UNIT REPORT

Manufacturing Research Center - Final Annual Report

Generated: 8/30/18, 10:44 AM

Definition of Unit: Center for Manufacturing Research

Start: 07/01/2016

End: 06/30/2017

Providing Department: Manufacturing Research Center

Department/Unit Contact: Vahid Motevalli

Mission/Vision/Goal Statement:

The Center for Manufacturing Research (CMR) was established in 1984 to leverage resources of the State of Tennessee, the University, industries, and government funding agencies into cooperative efforts to advance manufacturing research. The CMR's Mission stated below is driven by core principles from the College of Engineering's and the University's Mission.

CMR Mission

To advance and support scientific and engineering knowledge in areas related to manufacturing through fundamental research and technology transfer activities, and to impact the instructional program in those areas.

Strategic Research Areas

Using a strategic planning process that was based on national manufacturing roadmap strategies in alignment with the College of Engineering Strategic Research focus areas, the Center for Manufacturing Research has identified three strategic research areas: (1) Advanced Manufacturing, (2) Materials and Devices for Energy Storage and Conversion, and (3) Networking and Algorithm for Big Data.

Core Values

The CMR has established the core values listed below that define the behaviors we seek to reward and recognize.

1. Commitment to Personal and Scholarly Integrity
2. Teamwork
3. Commitment to Excellence
4. Commitment to Personal/Professional Development
5. Valuing Partnerships, Cooperation, and Collaboration
6. Commitment to Continuous Improvement

Definition of Unit: Center for Manufacturing Research

Start: 07/01/2017

End: 06/30/2018

Providing Department: Manufacturing Research Center

Department/Unit Contact: Vahid Motevalli

Mission/Vision/Goal Statement:

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CMR Mission

To advance and support scientific and engineering knowledge in areas related to manufacturing through fundamental research and technology transfer activities, and to impact the instructional program in those areas.

Research Areas

Using a strategic planning process that was based on national manufacturing roadmap strategies in alignment with the College of Engineering research focus areas, the Center for Manufacturing Research has identified three research areas: (1) Advanced Manufacturing, (2) Materials and Devices for Energy Storage and Conversion, and (3) Networking and Algorithm for Big Data in Manufacturing.

Core Values

The CMR has established the core values listed below that define the behaviors we seek to reward and recognize.

1. Commitment to Personal and Scholarly Integrity
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Goal 1. Increase national and international recognition for TTU manufacturing research

Define Goal:

Increase research activity in the CMR by increasing total funding requests through proposals submitted to external sources, and thus, increase funding impact at the University and State levels. The CMR is continuing to invest in faculty members in the College of Engineering who conduct research in manufacturing research areas. In addition to this investment, it is our goal that our external proposal activity and externally funded research will increase as a result of the efforts of the faculty and increased Center activities.

Intended Outcomes / Objectives:

Objective 1a. Increase externally funded research by a minimum of 5% annually.

Objective 1b. Increase proposal funding requests by 10% annually.

Goal 1. Increase national and international recognition for TTU manufacturing research

Define Goal:

Increase research activity in the CMR by increasing total funding requests through proposals submitted to external sources, and thus, increase funding impact at the University and State levels. The CMR is continuing to invest in new faculty members hired into the College of Engineering with some type of manufacturing-related focus. In addition to this investment, it is our goal that our external proposal activity and externally funded research will increase as a result of the efforts of the new faculty and increased Center activities.

Intended Outcomes / Objectives:

Objective 1a. Increase externally funded research and service funding by 25% annually using FY 2011-12 as a baseline ($1,236,826), (e.g., FY 2013-14 target would be $1,855,240; i.e., $1,236,826 + $309,207 + $309,207).

Objective 1b. Increase the dollar amount of proposals submitted by 25% annually using FY 2011-12 as a baseline ($10,895,277), (e.g., FY 2013-14 target would be $16,342,915; i.e., $10,895,277 + $2,723,819 + $2,723,819).

Goal 2. Increase student, faculty, & staff capabilities

Define Goal:

Increase the participation and capabilities of students, faculty, and staff in manufacturing related research and education via external funding, professional activities, and outreach programs.

