Innovative and Interdisciplinary Approach for Offering the Master of Science Degree in Mechatronics

Aleksandr Sergeyev, Adrienne Minerick and John L. Irwin

Mechatronics, Electrical, and Robotics Engineering Technology/ College of Computing/ Manufacturing and Mechanical Engineering Technology
Michigan Technological University
Houghton, Michigan

Abstract

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 MS degree in Mechatronics at Michigan Tech has a very flexible structure consisting of five pathways allowing students from technology, traditional engineering, community colleges, other institutions, and industry representatives to pursue an advanced degree in this emerging field. Students enrolled in the program have three graduation options: coursework, research with thesis, and internship with industry and report options. The industry-driven curriculum developed for the proposed program addresses the need for a skilled advanced manufacturing workforce and accelerate the development of a digitally-savvy workforce for emerging manufacturing technologies. It focuses 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, automotive and other advanced manufacturing industries. In this paper, authors provide details on organizational and administrative structure of the degree.

1. Introduction

This paper describes the establishment of a Master of Science in Mechatronics 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 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,

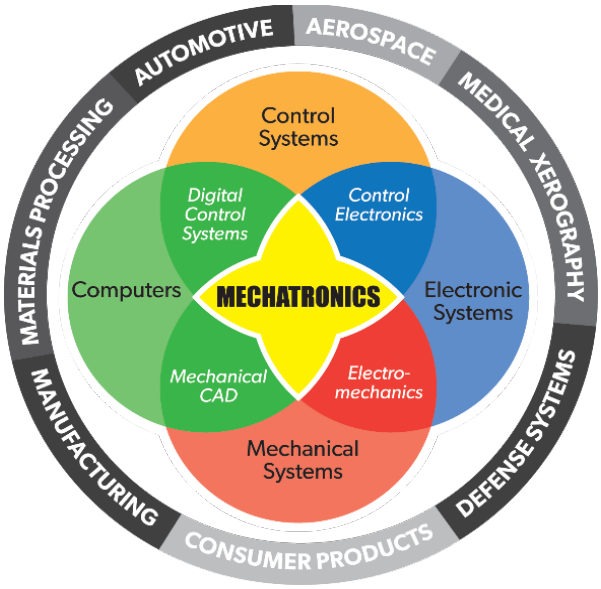

Figure 1. What Mechatronics is

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, 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 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, which 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 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

