td>
<td>Internship EET 5995</td>
<td>EE 4723 Network Security</td>
<td>Internship EET 5995</td>
</tr>
<tr>
<td>SAT 3812 Cyber Security I</td>
<td>Internship EET 5995</td>
<td>SAT 3812 Cyber Security I</td>
<td>Internship EET 5995</td>
</tr>
</tbody>
</table>

Master’s Degree in Mechatronics cross-disciplinary flowchart
EET Degree Example Flowchart: Coursework Option

**Fall**
- SAT 3812 Cyber Security I
- EET 5144 Real-Time Robotics Systems
- MET 3130 Statics and Dynamics

**Spring**
- EET 5373 Advanced PLC
- EET 5142 Digital Signal and Image Proc.
- EET 5990 Research Credits
- 5000/4000 Elective

**Fall**
- EET 5111 Advanced Circuits and Controls
- MET 5800 Dynamics and Kinematics of Robotic Platforms

**Spring**
- EET 5147 Robotic Vision Systems

---

EET Degree Example Flowchart: Thesis/Report Options

**Fall**
- EET 5144 Real-Time Robotics Systems
- MET 3130 Statics and Dynamics
- EET 5990 Research Credits

**Spring**
- EET 5373 Advanced PLC
- MET 5800 Dynamics and Kinematics of Robotic Platforms
- EET 5990 Research Credits

**Fall**
- SAT 3812 Cyber Security I
- EET 5990 Research Credits

**Spring**
- EET 5147 Robotic Vision Systems
- EET 5142 Digital Signal and Image Proc.
- EET 5990 Research Credits

---

EET Degree Example Flowchart: Coursework with Internship Path

**Fall**
- SAT 3812 Cyber Security I
- EET 5144 Real-Time Robotics Systems
- MET 3130 Statics and Dynamics

**Spring**
- EET 5373 Advanced PLC
- MET 5800 Dynamics and Kinematics of Robotic Platforms
- EET 5990 Research Credits

**Fall**
- Internship EET 5995

**Spring**
- EET 5147 Robotic Vision Systems
- EET 5142 Digital Signal and Image Proc.
### MET Degree Example Flowchart: Coursework Option

<table>
<thead>
<tr>
<th>Fall</th>
<th>Spring</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>EET 5311 Advanced Circuits and Controls</td>
<td>EET 5142 Digital Signal and Image Proc.</td>
<td>MET 5801 Controls of Dynamic Systems</td>
<td>SAT 3812 Cyber Security I</td>
</tr>
<tr>
<td>MET4378 Elective Service Course</td>
<td>MET 5800 Dynamics and Kinematics of Robotic Platforms</td>
<td>MET 5802 Vibrations of Mechanical Systems</td>
<td>MET 5802 Vibrations of Mechanical Systems</td>
</tr>
<tr>
<td>EET 5147 Robotic Vision Systems</td>
<td>EET 5147 Robotic Vision Systems</td>
<td>MET 5990 Research Credits</td>
<td>EET 5995</td>
</tr>
</tbody>
</table>

### MET Degree Example Flowchart: Thesis/Report Options

<table>
<thead>
<tr>
<th>Fall</th>
<th>Spring</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>EET 5311 Advanced Circuits and Controls</td>
<td>EET 5142 Digital Signal and Image Proc.</td>
<td>MET 5801 Controls of Dynamic Systems</td>
<td>SAT 3812 Cyber Security I</td>
</tr>
<tr>
<td>EET 5373 Elective Service Course</td>
<td>MET 5800 Dynamics and Kinematics of Robotic Platforms</td>
<td>EET 5990 Research Credits</td>
<td>MET 5990 Research Credits</td>
</tr>
<tr>
<td>MET 5990 Research Credits</td>
<td>MET 5990 Research Credits</td>
<td>MET 5990 Research Credits</td>
<td>EET 5995</td>
</tr>
</tbody>
</table>

### MET Degree Example Flowchart: Coursework with Internship Path

<table>
<thead>
<tr>
<th>Fall</th>
<th>Spring</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>EET 5311 Advanced Circuits and Controls</td>
<td>EET 5142 Digital Signal and Image Proc.</td>
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<td>SAT 3812 Cyber Security I</td>
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<tr>
<td>EET 5373 Elective Service Course</td>
<td>MET 5800 Dynamics and Kinematics of Robotic Platforms</td>
<td>EET 5990 Research Credits</td>
<td>MET 5990 Research Credits</td>
</tr>
<tr>
<td>MET 5990 Research Credits</td>
<td>MET 5990 Research Credits</td>
<td>MET 5990 Research Credits</td>
<td>EET 5995</td>
</tr>
</tbody>
</table>
MEEM Degree Example Flowchart: Coursework

<table>
<thead>
<tr>
<th>Fall</th>
<th>Spring</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>EET 5144 Real-Time</td>
<td>EET 5373 Advanced PLC</td>
<td>ECE 5455/MEEM 5300 Cybersecurity of Industrial Control Systems</td>
<td>5000 Elective</td>
</tr>
<tr>
<td>Robotics Systems</td>
<td>EET 5147 Robotic Vision</td>
<td></td>
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<tr>
<td>Systems</td>
<td></td>
<td>MEEM 5700 Dynamic Measurements/Signal Analysis</td>
<td>5000 Elective</td>
</tr>
<tr>
<td>MEEM 4775 Analysis and</td>
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<td></td>
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<tr>
<td>Design of Feedback Control</td>
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<tr>
<td>Systems</td>
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<tr>
<td>MEEM 5705 Introduction to</td>
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<td>Robotics and Mechatronics</td>
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<tr>
<td>Research</td>
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<tr>
<td>MEEM 5999</td>
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MEEM Degree Example Flowchart: Thesis/Report Options

<table>
<thead>
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<th>Fall</th>
<th>Spring</th>
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<tbody>
<tr>
<td>MEEM 4775 Analysis and</td>
<td></td>
<td>ECE 5455/MEEM 5300 Cybersecurity of Industrial Control Systems</td>
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<td>Design of Feedback Control</td>
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<tr>
<td>MEEM 5999</td>
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</table>

MEEM Degree Example Flowchart: Coursework with Internship Path

<table>
<thead>
<tr>
<th>Fall</th>
<th>Spring</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>EET 5144 Real-Time</td>
<td>EET 5373 Advanced PLC</td>
<td>ECE 5455/MEEM 5300 Cybersecurity of Industrial Control Systems</td>
<td></td>
</tr>
<tr>
<td>Robotics Systems</td>
<td>EET 5147 Robotic Vision</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MEEM 4775 Analysis and</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design of Feedback Control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MEEM 5705 Introduction to</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Robotics and Mechatronics</td>
<td></td>
<td></td>
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<tr>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
EE Degree Example Flowchart: Coursework Option

<table>
<thead>
<tr>
<th>Fall</th>
<th>Spring</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAT 3812 Cyber Security I</td>
<td>EET 5373 Advanced PLC</td>
<td>EET 5144 Real-Time Robotics Systems</td>
<td>EET 5147 Robotic Vision Systems</td>
</tr>
<tr>
<td>EE 4252 Digital Signal Processing and Applications</td>
<td>ECE 4262 Digital and Non-Linear Control</td>
<td>ECE 4262 Digital and Non-Linear Control</td>
<td>4000+ Elective</td>
</tr>
<tr>
<td>MET 5800 Dynamics and Kinematics of Robotic Platforms</td>
<td>EE 5590 Research Credits</td>
<td>MET 5800 Dynamics and Kinematics of Robotic Platforms</td>
<td>EE 5590 Research Credits</td>
</tr>
<tr>
<td>4000+ Elective</td>
<td>EET 5147 Robotic Vision Systems</td>
<td>5000 Elective</td>
<td>EE 5374 Elective (Service Course)</td>
</tr>
</tbody>
</table>