Intended Outcomes / Objectives:

Ensure productivity of the CMR in scholarly work and graduates.

Enhance professional development of faculty and staff.

Goal 2. Increase student, faculty, & staff capabilities

Define Goal:

Increase the participation and capabilities of students, faculty, and staff in manufacturing related research and education via external funding, professional activities, and outreach programs.

Intended Outcomes / Objectives:

Ensure productivity of the CMR in scholarly work and graduates.

Enhance professional development of faculty and staff.

Goal 3. Increase resources of the CMR to allow for research expansion

Define Goal:

Increase the amount of income (resources), both internally and externally, that can be used to expand research in the CMR research focus areas and improve staff support for research activities.

Intended Outcomes / Objectives:

Potential sources of additional income for the CMR comes from release time of personnel, graduate student support from externally funded research, gifts, testing/service income, F&A return, and equipment grants or gifts. Increase of 5% annually is targeted.

Goal 3. Increase resources of the CMR to allow for research expansion

Define Goal:

Increase the amount of income (resources), both internally and externally, that can be used to expand research in the CMR strategic research focus areas and improve staff support for research activities.

Intended Outcomes / Objectives:

Potential sources of additional income for the CMR comes from release time of personnel, graduate student support from externally funded research, gifts, testing/service income, F&A return, and equipment grants or gifts. The level of increase should be 25% annually by FY 2017 using FY 2011-12 as a baseline ($499,477).

Assessment Tool #1: Project Activations

Goal/ Outcome/ Objective: Goal 1 and Goal 2 and Goal 3

Type of Tool: Tracking Spreadsheet

Frequency of Assessment: Annually

Rationale:

a. Project activations indicate the productivity of both the Center faculty and faculty associates as well as the Center staff in attracting external funding from International, Federal, State, Industry, and Private sources. This is also the measure that the Tennessee Higher Education Commission (THEC) uses to measure the vitality of a Center of Excellence. b. Successful results will indicate annual increases as described. c. Project activations are a measure of the value associated by outside agencies to the manufacturing-related research conducted through our Center. Several faculty have been added to the college and the university has significantly invested to increase research productivity.

Assessment Tool #1: Project Activations

Goal/ Outcome/ Objective:

Goal 1 and Goal 2 and Goal 3

Type of Tool: Tracking Spreadsheet

Frequency of Assessment: Annually

Rationale:

a. Project activations indicate the productivity of both the Center faculty and faculty associates as well as the Center staff in attracting external funding from International, Federal, State, Industry, and Private sources. This is also the measure that the Tennessee Board of Regents uses to measure the vitality of a Center of Excellence.
b. Successful results will indicate a 25% annual increase using FY 2011-12 as a baseline.
c. Project activations are a measure of the value associated by outside agencies to the manufacturing-related research conducted through our Center. Several new faculty have been added and the university has significantly invested to increase research productivity.

Assessment Tool #2: External Proposal Submissions

Goal/ Outcome/ Objective: Goal 1 and Goal 2 and Goal 3

Type of Tool: Tracking Spreadsheet

Frequency of Assessment: Annually

Rationale:

a. Proposal valuations have been shown statistically to be a significant leading indicator of Project Activations. This will help to identify processes that can be implemented or modified to boost proposal activity.
b. Successful results will indicate a 25% annual increase using FY 2011-12 as a baseline.
c. Proposal valuations are a function of both the number of proposals as well as the size of larger collaborative proposals. As the College of Engineering increases their number of new tenure-track faculty, the number of proposals should increase. As the College's Strategic Research Areas grow and become self-sustaining, the number of larger collaborative proposals should increase as well.