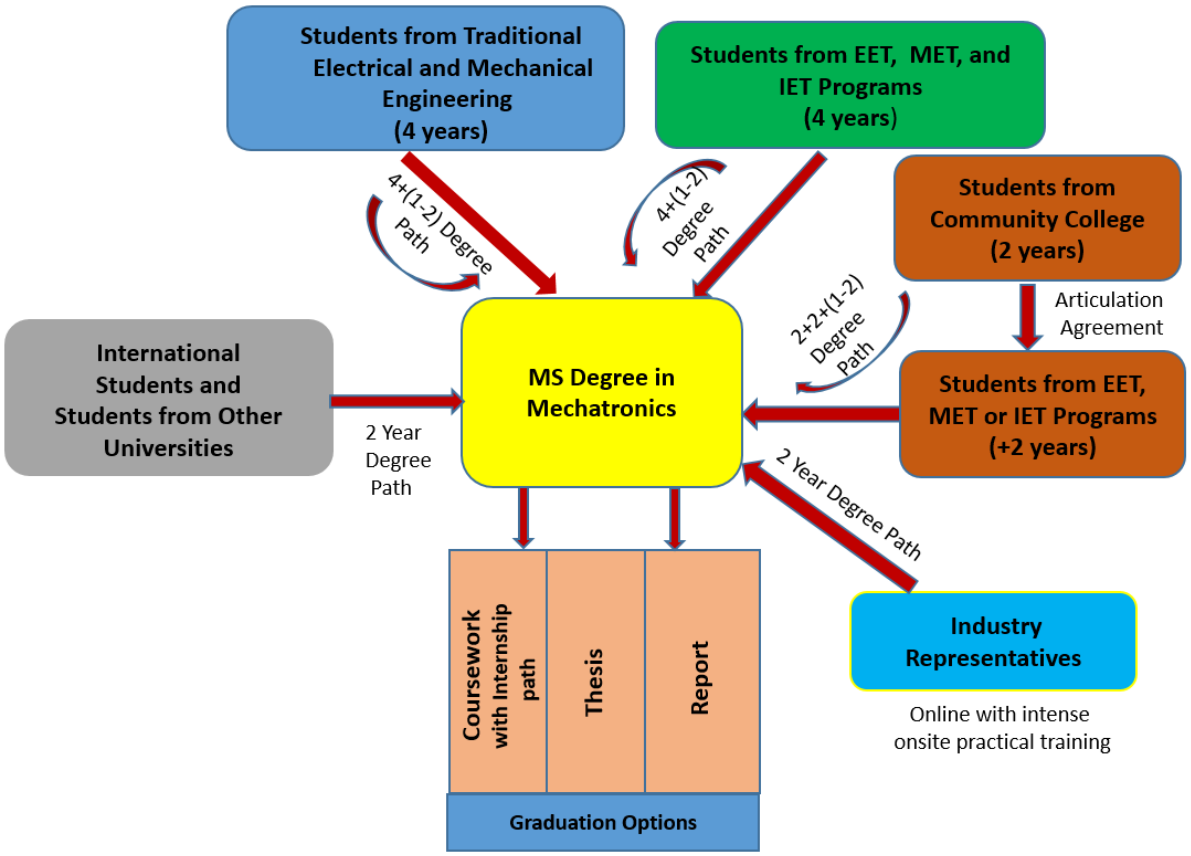

Figure 2. An overview of the proposed model for MS degree in Mechatronics at Michigan Tech

pre-requisites 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 a 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 or the accelerated master's program but will be able to enroll in the stand-alone 2-year MS program, as shown in Figure 2.

Michigan Tech 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 outlined above for traditional EET and MET students.

The proposed degree also targets industry representatives who may or may not be able to enroll full time. 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 upon program development (potential for partnership with Keypath) for the required master's-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 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 one-third 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 most desired option, by both students and industry (see survey below), is an internship with industry. Students who choose the internship option will be able to participate in at least one internship opportunity and will acquire up to a maximum 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 the students. The acquired credits will be counted towards coursework with the 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 later in the article 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, robotics, 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.

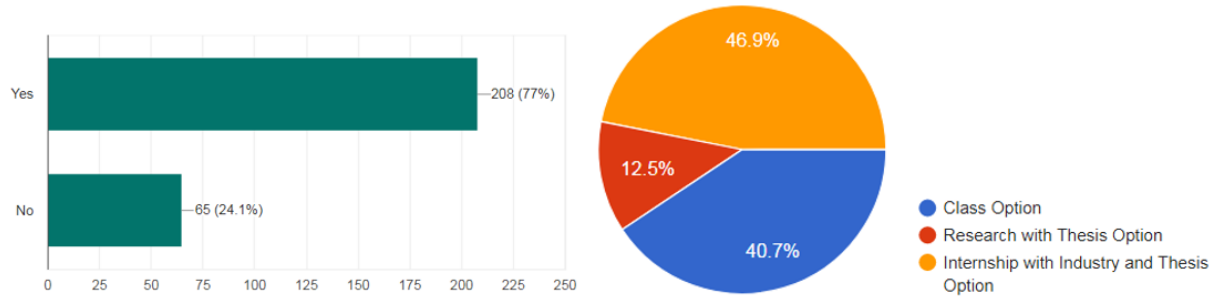

Figure 3. Students' survey on the relevance of Master of Science in Mechatronics

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 spend an additional 2 years on 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 Michigan Tech 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 represented a very broad range of industrial sectors including 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.

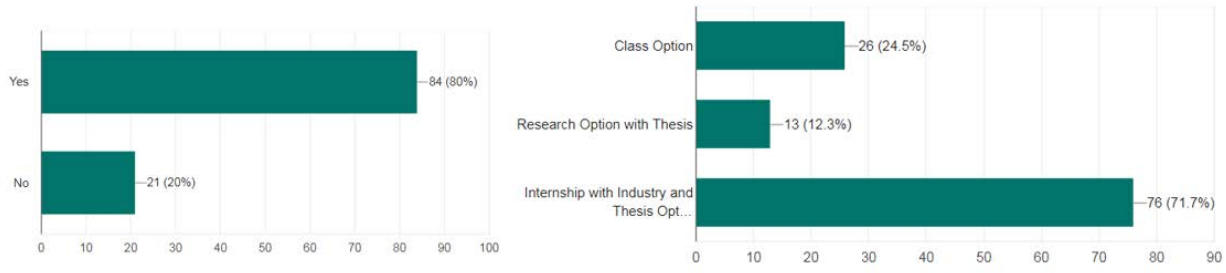

Figure 4. Industry response on the necessity of the master's degree in Mechatronics

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 preference (a rate of 80%) 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 complete 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, especially master's programs, exist in the United States. The University of Michigan offers a Master of Science in Robotics [1] with a focus on the research and development of human-robot interactions, bio-inspired

compliant systems, robotics, and nano-manipulation. Georgia Tech [2] 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 [3] 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 [4] that focuses on the development of solutions using robotic tools. Carnegie Mellon's robotics Master of Science [5] 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 [6] 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 [7] and stands out as having 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. Current enrolled students at Michigan Tech in bachelor's degrees who elect 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 the degree completion requirements.