EE Degree Example Flowchart: Thesis/Report Options

<table>
<thead>
<tr>
<th>Fall</th>
<th>Spring</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAT 3812 Cyber Security I</td>
<td>EET 5373 Advanced PLC</td>
<td>EET 5144 Real-Time Robotics Systems</td>
<td>EET 5147/4147 Robotic Vision Systems</td>
</tr>
<tr>
<td>EE 4252 Digital Signal Processing and Applications</td>
<td>ECE 4262 Digital and Non-Linear Control</td>
<td>ECE 4262 Digital and Non-Linear Control</td>
<td>4000+ Elective</td>
</tr>
<tr>
<td>MET 5800 Dynamics and Kinematics of Robotic Platforms</td>
<td>EE 5590 Research Credits</td>
<td>MET 5800 Dynamics and Kinematics of Robotic Platforms</td>
<td>EE 5590 Research Credits</td>
</tr>
<tr>
<td>EE 5590 Research Credits</td>
<td></td>
<td>EE 5590 Research Credits</td>
<td></td>
</tr>
</tbody>
</table>

EE Degree Example Flowchart: Coursework with Internship Path

<table>
<thead>
<tr>
<th>Fall</th>
<th>Spring</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAT 3812 Cyber Security I</td>
<td>EET 5373 Advanced PLC</td>
<td>EET 5144 Real-Time Robotics Systems</td>
<td>EET 5147 Robotic Vision Systems</td>
</tr>
<tr>
<td>ECE 4252 Digital Signal Processing and Applications</td>
<td>ECE 4262 Digital and Non-Linear Control</td>
<td>ECE 4262 Digital and Non-Linear Control</td>
<td>4000+ Elective</td>
</tr>
<tr>
<td>4000+ Elective</td>
<td>EET 5147 Robotic Vision Systems</td>
<td>5000 Elective</td>
<td>MET 5800 Dynamics and Kinematics of Robotic Platforms</td>
</tr>
</tbody>
</table>

Note: EETS400 Industrial Safety course can be offered on demand.
Number of research credits can be adjusted to account for either Report or Thesis option.
V-I. PROPOSAL FOR A BACHELOR'S OF SCIENCE IN CYBERSECURITY DEGREE

The faculty of the School of Technology at Michigan Technological University seek to establish a Bachelor's of Science (BS) degree program in Cybersecurity. This interdisciplinary degree is a joint effort of the Computer Network and System Administration (CNSA) Program in the School of Technology, the Department of Computer Science (CS) in the College of Sciences and Arts, and the Department of Electrical and Computer Engineering (ECE) in the College of Engineering. The new degree is strategically designed to build on the strengths of existing computing programs on campus and produce well-rounded students with strong theoretical and practical skills.

The new degree offers Michigan Tech students the opportunity to gain cutting-edge cybersecurity knowledge and skills with a solid theoretical foundation as well as a good understanding of the social, ethical, legal, and policy aspects of cybersecurity. Students learn to design and develop trusted software systems by adopting best practices and techniques in software development, manage and protect valuable computing infrastructure and data assets in an enterprise environment, and develop next-generation cyber skills to confront emerging cyber threats. The new degree will be hosted in the new computing college. The proposed BS degree in Cybersecurity is an integral part of the new college and is consistent with the mission of Michigan Tech and the new college.

The proposal has been approved by the University Senate and the University administration. The University is seeking Board of Trustees approval to advance the proposal to the State Academic Affairs Officers.

RECOMMENDATION: That the Board of Trustees approves the Bachelor's of Science in Cybersecurity degree.
PROPOSAL FOR A BACHELOR’S OF SCIENCE IN CYBERSECURITY DEGREE

The faculty of the School of Technology at Michigan Technological University seek to establish a Bachelor’s of Science (BS) degree program in Cybersecurity. This interdisciplinary degree is a joint effort of the Computer Network and System Administration (CNSA) Program in the School of Technology, the Department of Computer Science (CS) in the College of Sciences and Arts, and the Department of Electrical and Computer Engineering (ECE) in the College of Engineering. The new degree is strategically designed to build on the strengths of existing computing programs on campus and produce well-rounded students with strong theoretical and practical skills.

The new degree offers Michigan Tech students the opportunity to gain cutting-edge cybersecurity knowledge and skills with a solid theoretical foundation as well as a good understanding of the social, ethical, legal, and policy aspects of cybersecurity. Students learn to design and develop trusted software systems by adopting best practices and techniques in software development, manage and protect valuable computing infrastructure and data assets in an enterprise environment, and develop next-generation cyber skills to confront emerging cyber threats. The new degree will be hosted in the new computing college. The proposed BS degree in Cybersecurity is an integral part of the new college and is consistent with the mission of Michigan Tech and the new college.

The proposal has been approved by the University Senate and the University administration. The University is seeking Board of Trustees approval to advance the proposal to the State Academic Affairs Officers.

RECOMMENDATION: That the Board of Trustees approves the Bachelor’s of Science in Cybersecurity degree.
V-J. APPROVAL OF A DEPARTMENT OF MANUFACTURING AND MECHANICAL ENGINEERING TECHNOLOGY IN THE COLLEGE OF ENGINEERING AND SUPPORT FOR FORMATION OF A COLLEGE OF COMPUTING

As part of University transition that includes the dissolution of the School of Technology and establishment of a College of Computing, the Office of the Provost and Senior Vice President for Academic Affairs recommends that resources associated with the Bachelor of Science in Mechanical Engineering Technology program and the Minor in Manufacturing Systems (including the machine shop that is currently housed within the School of Technology) move into a new department to be named Manufacturing and Mechanical Engineering Technology that will be housed within the College of Engineering. Approval of the Board of Trustees is required to form a new department at Michigan Technological University.

RECOMMENDATION: That the Board of Trustees:

● Supports the dissolution of the School of Technology;
● Supports the formation of the College of Computing;
● Approves the formation of a new Department of Manufacturing and Mechanical Engineering Technology within the College of Engineering.
V-K. FY20 GENERAL FUND OPERATING BUDGET

The general fund budget was developed based on assumptions regarding tuition and state appropriations. However, when the State budget is approved by the Legislature, if there are changes from these assumptions, the Administration is requesting that the Board allow them the flexibility to revise the budget to reflect a change in appropriations and/or tuition cap while continuing to maintain a balanced budget.

RECOMMENDATION: That the Board of Trustees approves the FY20 General Fund Operating Budget as presented, including the FY20 Room & Board and Apartment Rental Rates, and authorizes the Administration to revise the general fund operating budget, without increasing resident undergraduate tuition and room & board and apartment rental rates, to reflect any changes in state appropriations and/or tuition cap while maintaining a balanced budget and informing the Board Audit and Finance Committee of any such changes that may be necessary.
FY20 General Fund Operating Budget
Formal Session of the Board of Trustees - V. Action/Discussion Items

Audit and Finance Committee | Board of Trustees | November 2018

Douglass Houghton Hall, McNair Hall, Wadsworth Hall
Occupancy Dates: August 24, 2019 - December 21, 2019 and January 11, 2020 - May 2, 2020

