MEEP Stakeholder Workshop Summary

Overview of the Project

To address the need for advanced interdisciplinary manufacturing education for the defense industry, the increasing gap in manufacturing skills and the growth in the talent pipeline required to meet future workforce demands, Clemson University Center for Workforce Development (CUCWD) has proposed the *Technology In Manufacturing Education (TIME) for Robotics*, a transformative interdisciplinary manufacturing education initiative. This education initiative will combine personalized learning, virtual reality, and in-person experiential learning to create a novel educational experience that can be used locally and nationally to create a more prepared and diverse pipeline of individuals entering a career in advanced manufacturing.

Advisory Board

- Lance Ferguson, JTEKT
- Bob Graff, Yaskawa/Motoman
- Gadrian Zayas, BMW
- Howie Choset, Carnegie Mellon
- Pat Hillberg, Oakland University
- Jeff Hunt, Spartanburg Community College
- Susan Pretulak, readySC
- Tom Peters, SC Coalition for Mathematics & Science
- Bob Grabowski, Raytheon
- Greg Hudas, TARDEC

Stakeholder Workshop

CUCWD held a stakeholder workshop on April 22, 2019 at One Research Drive on the CUICAR campus. The purpose of the workshop was to present the initial draft of the MEEP curriculum outline to both industry and academic stakeholders for the purpose of obtaining their feedback. By facilitating a conversation and holding breakout sessions with the stakeholders, the PIs gathered feedback from various domains that will be used to improve the curriculum and address identified gaps.

Attendance **(*presented during workshop)**

The Stakeholder Workshop brought together 28 participants from various backgrounds including 20 from academia and the remaining 8 participants bringing an industry perspective. Below is a comprehensive list of the participants and their respective organizations:

- Anand Gramopadhye*, Clemson University
- Blake Fulton, GE
- Bob Grabowski, Raytheon
- Bob Graff, Motoman

MEEP Stakeholder Workshop Summary

- Chuck Spangler, SCMEP
- Eddie Bennett, Clemson University
- Evans Coleman, Clemson University
- Gadrian Zayas, BMW
- Jay Coffer, Spartanburg Community College
- Jeff Bertrand, Clemson University
- John Wagner, Clemson University
- John Williams, Clemson University
- Kapil Chalil Madathil, Clemson University
- Kelvin Byrd, Greenville Technical College
- Laine Mears*, Clemson University
- Lance Ferguson, JTEKT
- Patrick Hillberg, Siemens
- Philip Caruso, Greenville Technical College
- Rebecca Hartley, Clemson University
- Rodney Jones, Greenville Technical College
- Ron Potter*, Factory Automation System
- Stephen Cotton, Clemson University
- Tom Peters, Clemson University
- Venkat Krovi*, Clemson University
- Yue Wang*, Clemson University
- Yunyi Jia, Clemson University
- Zachary Trabookis, Clemson University
- Zaker Syed, Clemson University

Presentation Summaries

Industry Perspective: *Ron Potter, Factory Automation Systems*

Ron Potter is an expert in advanced manufacturing robotics and serves as the director of Robotics Technology at the Factory Automation System in Atlanta. He has over 50 years of experience working in the robotics industry and holds a degree in Mechanical Engineering from Michigan State University. Mr. Potter co-founded the first robotics integration company in the nation and he received the Joseph F. Engelberger Award for Applications from the Robotics Industry Association (RIA) in 1995. He has continued to educate various industries on the benefits of robotics integration delivering over 170 presentations to various companies in multiple industries around the world.

During his presentation, Ron Potter gave an overview of the business case for robotics, explaining that robotics was not only a technical solution, but also a business solution. He discussed the current challenges associated with offshore manufacturing including: high total supply chain costs, low product quality, decreased productivity, and high time to market. These challenges drive manufacturers to consider investing in industrial robots which offer an around-the-clock workforce, costing an average of $0.50/robot/hr. This low-cost workforce has the potential to increase product quality, productivity, manufacturing flexibility, and utilization of capital equipment. He also emphasized that future product design should not focus on duplicating what human does, rather building a final product line which can be modified to make the robot-human interaction usable toward factory automation.

By integrating robots, companies can decrease scrap, rework, work-in-process, inventory and floor space demands. Mr. Potter also shared resources that are offered to manufacturers such as a DOI calculator which calculates the cost savings of robot implementation and gives manufacturers a picture of their future cash flow.

MEEP Stakeholder Workshop Summary

Curriculum Outline Presentations
Subject Matter Experts (SMEs) gave an overview of their research, presented their vision for the curriculum, and how they plan to structure the development of the curriculum modules to address the needs of the students and the advanced manufacturing industry.

Dr. Laine Mears: Advanced Manufacturing SME
Dr. Laine Mears serves as the BMW SmartState Chair and professor in Automotive Manufacturing at Clemson University. He teaches modeling and analysis of automotive manufacturing processes and automation integration in manufacturing. During his presentation, Dr. Mears spoke of his most current research and explained the importance of keeping the human in the loop in advanced manufacturing. He also presented his comprehensive approach to the Advanced Manufacturing curriculum for each of the three higher education tracks of the TIME for Robotics project. His focus across these tracks centered around three key subject areas: Smart Manufacturing Systems, Manufacturing Process Modeling, and Manufacturing Automation Systems. As the learner progresses through each track (Associate's degree through Master's), these subject areas will increase in rigor that best suit the level of education pursued.