Assessment Tool #2: External Proposal Submissions

Goal/ Outcome/ Objective: Goal 1 and Goal 2 and Goal 3

Type of Tool: Tracking Spreadsheet

Frequency of Assessment: Annually

Rationale:

a. Proposal valuations have been shown statistically to be a significant leading indicator of Project Activations. This will help to identify processes that can be implemented or modified to boost proposal activity. b. Successful results will indicate an annual increase as described above. c. Proposal valuations are a function of both the number of proposals as well as the size of larger collaborative proposals. As the College of Engineering increases their number of tenure-track faculty, the number of proposals should increase. As the College's research areas grow and become self-sustaining, the number of larger collaborative proposals should increase as well.

Assessment Tool #3: Publications and Supported Graduate Student Degree Completion

Goal/ Outcome/ Objective: Goal 1 and Goal 2

Type of Tool: Other

Frequency of Assessment: Annually

Rationale:

1. Publications 2. Outreach Activities 3. Graduate Students Completing Degrees 4. Awards & Recognition

Assessment Tool #3: Publications and Supported Graduate Student Degree Completion

Goal/ Outcome/ Objective: Goal 1 and Goal 2

Type of Tool: Other

Frequency of Assessment: Annually

Rationale:

1. Publications 2. Outreach Activities 3. Graduate Students Completing Degrees 4. Awards & Recognition

Assessment Tool #4: Income Generation

Goal/ Outcome/ Objective: Goal 1 and Goal 2 and Goal 3

Type of Tool: Tracking Spreadsheet

Frequency of Assessment: Annually

Rationale:

a. The CMR uses its annual State Appropriation for basic resources including salaries, benefits, graduate assistantships and fees. In order to expand capabilities and increase seed funding in exploratory areas, the CMR must rely on supplementing State appropriations with release of salaries from external projects, testing and service income, and indirect return.
b. This assessment tool is highly correlated to project activations and is less likely to change dramatically. There are specific activities and processes that can be instituted that will positively affect this measure including direct requests for gifts to support graduate assistantships, marketing testing and service capabilities, and requiring Center faculty to claim more release on their funded projects.
c. Sampling includes all sources of additional income. The data comes directly from internal working spreadsheets and data readily available through BANNER.

Assessment Tool #4: Income Generation

Goal/ Outcome/ Objective: Goal 1 and Goal 2 and Goal 3

Type of Tool: Tracking Spreadsheet

Frequency of Assessment: Annually

Rationale:

a. The CMR uses its annual State Appropriation for basic resources including salaries, benefits, graduate assistantships and fees. In order to expand capabilities and increase seed funding in exploratory areas, the CMR must rely on supplementing State appropriations with release of salaries from external projects, testing and service income, and indirect return.
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c. Sampling includes all sources of additional income. The data comes directly from internal working spreadsheets and data readily available through BANNER.

Goal 1: Results/Outcomes/Accomplishments

Goal/Objective/Outcome Number: Goal 1. Increase national and international recognition for TTU manufacturing research

Results:

The CMR secured thirty-four externally funded projects for a total amount of $2,981,089, resulting in an approximate 21% decrease from the previous year. However, this is the fourth highest year of external funding since the center's inception in 1984. These activations included $541,251 of Indirect Costs to be processed through the University. A total of forty-seven research proposals in the amount of $12,788,866 were submitted to be considered for external funding, some of which will be funded during the next year. The total value of the proposals was a 21% decrease from the value of proposals submitted in 2016-2017. Nineteen of these proposals were submitted by new faculty hires in the Departments of Chemical, Electrical, and Mechanical Engineering. Thus, the refocusing of State Appropriations towards new faculty investment to support the College of Engineering and the University's Strategic Plan as well as the impact of new faculty hires since 2013 are becoming much more evident in proposal activities and external funding.