<table>
<thead>
<tr>
<th>Housing (Regular Occupancy) and Dining</th>
<th>2018-2019 Housing &amp; Gold Plan Dining</th>
<th>Proposed Increase</th>
<th>2019-2020 Housing &amp; Unlimited Dining</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wadsworth Hall and McNair Hall</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Double Occupancy</td>
<td>$10,726</td>
<td>$310</td>
<td>$11,036</td>
<td>2.89%</td>
</tr>
<tr>
<td>Single Occupancy</td>
<td>$12,183</td>
<td>$310</td>
<td>$12,493</td>
<td>2.54%</td>
</tr>
<tr>
<td>Triple/Quad Occupancy</td>
<td>$10,540</td>
<td>$310</td>
<td>$10,850</td>
<td>2.94%</td>
</tr>
<tr>
<td>Wadsworth Hall w/ private bath</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Double Occupancy</td>
<td>$11,470</td>
<td>$310</td>
<td>$11,780</td>
<td>2.70%</td>
</tr>
<tr>
<td>Single Occupancy</td>
<td>$13,268</td>
<td>$310</td>
<td>$13,578</td>
<td>2.34%</td>
</tr>
<tr>
<td>Douglass Houghton Hall</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard Occupancy (Double and Quad)</td>
<td>$10,540</td>
<td>$310</td>
<td>$10,850</td>
<td>2.94%</td>
</tr>
<tr>
<td>Single Occupancy</td>
<td>$12,183</td>
<td>$310</td>
<td>$12,493</td>
<td>2.54%</td>
</tr>
<tr>
<td>Housing (Reduced/Temporary Occupancy) and Dining</td>
<td>2018-2019 Housing &amp; Gold Plan Dining</td>
<td>Proposed Increase</td>
<td>2019-2020 Housing &amp; Unlimited Dining</td>
<td>Percent Change</td>
</tr>
<tr>
<td>Temporary Housing</td>
<td>$8,866</td>
<td>$310</td>
<td>$9,176</td>
<td>3.50%</td>
</tr>
<tr>
<td>Quad to 2</td>
<td>$11,036</td>
<td>$310</td>
<td>$11,346</td>
<td>2.81%</td>
</tr>
<tr>
<td>Quad to 3/Quad to 2</td>
<td>$10,664</td>
<td>$310</td>
<td>$10,974</td>
<td>2.91%</td>
</tr>
<tr>
<td>Triple to 1</td>
<td>$12,183</td>
<td>$310</td>
<td>$12,493</td>
<td>2.54%</td>
</tr>
<tr>
<td>Wads Quad to 2</td>
<td>$11,129</td>
<td>$310</td>
<td>$11,439</td>
<td>2.79%</td>
</tr>
<tr>
<td>Wads Quad to 3</td>
<td>$10,943</td>
<td>$310</td>
<td>$11,253</td>
<td>2.83%</td>
</tr>
<tr>
<td>Triple Suite to 2</td>
<td>$11,873</td>
<td>$310</td>
<td>$12,183</td>
<td>2.61%</td>
</tr>
<tr>
<td>DHH Quad Suite to 3</td>
<td>$11,873</td>
<td>$310</td>
<td>$12,183</td>
<td>2.61%</td>
</tr>
</tbody>
</table>

Unlimited Dining has $200 dining dollars and 8 guest meal swipes per semester. Guest meal swipes expire at the end of the semester. Dining Dollars carry over from fall to spring semester. Dining Dollars expire at the end of the spring semester.

* Rate reported to US Department of Education Integrated Postsecondary Education Data System

Hillside Place Residence Hall
Occupancy Dates: August 24, 2019 - December 21, 2019 and January 11, 2020 - May 2, 2020

<table>
<thead>
<tr>
<th>Single Bedroom and Meal Rate</th>
<th>2018-2019 Housing &amp; 150 Block Dining</th>
<th>Proposed Increase</th>
<th>2019-2020 Housing &amp; 150 Block Dining</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Bedroom in Shared Apartment</td>
<td>$11,340</td>
<td>$570</td>
<td>$11,910</td>
<td>5.03%</td>
</tr>
<tr>
<td>Single Bedroom Apartment</td>
<td>$12,010</td>
<td>$675</td>
<td>$12,685</td>
<td>5.62%</td>
</tr>
</tbody>
</table>

Renewing Hillside Place tenants are eligible for the 75 Meal Block meal plan, rate as recommended above, minus $1060. Block meal plans are only available for the Hillside Place. Meals expire at the end of each semester. Unlimited Dining plan is available.

Daniell Heights Apartments
Lease Agreement Dates: July 1, 2019 to June 30, 2020 or August 15, 2019 to June 30, 2020

<table>
<thead>
<tr>
<th>Monthly Rental Rate</th>
<th>2018-2019</th>
<th>Proposed Increase</th>
<th>2019-2020</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student Rates</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One Bedroom</td>
<td>$705</td>
<td>$15</td>
<td>$720</td>
<td>2.13%</td>
</tr>
<tr>
<td>Two Bedroom</td>
<td>$1,000</td>
<td>$20</td>
<td>$1,020</td>
<td>2.00%</td>
</tr>
<tr>
<td>Three Bedroom</td>
<td>$1,260</td>
<td>$30</td>
<td>$1,290</td>
<td>2.38%</td>
</tr>
<tr>
<td>University Employee Rates</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One Bedroom</td>
<td>$880</td>
<td>$20</td>
<td>$900</td>
<td>2.27%</td>
</tr>
<tr>
<td>Two Bedroom</td>
<td>$1,080</td>
<td>$35</td>
<td>$1,115</td>
<td>3.24%</td>
</tr>
<tr>
<td>Three Bedroom</td>
<td>$1,375</td>
<td>$50</td>
<td>$1,425</td>
<td>3.64%</td>
</tr>
</tbody>
</table>
V-L. APPOINTMENT OF TREASURER

Public Act 70 of 1885 as amended in 1963 states that no member of the Board of Control can serve as secretary or treasurer and that the Board elect a secretary and treasurer to serve at their pleasure.

As Ms. Susan Kerry begins her employment as Chief Financial Officer and Senior Vice President of Administration on June 30, 2019, it is being recommended that the Board appoint a Treasurer effective June 1, 2019.

Included herein is the nomination for the position of Treasurer.

RECOMMENDATION: That the Board of Trustees appoint Susan Kerry as the Treasurer of the Board of Trustees effective June 1, 2019.
V-M. ELECTION OF CHAIR AND VICE CHAIR

The Bylaws of the Board of Trustees record that at the last meeting of the fiscal year, the Board shall elect a chair to take office at the first meeting in the following fiscal year. It further states that the Board shall also elect a vice chair to preside in the absence of the chair.

RECOMMENDATION: That the Board of Trustees elects a chair for the fiscal year 2019-2020; and that further, the Board elects a vice chair for the same period.
VI. REPORTS

A. Undergraduate Student Government Report
   Melanie Thomas, President

B. Graduate Student Government Report
   Apurva Baruah, President

C. University Senate Report
   Dr. Michael Mullins, President

D. School of Business and Economics Report
Undergraduate Student Government (U.S.G.) Update

May 3, 2019
Melanie Thomas, U.S.G. President
Agenda

- U.S.G. 2019-2020 Elections
- U.S.G. Body 2019-2020
- U.S.G. Student Led Initiatives
- Student Organization Funding
- Student Organization Funding Highlights
- Goals for 2019-2020
U.S.G. 2019-20 Elections

- Transition took place April 4, 2019.
  - Executive Board
    - President - Melanie Thomas
    - Vice President - Zbigniew Bell
    - Treasurer - Leo Stelmaszek
    - Secretary - Zachary Olson
  - Representative Positions
    - Potential shift in representative positions with the development of the College of Computing
U.S.G. 2019-2020 Body
U.S.G. Student Led Initiatives

- Undergraduate Student Government Bylaws Updated
- Pop Up Office Hours
- Student Storage Barn Organization
- U.S.G. Graduation Cords
- Meet Your Organization
- Career Fair Proposal
Student Organization Funding

● Annual Student Organizational Funding Process Concluded
  ○ March 27th
  ○ RSO Allocations
  ○ SBG and Traditions Allocations

● Funding Recap
  ○ $77,688.46 total Opportunity and Reserve Fund Requests
    ■ $36,826.00 from the Opportunity Fund, $40,862.46 from the Reserve Fund
Student Organization Funding Highlights

● Mushing Club
  ○ 1st Year Organization
  ○ First student organization of its kind in the nation

● Snowboard Racing Team
  ○ 1st Year Organization
  ○ Members of the team competed at Nationals

● Golf Club
  ○ Opportunity to fund national qualifier, first time in Golf Club History

● WMTU
Goals for 2019-2020

- Empowering Registered Student Organizations to excel
  - Work to promote networking among Registered Student Organizations
- Improving internal committees
  - Focus on productivity and instilling responsibility in members
- Expanding U.S.G.’s role on campus to offer more student led initiatives
  - Provide more than just financial support to Registered Student Organizations
- Continuing 1UP Development Committee
  - Coalition between the student government of Michigan Technological University, Northern Michigan University and Lake State Superior University
Questions?
Graduate Student Government of Michigan Tech

Apurva Baruah

May 03 2019

Board of Trustees
Michigan Technological University
Community

➔ Huge shout-out to Transportation Services
  ○ Theresa Coleman-Kaiser
  ○ Dan Bennett
  ○ Gail Kotajarvi-Gerard
  ○ Jeremy Lundy
  ○ Shuttle drivers & everyone else at TS

➔ Amazing service
  ○ Highly positive feedback from students

THANK YOU!!!!
New Programs

- Graduate Student Conference Award
- Husky Col-Lab - grad research collaboration initiative
  - Connecting graduate students across campus
- Emergency/Healthcare Resource document for graduate students
Enrichment & Collaboration

- 6 Academic Seminars
  - Time Management, Grant Writing, Innovation & Entrepreneurship etc.