Dr. Yue "Sophie" Wang: Robotics SME for Baccalaureate track
Dr. Wang works as an associate professor at Clemson University in the department of Mechanical Engineering and is the Robotics SME for the Baccalaureate track of the project. She presented her ideal lesson plan for a course in robotics and human-robot interaction. Her outline detailed content development for foundational and progressed to advanced robotics applications and how robotics fits into the advanced manufacturing landscape.

Dr. Venkat Krovi: Robotics SME for Associates and Masters tracks
Dr. Krovi serves as the Michelin Endowed SmartState Chair and professor of Vehicle Automation in the departments of Automotive Engineering and Mechanical Engineering at Clemson University. He is the primary Robotics SME and has been developing for the Associate and Master tracks for the project. His discussion proposed two courses focused on theory and practical applications of robotic operations. He and Dr. Wang will synchronize efforts to develop a set of scaffolded modules that progress learners from applied robotics for 2-year focus, through basic and advanced robotics for 4-year concentrations, and lead to a specialization areas in the Masters curriculum.

These three experts have already brought a wealth of experience into the courseware and will continue to impress as the project deliverables are realized.

Breakout Session

In an effort to engage participants for real-time feedback, CUCWD held a breakout session which split the participants into two smaller subgroups which focused on maximum interaction with stakeholders.

MEEP Stakeholder Workshop Summary

First, we used a simple “post-it on a whiteboard” exercise to break the ice and capture raw feedback. In order to do this, we posed four overarching questions and had the subgroups further pair up, brainstorm their thoughts and post them under each question on the whiteboard. The questions were structured as follows:

- Alignment to industry/institutional needs
- Challenges in development and implementation
- Experiential components
- Gaps in curriculum outlines

The bulk of the conceptual challenges were identified here, and the group discussed amongst to find resolutions. These four focus areas were expanded upon further in the next activity called a “Jigsaw” activity. In the jigsaw, each pair examined one track of the curriculum outline and wrote feedback on a worksheet as to areas needing help and recommendations. A link to the Jigsaw worksheet can be found here: Breakout Jigsaw.

There was a great deal of feedback garnered in the session, which is largely discussed in the **Key Takeaways** section below.

Key Takeaways

The breakout sessions began by industry experts discussing their current needs and the deficiencies they see in the current workforce and the difficulties they are having recruiting people for positions in advanced manufacturing. Overall it was determined that students entering the workforce have a lower technical aptitude than those in the previous generations and that there is a stigma associated with working for the manufacturing industry. To address these challenges, participants discussed the alignment of the developed curriculum with the industry and institutional needs. Feedback from the discussion is categorized around these areas:

Prerequisite Knowledge

- mechanical and mathematical aptitude challenges with the material
- measuring proficiency in code languages required in robotics

Student Engagement/Experience

- access to automation opportunities and hands-on lab experiences
- practical internships/apprenticeships across all institutions that adopt the material
- engagement at the high school level to gain intertest in 2- and 4-year tracks
- how online courseware facilitates student feedback and engagement within teams
- training on actual equipment
- adding real-world components into course scenarios

MEEP Stakeholder Workshop Summary

Institutional Adoption and Verification of Skills

- are these supplemental courses or credit-hour courses?
  - answer: this curriculum is supplemental to existing institutional courses
- how to fit these courses in an already full degree program
- credentials to show proof of focus areas

Curriculum Needs/Software Licensure

- incorporation of maintenance and troubleshooting practices in the curriculum
- software access challenges and data analytics for students to use
- how could virtual content help
- incorporate information on employer needs, degree requirements, benefits
- incorporate Internet of Things (IoT) into curriculum
- extensive electrical component for 2-year courses are critical
- avoid duplication across tracks where possible

Alignment Summary

Overall, the industry leaders were pleased with the proposed curriculum and saw that it addressed many of their needs. Addressing the workforce shortage through implementing curriculum in all levels of the education system will increase future capacity of trained, competent workers who can adapt to emerging technologies. Work is needed to ensure the comments annotated above are reflected in the curriculum development process, where applicable.

Plan of Action

Through analysis of the meeting notes, the area SMEs for the project will take into account the summarized feedback and request additional information if needed. With this information, development can now be in full development. The general timeline for content development completion is below. CUCWD and SMEs will work together to develop specific target timelines to help facilitate reaching overall target timelines below. Adjustments can be made as required.

Associate Track

- Content developed: 10/15/19
- Instructional Design: 11/15/19
- Course Review: 12/1/19
- LMS Upload and Deployment: 12/20/19

Baccalaureate Track

- Content developed: 10/15/19
- Instructional Design: 11/15/19
- Course Review: 12/1/19
- LMS Upload and Deployment: 12/20/19

MEEP Stakeholder Workshop Summary

Masters Track

- Content developed: 10/15/19
- Instructional Design: 11/15/19
- Course Review:12/1/19
- LMS Upload and Deployment:12/20/19

High School Track (developed last)

- Content developed: 11/15/19
- Instructional Design: 12/1/19
- Course Review:12/15/19
- LMS Upload and Deployment: 1/5/20