4. Curriculum Design

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

Table 1. MS degree requirements

Option	Minimum Course credits	Research credits	Internship credits (included in course credits)	Minimum Total Credits
Coursework	30			30
Internship path	30		1-6	30
Thesis	20-24	6-10		30
Report	24-28	2-6		30

Figure 5 depicts the curriculum dodel 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 EET 5144, Real Time Robotics, and EET 5373, Advanced Programmable Logic Controllers. Knowledge of robotic systems and the ability to smartly program robots are 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 EET 5144 and EET 5373. The prerequisites are designed to allow students from EET, EE, MET, and ME-EM to be able to enroll in these courses.

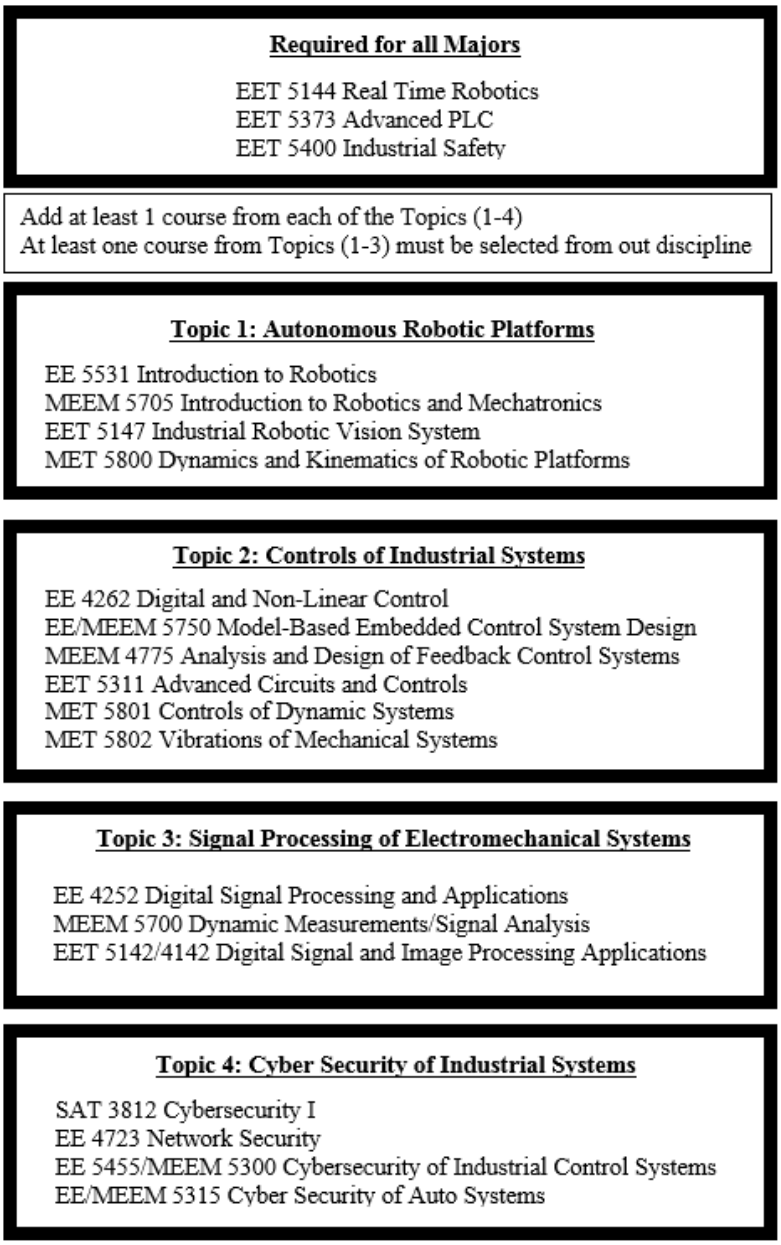

Figure 5. Curriculum model for MS

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 required that students with an electrical engineering background will complement their knowledge with mechanical engineering concepts by enrolling in at least one course outside of their disciplin, and vice versa for students with mechanical engineering backgrounds. This will be accomplished by supplementing the required courses with various technical elective courses needed to qualify as prerequisites.

5. 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 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 more than 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 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 an advocate of Michigan Tech for many years. 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 several 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, and 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 GM 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.