- 6 Professional Development Workshops
  - Publishing, Communication, Networking, Job search etc

- 3MT - 14 participants

- GRC - Largest ever
  - 101 Registered Presentations
    - 66 Oral
    - 35 Poster
Enrichment & Collaboration

Travel Grants Program

● Total Applications : 128 (PhD - 92, MS - 36)
  ○ Presenting - 110 (PhD - 83, MS - 27)
  ○ Attending - 18 (PhD - 9, MS - 9)

● Total - $30,200
  ○ Presenting - $27,500 @ $250/student
  ○ Attending - $2,700 @ $150/student

● Working on expanding support
Community

- Summer’18 Softball
- New Student Arrival @ Chicago
- Orientation Picnic
- First Friday Social
- Fall Colors Tour
  - Lake of the Clouds
- Laser Tag (HOT fav!)
- Grad Movie Nights
Advocacy

➔ Tech Forward Task Forces
  ○ Thank you for involving students
  ○ Continue to work on goals set forth in proposals

➔ CFO search
  ○ Thank you for involving student governance
  ○ Humbling, learning experience for us
  ○ Look forward to working with our new leader

➔ JED Campus
  ○ Looking forward for exciting things
Next steps

➔ Insurance
  ○ Dental included
  ○ New policy, relook benefits
  ○ Support for students

➔ Commencement

➔ Work with different units
  ○ Grad handbook
  ○ University policies
2019-20 Team

President : Apurva Baruah (PhD, ME-EM)

Vice-President : Daniel Byrne (PhD, CS)

Secretary : Ranit Karmakar (PhD, ECE)

Treasurer : Bethel Tarekegne (PhD, Social Sciences)

Research Chair : Nathan Ford (PhD, ME-EM)

Professional Development Chair : Ami Kling (PhD, BME)

Social Chair : Wesley McGowan (PhD, DS)

Public Relations Chair : Marina Choy (PhD, Humanities)
Advocacy • Enrichment • Community

Thank You!!
UNIVERSITY SENATE END OF YEAR OVERVIEW
MOST IMPACTFUL PROPOSALS

- Proposal 2-19: Revision to Policy 104.1 Developing Academic Policy at MTU
- Proposal 8-19: Sabbatical Leave for Lecturer Track Faculty
- Proposal 12-19: Establish a Policy on the Quality of Online Courses
- Proposal 28-19: Proposal to Modify Class Start Times
- Proposal 29-19: Proposal to Reinstate (Unshelve) the Bachelor of Science Degree in Mining Engineering
- Proposal 37-19: Proposal to Change the University Defined Contribution Plan to a 10% Base Contribution With a 2.5% 1:1 Match
- Proposal 39-19: Proposal to Constitute a Representative University Benefits Planning Committee
- Proposal 41-19: Update Senate Procedure 504.1.1: Teaching Effectiveness Evaluations
- Proposal 44-19: Proposal for Career Fair Recess
- Proposal 45-19: Proposal to Change the Tuition Reduction Incentive Plan (TRIP) Benefit to 100% for Dependents, Spouses, and Designated Eligible Individuals
- Proposal 46-19: A Proposal to Update Section 1.5.5 “Non-Tenure-Track Academic Rank Definitions” in the Michigan Technological University Faculty Handbook and Board of Trustees Policy 6.01: Faculty Definitions to Include Non-Tenure Track Faculty Appointments for University Librarians and Archivists
MOST SIGNIFICANT PRESENTATIONS AND REPORTS

• Having Productive University Senate Meetings
• History of Total Compensation at Michigan Tech, 2008-2017
• Food Insecurities
• University Senate Overview of MTU Finances December
• Data Revolution and Sensing Task Force and New College Planning
• Spring 2019 Benefit History Report
• H-STEM Building Update
• Michigan Tech Financial Overview
• Transportation Services and Senate Parking Survey
• Update on the Future of Computing at Michigan Tech
SENATE INVOLVEMENT IN UNIVERSITY INITIATIVES

- Retention Task Force
- Diversity Counsel
- CFO Search Committee
- General Counsel Search Committee
- Committee on Academic Tenure, Promotion and Reappointment (CATPR)
- Benefits Liaison Group
- New Code of Conduct
- Consensual Relations Working Group
- Tech Forward Initiatives
GOING FORWARD

• Audit of Senate Policies and Procedures
• Seek to enhance the roles and involvement of professional staff in the Senate and realign professional staff units
• Initiate faculty workload analysis
• Improve communication with all constituents
• Prepare for upcoming administration evaluations
• Manage the new programs/certificates/minors coming from the new College of Computing
• Recommend living wage for all non-student employees of the University
• Submit a grant proposal for textbooks and course material accessability
• Seek to expand laptop initiative
School of Business Report
VII. INFORMATIONAL ITEMS

A. Analysis of Investments
B. University Issued Bond Balances
C. Research and Sponsored Programs Report
D. Advancement and Alumni Engagement Report
E. Recent Media Coverage
VII-A. ANALYSIS OF INVESTMENTS

Attached are analyses of investments as of June 30, 2018 to March 31, 2019.
### MICHIGAN TECH UNIVERSITY
#### INVESTMENT PORTFOLIO
##### JUNE 30, 2018 THROUGH MARCH 31, 2019

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Money Market Fund</td>
<td>$ 2,140,030</td>
<td>$ 2,149,137</td>
<td>$ 9,107</td>
<td>1.61%</td>
</tr>
<tr>
<td>Equity Funds:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Core Equity Fund</td>
<td>8,672,775</td>
<td>9,188,951</td>
<td>516,176</td>
<td>5.55%</td>
</tr>
<tr>
<td>Commonfund Strategic Solutions Equity Fund</td>
<td>5,316,134</td>
<td>5,550,309</td>
<td>234,175</td>
<td>9.39%</td>
</tr>
<tr>
<td>Total Equity Funds</td>
<td>13,988,909</td>
<td>14,739,260</td>
<td>750,351</td>
<td></td>
</tr>
<tr>
<td>Fixed Income Funds:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intermediate Term Fund</td>
<td>6,348,165</td>
<td>7,129,521</td>
<td>781,356</td>
<td>2.85%</td>
</tr>
<tr>
<td>Commonfund Contingent Asset Portfolio</td>
<td>7,442,980</td>
<td>7,300,163</td>
<td>(142,817)</td>
<td>2.35%</td>
</tr>
<tr>
<td>High Quality Bond Fund</td>
<td>5,328,730</td>
<td>5,570,343</td>
<td>241,613</td>
<td>4.74%</td>
</tr>
<tr>
<td>Total Fixed Income Funds</td>
<td>19,119,875</td>
<td>20,000,027</td>
<td>880,152</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>$ 35,248,814</td>
<td>$ 36,888,424</td>
<td>$ 1,639,610</td>
<td>5.04%</td>
</tr>
</tbody>
</table>

### Current Asset Allocation
- **Money Market, 6%**
- **Fixed Income, 54%**
- **Equities, 40%**
VII-B. UNIVERSITY ISSUED BOND BALANCES

Attached is an analysis of net revenues, debt retirement, and trustee reserve funds for University Bonded Operations for the period ended March 31, 2019.
### Bonds Outstanding

<table>
<thead>
<tr>
<th>Bonds Outstanding</th>
<th>Long-Term Outstanding Amount</th>
<th>Current Outstanding Amount</th>
<th>Total Outstanding</th>
<th>Original Issue Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Series 2008 Bond Issue (maturity 2038)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purchase of UPPCO Building</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Partial Funding of KRC Building</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MUB Ballroom Renovation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Series 2008 Bond Issue</strong></td>
<td>$5,090,000</td>
<td>-</td>
<td>$5,090,000</td>
<td>$15,880,000</td>
</tr>
<tr>
<td><strong>Series 2009A Bond Issue (maturity 2039)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New Student Apartment Building</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Partial Funding of KRC Building</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Series 2009 Bond Issue</strong></td>
<td>$14,305,000</td>
<td>445,000</td>
<td>$14,750,000</td>
<td>$18,235,000</td>
</tr>
<tr>
<td><strong>Series 2010A Bond Issue (maturity 2040)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Great Lakes Research Center</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A.E. Seaman Mineral Museum</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KRC Building Purchase (Blizzard Building)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Life Safety Improvements on Campus</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Series 2010 Bond Issue</strong></td>
<td>$7,655,000</td>
<td>235,000</td>
<td>$7,890,000</td>
<td>$10,975,000</td>
</tr>
<tr>
<td><strong>Series 2012A Bond Issue (maturity 2034)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Refunding of 2003 &amp; 2004 Fixed Rate Bond Issues</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SDC Ice Plant and Partial Roof of SDC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Series 2012 Bond Issue</strong></td>
<td>$24,985,000</td>
<td>1,365,000</td>
<td>$26,350,000</td>
<td>$33,070,000</td>
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<tr>
<td><strong>Series 2013A Bond Issue (maturity 2036)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Refunding 2006 Bond Issue</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Refunding partial 2008 Bond Issue</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Series 2013 Bond Issue</strong></td>
<td>$10,570,000</td>
<td>665,000</td>
<td>$11,235,000</td>
<td>$14,265,000</td>
</tr>
<tr>
<td><strong>Series 2015A Bond Issue (maturity 2046)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daniell Heights Renovation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Campus Dining Renovation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel Storage Tank Facility</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemical Storage Facility</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemistry Labs Renovation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IT and Safety Systems Upgrades</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>McNair Hall Bathrooms Renovation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Series 2015 Bond Issue</strong></td>
<td>$22,525,000</td>
<td>465,000</td>
<td>$22,990,000</td>
<td>$24,295,000</td>
</tr>
<tr>
<td><strong>Total - All Bond Issues</strong></td>
<td>$85,130,000</td>
<td>$3,175,000</td>
<td>$88,305,000</td>
<td>$116,720,000</td>
</tr>
</tbody>
</table>

**MICHIGAN TECH UNIVERSITY**

**OUTSTANDING BALANCES ON BOND ISSUANCES**

**MARCH 31, 2019**
VII-C. RESEARCH AND SPONSORED PROGRAMS REPORT

A report of contracts and grants is attached hereto.

This is for the Board's information.
Sponsored Awards
Fiscal Year 2019
3rd Quarter
Ended March 31, 2019
TOTAL: $43,559,579

Pre-Proposals Submitted
(excluded from Proposals Submitted figures below)
FYTD 2018: 34
FYTD 2019: 58

Formal Session of the Board of Trustees - VII. Informational Items

Proposals Submitted | Awards Received | Awards Received ($) | Variance $ | Variance %
---|---|---|---|---
Sponsor | FY ’19 as of 03/31 | FY ’18 as of 03/31 | FY ’19 as of 03/31 | FY ’18 as of 03/31 | Variance $ | Variance %

| NASA | 48 | 44 | 37 | 19 | 4,678,779 | 4,155,923 | 522,856 | 12.6% |
| National Science Foundation | 124 | 157 | 39 | 37 | 7,176,470 | 6,781,238 | 395,232 | 5.8% |
| US Department of Agriculture | 49 | 39 | 31 | 42 | 989,787 | 1,523,412 | -533,625 | -35.0% |
| US Department of Defense | 91 | 69 | 84 | 63 | 8,876,802 | 9,351,470 | -474,668 | -5.1% |
| US Department of Education | 4 | 2 | 3 | 1 | 88,732 | 35,317 | 53,415 | 151.2% |
| US Department of Energy | 28 | 29 | 13 | 12 | 1,654,859 | 1,585,333 | 69,526 | 4.5% |
| US Department of HHS | 46 | 29 | 6 | 7 | 1,850,620 | 1,905,550 | -54,930 | -2.9% |
| US Department of Transportation | 12 | 8 | 11 | 9 | 1,783,742 | 1,495,825 | 287,917 | 19.2% |
| Other Federal Agencies* | 31 | 31 | 34 | 28 | 2,826,769 | 2,984,492 | -157,723 | -5.3% |
| Federal Agency Total | 433 | 408 | 258 | 218 | 29,926,560 | 28,929,636 | 996,924 | 3.4% |
| State of Michigan | 42 | 36 | 21 | 22 | 1,806,015 | 2,046,748 | -240,733 | -11.6% |
| Industrial | 191 | 142 | 160 | 125 | 7,060,552 | 5,721,452 | 1,339,100 | 23.4% |
| Foreign | 17 | 25 | 12 | 19 | 366,938 | 970,523 | -503,585 | -52.2% |
| All Other Sponsors | 72 | 52 | 35 | 30 | 1,945,561 | 1,212,847 | 732,714 | 60.4% |
| **Subtotal** | 755 | 662 | 486 | 414 | 41,105,626 | 38,881,206 | 2,224,420 | 5.7% |
| Gifts** | N/A | N/A | 210 | 215 | 2,396,267 | 2,236,618 | 159,649 | 7.1% |
| Crowd Funding | N/A | N/A | 3 | 3 | 57,686 | 13,011 | 44,675 | 343.4% |
| Grand Total | 755 | 662 | 709 | 632 | 43,559,579 | 41,130,835 | $2,428,744 | 5.9% |


**Gifts represent non-contractual funding from corporations, foundations, associations and societies in support of academic programs, scholarships/fellowships, student design & enterprise, research, youth programs and special programs.
Formal Session of the Board of Trustees - VII.  Informational Items

Vice President for Research
Fiscal Year 2019
3rd Quarter
Ended March 31, 2019

TOTAL: $43,559,579

Percentages of Tenured & Tenure Track Faculty (as either PI or Co-PI)