6. Description of the Equipment

The EET, MET, 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 will need to be shared between EET and ECE as well as ME and MET programs upon mutual agreement. The two courses, Advanced PLC Programming and Real-Time Robotics required for all majors, will be taught in the EET program using state- of-the-art laboratory equipment. The EET 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 conveyer, 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 fourth 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 and one process control system, shown in Figure 9. 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

Figure 6. Industrial robotic workcell

Figure 7. Amatrol mechatronics stations

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.

Figure 8. Amatrol PLC portable training station

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.

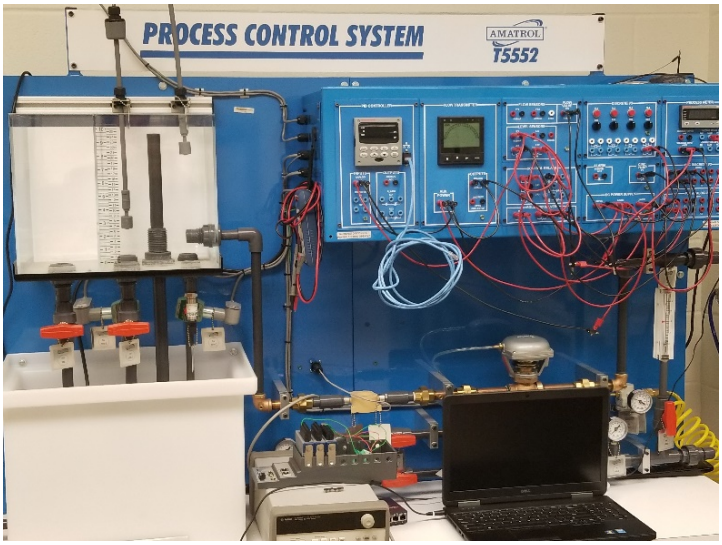

Figure 9. Amatrol process control system

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 more than 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 is important to enable the teaching of critical skills that are very relevant to current industry needs. Currently, laboratory equipment associated with teaching introductory and advanced 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 funding, additional equipment will be acquired to support larger classes and provide valuable hands-on training with adequate equipment to student ratio. The dean of the School of Technology is currently communicating with potential industrial partners, donors, and friends to bolster the equipment availability.

7. Conclusion

In this paper, we described the development and incorporation of a new Master of Science degree in Mechatronics at Michigan Tech. 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 who apply in their junior or senior year and meet the qualifications. The designated 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 degree in Mechatronics. The proposed degree also targets industry representatives; online courses will be made available in the second year after program development for the required master's-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 students from other universities will be able to enroll in the MS degree of Mechatronics based on 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. 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. Industry-driven curriculum advised by the industrial advisory board will provide students with the skills that are relevant to the current industry needs. The new Master of Science degree at Michigan Tech has been approved by the Board of Trustees and the State of Michigan. First cohort of students for this degree are now being accepted for Fall 2019.

References

[1] University of Michigan, Master of Science in Robotics

https://robotics.umich.edu/academic-program/

[2] Georgia Tech, https://www.gatech.edu/

[3] Massachusetts Institute of Technology, http://www.mit.edu/

[4] School of Engineering at Stanford University Master of Science degree in Engineering, https://exploredegrees.stanford.edu/schoolofengineering/

[5] Carnegie Mellon's robotics Master of Science program, https://www.ri.cmu.edu/ri-education/

[6] Oregon State University, Master's Degree in Robotics, https://gradschool.oregonstate.edu/programs/3250/robotics-phd-ms-minor

[7] The University of Pennsylvania, Master of Science Degree in Robotics, https://www.grasp.upenn.edu/academics/masters

Biographical Information

Dr. ALEKSANDR SERGEYEV is a professor of MERET program and a director of Mechatronics Graduate Program in the College of Computing at Michigan Tech. He has a strong record publishing in prestigious journals and conference proceedings such as *Measurement Science and Technology*, *Adaptive Optics*, *Sensors and Materials*, the *Technology Interface International Journal*, ASEE, IEEE, and SPIE. Dr. Sergeyev is a PI and co-PI on several NSF and DOL awards and multiple significant industry awards.

Dr. ADRIENNE MINERICK is a dean of the College of Computing at Michigan Tech. She is also a professor of Chemical Engineering at Michigan Tech. Minerick's primary area of research is electrokinetics with a focus on medical microdevices, blood cell dynamics and point-of-care diagnostics. Dr. Minerick is a fellow of AAAS and ASEE.

Dr. JOHN IRWIN is a professor and associate chair of the Department of Manufacturing and Mechanical Engineering Technology at Michigan Tech. His areas of expertise include jig, fixture, and gage design; the design and manufacture of environmental simulation chambers and A/C units for locomotives and mass-transit units; development of manufacturing workcell simulations, design and testing of residential axial flux alternator turbine systems, and development and training related to open source 3D printing technologies.