Submitting Proposals since 07/01/2018
68.01%

On Active Projects as of 03/31/2019
60.25%

<table>
<thead>
<tr>
<th>SPO &amp; OIC Metrics</th>
<th>Administration</th>
<th>College of Engineering</th>
<th>College of Sciences &amp; Arts</th>
<th>Great Lakes Research Center</th>
<th>Keweenaw Research Center</th>
<th>Michigan Tech Research Institute</th>
<th>Pavlis Honors College</th>
<th>School of Business &amp; Economics</th>
<th>School of Forest Resources &amp; Environ Science</th>
<th>School of Technology</th>
<th>Totals</th>
<th>Fiscal Comparison</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proposals Submitted</td>
<td>113</td>
<td>280</td>
<td>63</td>
<td>15</td>
<td>59</td>
<td>56</td>
<td>33</td>
<td>3</td>
<td>19</td>
<td>621</td>
<td>755</td>
<td>662</td>
<td>14.0%</td>
</tr>
<tr>
<td>Federal Pass-Through</td>
<td>666,874</td>
<td>4,350,154</td>
<td>403,865</td>
<td>182,407</td>
<td>751,385</td>
<td>3,205,203</td>
<td>308,675</td>
<td>-</td>
<td>143,420</td>
<td>5,000</td>
<td>10,016,983</td>
<td>7,744,515</td>
<td>29.3%</td>
</tr>
<tr>
<td>Foreign</td>
<td>-</td>
<td>342,564</td>
<td>652</td>
<td>-</td>
<td>15,722</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>366,938</td>
<td>-62.2%</td>
</tr>
<tr>
<td>Gifts</td>
<td>1,321,519</td>
<td>566,983</td>
<td>99,977</td>
<td>14,500</td>
<td>40,585</td>
<td>1,800</td>
<td>314,650</td>
<td>500</td>
<td>32,403</td>
<td>3,350</td>
<td>2,396,267</td>
<td>2,236,618</td>
<td>7.1%</td>
</tr>
<tr>
<td>Crowd Funding</td>
<td>481</td>
<td>2,281</td>
<td>28,604</td>
<td>11,562</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>10,369</td>
<td>-</td>
<td>-</td>
<td>57,868</td>
<td>13,011</td>
<td>343.4%</td>
</tr>
<tr>
<td>Industry</td>
<td>-</td>
<td>2,633,462</td>
<td>53,444</td>
<td>80,850</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>7,060,552</td>
<td>5,721,452</td>
<td>23.4%</td>
</tr>
<tr>
<td>Other</td>
<td>4,400</td>
<td>829,207</td>
<td>930,406</td>
<td>65,677</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1,345,561</td>
<td>1,212,847</td>
<td>60.4%</td>
</tr>
<tr>
<td>State of MI</td>
<td>90,824</td>
<td>1,600,447</td>
<td>77,244</td>
<td>25,000</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1,806,015</td>
<td>2,046,748</td>
<td>-11.8%</td>
</tr>
<tr>
<td>Total S by Division</td>
<td>2,084,098</td>
<td>21,450,548</td>
<td>4,562,010</td>
<td>379,996</td>
<td>4,162,252</td>
<td>7,610,449</td>
<td>731,194</td>
<td>35,500</td>
<td>2,498,589</td>
<td>44,943</td>
<td>43,559,579</td>
<td>41,130,835</td>
<td>2.9%</td>
</tr>
<tr>
<td>Fiscal Comparison</td>
<td>2,977,725</td>
<td>15,016,884</td>
<td>6,932,569</td>
<td>1,009,438</td>
<td>7,280,450</td>
<td>4,794,169</td>
<td>273,893</td>
<td>51,000</td>
<td>2,455,222</td>
<td>3,350</td>
<td>41,130,835</td>
<td>41,130,835</td>
<td>2.9%</td>
</tr>
</tbody>
</table>

Percent Change

-30.0% 42.8% -23.1% -82.4% -68.4% 98.7% -167.0% -30.4% 1.8% -96.6% 5.9%

Disclosures Received

NonDisclosure Agreements

Patents Filed or Issued

License Agreements

Gross Royalties

1 Combined Metrics from both the Sponsored Programs Office (SPO) and Office of Innovation & Commercialization (OIC)
2 Percentages reflect the proportional contribution from each Division (calculated by dividing the sum of the fractional contributions of all inventors for each unit by the total number of inventors)
## Sponsored Awards by Industry

*Industry-COMBINED*

Fiscal Year 2019
3rd Quarter
Ended March 31, 2019

TOTAL: $13,004,014

<table>
<thead>
<tr>
<th>Industry Segment</th>
<th>Proposals Submitted FY '19</th>
<th>Proposals Submitted FY '18</th>
<th>Proposals Submitted Variance</th>
<th>Awards Received FY '19 as of 3/31</th>
<th>Awards Received FY '18 as of 3/31</th>
<th>Awards Received Variance</th>
<th>Awards Received ($) FY '19 as of 3/31</th>
<th>Awards Received ($) FY '18 as of 3/31</th>
<th>Awards Received Variance</th>
<th>Awards Received Variance %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automotive</td>
<td>65</td>
<td>60</td>
<td>106</td>
<td>5,012,581</td>
<td>4,757,415</td>
<td>255,166</td>
<td>5,012,581</td>
<td>4,757,415</td>
<td>255,166</td>
<td>5.4%</td>
</tr>
<tr>
<td>Business &amp; Economics</td>
<td>1</td>
<td>2</td>
<td>11</td>
<td>44,500</td>
<td>254,561</td>
<td>-210,061</td>
<td>44,500</td>
<td>254,561</td>
<td>-210,061</td>
<td>-82.5%</td>
</tr>
<tr>
<td>Chemical</td>
<td>13</td>
<td>3</td>
<td>17</td>
<td>562,367</td>
<td>218,695</td>
<td>343,672</td>
<td>562,367</td>
<td>218,695</td>
<td>343,672</td>
<td>157.1%</td>
</tr>
<tr>
<td>Civil</td>
<td>9</td>
<td>8</td>
<td>26</td>
<td>465,177</td>
<td>64,359</td>
<td>400,818</td>
<td>465,177</td>
<td>64,359</td>
<td>400,818</td>
<td>622.8%</td>
</tr>
<tr>
<td>Consumer Products</td>
<td>41</td>
<td>17</td>
<td>29</td>
<td>549,399</td>
<td>951,805</td>
<td>-402,406</td>
<td>549,399</td>
<td>951,805</td>
<td>-402,406</td>
<td>-42.3%</td>
</tr>
<tr>
<td>Defense &amp; Space</td>
<td>25</td>
<td>26</td>
<td>33</td>
<td>2,683,820</td>
<td>1,990,884</td>
<td>692,936</td>
<td>2,683,820</td>
<td>1,990,884</td>
<td>692,936</td>
<td>34.8%</td>
</tr>
<tr>
<td>Energy</td>
<td>14</td>
<td>9</td>
<td>28</td>
<td>660,945</td>
<td>456,554</td>
<td>204,391</td>
<td>660,945</td>
<td>456,554</td>
<td>204,391</td>
<td>44.8%</td>
</tr>
<tr>
<td>Environmental</td>
<td>5</td>
<td>4</td>
<td>13</td>
<td>170,141</td>
<td>186,694</td>
<td>-16,553</td>
<td>170,141</td>
<td>186,694</td>
<td>-16,553</td>
<td>-9.8%</td>
</tr>
<tr>
<td>Health</td>
<td>18</td>
<td>10</td>
<td>22</td>
<td>334,313</td>
<td>752,816</td>
<td>-418,503</td>
<td>334,313</td>
<td>752,816</td>
<td>-418,503</td>
<td>-55.6%</td>
</tr>
<tr>
<td>Industrial Engineering</td>
<td>7</td>
<td>5</td>
<td>17</td>
<td>145,500</td>
<td>164,923</td>
<td>-19,423</td>
<td>145,500</td>
<td>164,923</td>
<td>-19,423</td>
<td>-11.8%</td>
</tr>
<tr>
<td>IT Services</td>
<td>8</td>
<td>2</td>
<td>11</td>
<td>484,419</td>
<td>170,600</td>
<td>313,819</td>
<td>484,419</td>
<td>170,600</td>
<td>313,819</td>
<td>184.0%</td>
</tr>
<tr>
<td>Mining &amp; Metals</td>
<td>13</td>
<td>18</td>
<td>34</td>
<td>791,103</td>
<td>358,935</td>
<td>432,168</td>
<td>791,103</td>
<td>358,935</td>
<td>432,168</td>
<td>120.4%</td>
</tr>
<tr>
<td>Other</td>
<td>4</td>
<td>6</td>
<td>20</td>
<td>146,099</td>
<td>204,422</td>
<td>-58,323</td>
<td>146,099</td>
<td>204,422</td>
<td>-58,323</td>
<td>-28.5%</td>
</tr>
<tr>
<td>Technology</td>
<td>13</td>
<td>7</td>
<td>27</td>
<td>953,650</td>
<td>813,230</td>
<td>140,420</td>
<td>953,650</td>
<td>813,230</td>
<td>140,420</td>
<td>17.3%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>236</strong></td>
<td><strong>177</strong></td>
<td><strong>394</strong></td>
<td><strong>13,004,014</strong></td>
<td><strong>11,345,893</strong></td>
<td><strong>1,658,121</strong></td>
<td><strong>13,004,014</strong></td>
<td><strong>11,345,893</strong></td>
<td><strong>1,658,121</strong></td>
<td><strong>14.6%</strong></td>
</tr>
</tbody>
</table>

*Gifts represent non-contractual funding from corporations, foundations, associations and societies in support of academic programs, scholarships/fellowships, student design & enterprise, research, youth programs and special programs.

**Gift numbers include Industry gifts ONLY, not others including Association or Society gifts.
Michigan Technological University  
Total Research Expenditures by College/School/Division  
Fiscal Year 2019 & 2018  
As of March 31, 2019 and March 31, 2018

<table>
<thead>
<tr>
<th>College/School/Division</th>
<th>FY2019</th>
<th>FY2018</th>
<th>Variance</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administration*</td>
<td>3,312,565</td>
<td>2,858,818</td>
<td>453,747</td>
<td>15.9%</td>
</tr>
<tr>
<td>College of Engineering</td>
<td>22,496,100</td>
<td>21,955,410</td>
<td>540,690</td>
<td>2.5%</td>
</tr>
<tr>
<td>College of Science &amp; Arts</td>
<td>12,308,552</td>
<td>12,783,742</td>
<td>(475,190)</td>
<td>-3.7%</td>
</tr>
<tr>
<td>Great Lakes Research Center**</td>
<td>443,403</td>
<td>256,473</td>
<td>186,930</td>
<td>72.9%</td>
</tr>
<tr>
<td>Pavlis Honors College</td>
<td>509,254</td>
<td>194,377</td>
<td>314,877</td>
<td>162.0%</td>
</tr>
<tr>
<td>Keweenaw Research Center (KRC)</td>
<td>6,874,121</td>
<td>6,552,805</td>
<td>321,316</td>
<td>4.9%</td>
</tr>
<tr>
<td>Michigan Tech Research Institute (MTRI)</td>
<td>6,440,836</td>
<td>6,296,773</td>
<td>144,063</td>
<td>2.3%</td>
</tr>
<tr>
<td>School of Business &amp; Economics</td>
<td>1,317,887</td>
<td>1,176,417</td>
<td>141,470</td>
<td>12.0%</td>
</tr>
<tr>
<td>School of Forest Resources &amp; Environmental Science</td>
<td>3,898,024</td>
<td>4,139,788</td>
<td>(241,764)</td>
<td>-5.8%</td>
</tr>
<tr>
<td>School of Technology</td>
<td>775,617</td>
<td>373,177</td>
<td>402,440</td>
<td>107.8%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>58,376,359</td>
<td>56,587,780</td>
<td>1,788,579</td>
<td>3.2%</td>
</tr>
</tbody>
</table>

*Includes the Vice Presidents, Provost, and others who report to a VP, Provost or the President. Except for the research institutes that report to the VPR.

**Includes GLRC department (non-academic researchers) expenditures only.
All other GLRC center expenditures are shown in the researchers’ respective colleges.
VII-D. ADVANCEMENT AND ALUMNI ENGAGEMENT REPORT

Attached is a report from Dr. William Roberts, Interim Vice President for Advancement and Alumni Engagement, on the university’s advancement and alumni engagement activities.

This is for the Board's information.
Advancement

- Staff Changes:
  - Eric Halonen - Assistant Vice President for Principal Gifts
  - Beth Pollins - Principal Gifts Associate
  - Jodi Lehman - Director of Foundation Relations
  - Katie Buehner - Assistant Director of Foundation Relations
  - Cody Kangas - Director of Industry Engagement
  - Jim Desrochers - Director of Advancement with focus on SFRES and Student Affairs
  - Shannon Meller - Prospect Research and Data Supervisor

- Resignations:
  - Erin Thompson, Associate Director of Alumni Programming
  - Becky Codere, Administrative Aide 8, Alumni Engagement

- In the process of reorganizing territories and reassigning individual donors.
- Principal Level Gifts: Eric has been meeting with deans and chairs to launch the new program.
- Estate Planning Seminar: seminar will be held on campus this year (October 11-13) instead of Mackinac Island.

Planned Giving

- Planned Giving Registry Value: $173.2 million (as of 3/31).
- Realized Planned Gifts: $2.67 million (as of 3/31).

Annual Giving

- First 24 Hour Giving Challenge, Gold and Black Give Back was held on April 11, 2019.
- We raised $570,813 from 1,337 gifts.

Alumni Engagement

- Commencement: all graduates will receive a gift of a two sided flag. The post ceremony celebration has been redesigned to allow for greater interaction between graduates, their families and staff members.
- Reunion: newsletters, revamped webpages and Facebook pages have been created for each of the special class years.
- E-Newsletter: after one year we have learned that the newsletter topics that garner the most engagement are: snow, Father’s Day flood, our new president, MTU closures, storied from the Archives and the new campus map. Average open rates for the three segments is 32% (over 60 36%, 34-59 27%, under 34 30%).

Foundations

- Major submission: $7.5 Million request made to the Herbert H. and Grace A. Dow Foundation for Mi-STAR.
● Major award: $500,000.00 award granted from NCAA Strategic Alliance Matching Grant, for Director of Student-Athlete Wellness and Clinical Counselor.

● Media spotlight: Bridge Michigan’s UP is full of closed mines. Technology may give them new life. RTO Insider Michigan Energy Storage Idea Poses New Life for Old Mines. This is our first Sloan Foundation funded project. Lead: Roman Sidorsov.

● Travel: Jodi is attending the Carnegie Foundation Summit on Education (Walton and Gates foundations) with Mary Raber and will be meeting with the President of the Asante Foundation to work on resubmission of Gates/Misk Foundation proposal.

● Tech Forward: Five key foundation opportunities per initiative discussed with following Tech forward leads:
  ○ Education for 21st Century-Lorelle Meadows
  ○ Policy, Ethics, and Culture-Jennifer Slack
  ○ Health and Quality of Life- Caryn Heldt

● Visits: JED Campus consultants (March), Blue Cross Blue Shield Foundation (rescheduled due to April snowstorm for June), Superior Health Foundation (rescheduled June), Michigan Health Endowment Fund (June).

● Michigan based H-STEM considerations: Carls (alumni affiliated with foundation identified), Gerber (established relation), and Mott (leverage Portage Health Foundation and MSU-Extension partnerships) foundations.

● Internal review process for Keck Foundation approved by Academic Leadership Council.

● Stewardship: Portage Health Foundation Community Report (copies provided) and Research Magazine mailed to top 50 priority foundations.
VII-E. RECENT MEDIA COVERAGE

Included herein are recent news items that have appeared throughout the country.

This is for the Board’s information.
News Media Report

Regular Meeting of the Board of Trustees, May 3, 2019

Feb 12, 2019 - Apr 5, 2019

Michigan Technological University
Coverage Summary

Total Mentions

Reach

Tag Usage Over Time

Tag Usage

Events: 41.2%  Athletics: 35.8%  Research: 9.8%  Alumni: 8.7%
Curricula/Programs: 3.8%  Other: 0.5%  Student Life: 0.1%
News Media Report
Regular Meeting of the Board of Trustees, May 3, 2019

Trend of Coverage by Media Type

Share of Coverage by Media Type

Mentions by Location

Top Locations

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>NUMBER OF CLIPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Michigan</td>
<td>290</td>
</tr>
<tr>
<td>California</td>
<td>263</td>
</tr>
<tr>
<td>Minnesota</td>
<td>135</td>
</tr>
<tr>
<td>New York</td>
<td>112</td>
</tr>
<tr>
<td>Washington DC</td>
<td>112</td>
</tr>
<tr>
<td>North Dakota</td>
<td>81</td>
</tr>
<tr>
<td>Ohio</td>
<td>81</td>
</tr>
<tr>
<td>Texas</td>
<td>72</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>67</td>
</tr>
<tr>
<td>Virginia</td>
<td>63</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>57</td>
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<tr>
<td>Florida</td>
<td>37</td>
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<tr>
<td>Illinois</td>
<td>34</td>
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<tr>
<td>Indiana</td>
<td>32</td>
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<tr>
<td>Washington</td>
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<tr>
<td>Connecticut</td>
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<tr>
<td>Maryland</td>
<td>25</td>
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<tr>
<td>Montana</td>
<td>24</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>23</td>
</tr>
<tr>
<td>New Jersey</td>
<td>22</td>
</tr>
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</table>
Formal Session of the Board of Trustees - VII. Informational Items

News Media Report
Regular Meeting of the Board of Trustees, May 3, 2019

Value of Coverage

<table>
<thead>
<tr>
<th>Date</th>
<th>Value of Coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/12/19</td>
<td>120K</td>
</tr>
<tr>
<td>2/24/19</td>
<td>150K</td>
</tr>
<tr>
<td>3/7/19</td>
<td>220K</td>
</tr>
<tr>
<td>3/19/19</td>
<td>140K</td>
</tr>
<tr>
<td>3/21/19</td>
<td>180K</td>
</tr>
</tbody>
</table>

Sentiment Over Time

<table>
<thead>
<tr>
<th>Date</th>
<th>Sentiment Over Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/12/19</td>
<td>Neutral (4.0K)</td>
</tr>
<tr>
<td>2/24/19</td>
<td>Positive (3.0K)</td>
</tr>
<tr>
<td>3/7/19</td>
<td>Negative (1.1K)</td>
</tr>
<tr>
<td>3/19/19</td>
<td>Neutral (4.0K)</td>
</tr>
<tr>
<td>3/21/19</td>
<td>Positive (3.0K)</td>
</tr>
<tr>
<td>3/23/19</td>
<td>Negative (1.1K)</td>
</tr>
</tbody>
</table>

Feb 12, 2019 - Apr 5, 2019 | 3
News Media Report Annotations: It’s All About the Wolves

In this quarter’s News Media Report, you’ll notice a peak in Total Mentions, Reach, and Sentiment on March 6 and 7, 2019. Two news stories account for this, and both stem from the University’s expertise in wildlife biology, specifically wolves and predator-prey dynamics. First, the Associated Press ran a story on March 6 entitled, “US plans end to wolf protections; critics say it’s premature.”

The story featured John Vucetich (screenshot below), a professor in Michigan Tech’s School of Forest Resources and Environmental Science (SFRES) who is also a lead researcher on the Isle Royale wolf-moose study. The March 6 story ran in hundreds of AP outlets and accounted for the vast majority of our peak in reach, unique visitors per mention, and sentiment on March 6. Please note that while the sentiment has been tagged “negative,” this is because most readers/viewers were opposed to the end in wolf protections. This article should not be viewed as negative coverage of Michigan Tech.
On March 7, Professor Vucetich was quoted in an IFL Science story — “4 Canadian wolves have been airdropped into a US national park to deal with the growing moose population” — that was picked up by Business Insider and other major media outlets (screenshots on following page).
The two wolf stories account for the vast majority of the estimated $394,200 value in news coverage we received for March 6 and 7.

Relatedly, on April 5, 2019, SFRES Assistant Professor Kristin Brzeski, an expert in conservation genetics who studies wolves, was featured in a National Geographic article entitled, “These rare wolves are unique species. Here’s why that matters.”

(Screenshots on following page.)
These rare wolves are unique species. Here’s why that matters.

Mexican gray wolves and red wolves are taxonomically unique, a federal report says, and require protection under the Endangered Species Act.

Scientists and conservationists expressed hope that the paper would put to rest an unhelpful debate, and allow for new progress toward the species’ conservation.

“This will hopefully move the discussion at the federal policy level toward effective conservation... and away from controversies about hybridization,” says Kristin Erzieski, a conservation geneticist who studies wolves at Michigan Technological University and wasn’t involved in the paper.
Other top earned media clips include:

1) An NPR story that originally ran in The Hechinger Report on the failure of colleges to visit rural schools for recruitment. The story featured Michigan Tech as one of the few universities effectively reaching out to rural students.
'A community of nerds like me'

David Hochstetler, the Maple Valley student interested in engineering, met with representatives from Michigan Technological University at the college recruiting fair in Grand Rapids. That meeting helped him decide to attend. The school also sent him an invitation to apply as a "select nominee." He applied and was accepted early and given a yearly academic scholarship.

He was also able to visit the campus in Houghton, more than eight hours away by car, because his family vacations on the Upper Peninsula. There, he took a college tour and connected with current students over his passion for engineering.

"Around here [home], there aren't that many people on the engineering or computer side of things," he says. "I thought it would be cool to go into a community of nerds like me."

This story about rural students was produced by The Hechinger Report, a nonprofit, independent news organization focused on inequality and innovation in education.

2) An article in the April 2019 issue of Scientific American that featured Simon Carn, volcanologist and professor of geological and mining engineering and sciences.
Many of Earth's roughly 1,500 potentially active volcanoes are in remote areas, so it can be difficult to regularly study ongoing eruptions or identify new ones, says Simon Carn, a volcanologist at Michigan Technological University. "U.S. volcanoes are pretty well monitored, but elsewhere it's a different story," Carn adds. "There's definitely a need for satellite monitoring."

Carn and his colleagues used DISCOVER's Earth Polychromatic Imaging Camera (EPIC) to observe 16 eruptions. They collected ultraviolet measurements of sulfur dioxide (SO$_2$), a gas frequently emitted by volcanoes. Sulfur dioxide is the easiest volcanic gas to measure because it is relatively rare in the atmosphere, Carn says. The EPIC observations provided a new view of Earth's surface every 68 to 110 minutes—much more frequently than most other ultraviolet satellite instruments. "Eruptions can evolve rapidly, so the higher the frequency of observations, the better our ability to track them," Carn says.

3) A Live Science article that featured Aleksey Smirnov, professor of geological and mining engineering and sciences.
Where does the field come from?

While still a bit of a mystery, scientists generally agree that the magnetic field of the Earth starts **deep in the core** of the planet. The outer core of the planet is made up of molten metals, primarily iron, which is a conductor.

"Churning, molten metal in the outer core generates the [magnetic] field by what is known as dynamo action," said Aleksey Smirnov, a geophysics professor at Michigan Technological University.

Dynamo action, or the dynamo theory, describes the way a planet can sustain a magnetic field. The dynamo, or source of the magnetic field, is created by a rotating, convecting and electrically conducting material, such as the molten iron **inside the Earth**.
SPOTLIGHT

Humans of Michigan Tech tells our stories via short interviews—what motivates our students, why our staff loves what they do, and what makes Michigan Tech unique. When bringing the series back after a hiatus, our first post introduced some locally-famous faces to our larger Facebook audience. Curt and Rachel Eikenberry are the greeters in Wadsworth Dining Hall. They greet students, swipe cards, and, most importantly, connect with our students. And with 157 comments and 35,000 reach, they’re one of our most popular posts of the year.

Social Media Report 2/11/19 to 4/5/19
Over 4M impressions* this quarter

BY PLATFORM

Facebook
@michigantech

- 43.8k followers, up 502 from last quarter
- 1.24 million impressions (organic)
- 2.26 million impressions (sponsored)

Twitter
@michigantech

- 11.5k followers, up 300 from last quarter
- 550k impressions

Instagram
@michigantech

- 10,900 followers, up 500 from last quarter

LinkedIn

- 55,481 followers, up 337 from last quarter
- 377k impressions (organic)
- 113k impressions (sponsored)

(*Impressions: The number of times any content from your page or profile enters a person's screen. This includes posts, check-ins, ads, and interactions. Instagram does not provide impression information.)

Social Media Report 2/11/19 to 4/5/19
VIII. OTHER BUSINESS
IX. PUBLIC COMMENTS
X. ADJOURNMENT