Included in the externally funded grants this past year were:

- Thirty-four different research projects were funded for a total of $2,981,089 from various funding agencies, i.e., U.S. Department of Energy, National Science Foundation, National Institute of Health, National Institute of Standards and Technology, Air Force Office of Scientific Research, and Oak Ridge National Laboratory. In addition, 47 externally funded research proposals in the amount of $12,788,866 were submitted by 25 different Center faculty associates to be considered for funding.
- The Industrial Assessment Center (IAC), led by Dr. Glenn Cunningham and Dr. Ethan Languri, CMR Faculty Associates (Mechanical Engineering), was awarded 2018 Center of Excellence by the U.S. Department of Energy (DOE). This award places the IAC as the top-ranking center out of 28 centers nationwide. $471,321 in Year 2 funding was awarded by DOE. The IAC has been in existence at Tennessee Tech since 2006.
- CMR Faculty Associate Dr. Ambareen Siraj continues to serve as PI for the Tennessee CyberCorps: Scholarship for Service Program with Drs. Mohammad Rahman and Douglas Talbert serving as Co-PI's. Additional funding is expected for the continuation of this effort. NSF provided additional funding of this Cybersecurity Program by awarding two separate supplemental components: 1) Bootcamp Funding

Supplement for $50,973 and 2) Community College Inclusion for $176,158. Dr. Siraj was also awarded second-year funding from the National Security Agency for $123,245 for GenCyber Camp during the summer of 2018. This combined funding for Cybersecurity research continues to make Tennessee Tech one of the highly visible cyber defense education programs in the country as well as designation by both NSA and the Department of Homeland Security (DHS) as a National Center of Academic Excellence in Cyber Defense Education (CAE-CD) through AY 2021.

- Dr. Jiahong Zhu, CMR Faculty Associate, was awarded $154,861 for a two-year DOE grant entitled “Development and Validation of Low-Cost, Highly-Durable, Spinel-Based Contact Materials for SOFC Cathode-Side Contact Application”. As a collaborative research effort between TTU (the leading research institute) and FuelCell Energy (FCE, the subawardee), this project focuses on developing and validating the low-cost, highly-durable, spinel-based material for SOFC cathode-side contact application utilizing a unique environmentally-assisted reactive sintering process to lower the sintering temperature.
- CMR Faculty Associate Steven Anton was awarded $135,554 for the second year of a three-year grant entitled "Self-Powered in Vivo Force and Implant Wear Sensing in Knee Arthroplasty" from the National Institute of Health. This research will help to determine if sensors can be used to record force and wear data, which in turn could develop better surgical procedures and implant designs in order to improve surgical outcomes and ultimately better public health.
- Dr. Ismail Fidan, CMR Faculty Associate, was awarded $310,759 for the second year of a three-year NSF grant entitled "AM-WATCH: Additive Manufacturing - Workforce Advancement Training Coalition and Hub". The primary goal of AM-WATCH is to bridge the gap between industry needs and future workforce skills via the enhancement of high school and community college curriculum with Additive Manufacturing practices. This will be accomplished through the development of curriculum and the delivery of professional development.
- Dr. Ambareen Siraj, CMR Faculty Associate, continued to lead the Collaborative Research in Capacity Building in Cybersecurity with Tennessee Tech and the Illinois Institute of Technology hosting the fifth annual Women in Cybersecurity Conference in Chicago, Illinois, that registered 1100 participants in attendance. A total of $456,000 of financial support for the Conference was secured from registration fees as well as matching commitments paid from 80 different sponsorships, including Facebook, Cisco Systems, IBM, Fidelity Investments, Google, and other large IT-focused corporations as well as Universities including Georgia Tech, University of Washington and the Institutions of Carnegie Mellon University.
- The CMR recruited two new Visiting International Researchers to Tennessee Tech during the past year to join the Center's Wireless Communications/Networking Systems Research Group.

Goal 1: Results/Outcomes/Accomplishments

Goal/Objective/Outcome Number: Goal 1. Increase national and international recognition for TTU manufacturing research

Results:

The CMR secured thirty-four externally funded projects for a total amount of $3,782,809, resulting in an approximate 30.6% increase from the previous year. These activations included $688,496 of Indirect Costs to be processed through the University. A total of fifty-eight research proposals in the amount of $16,175,678 were submitted to be considered for external funding, some of which will be funded during the next year. Even though almost the same number of proposals were submitted this past year as compared to last year, the total value of the proposals was a 23% decrease due to the high dollar value of proposals submitted in 2015-2016. Twenty-one of these proposals were submitted by new faculty hires in the Departments of Chemical, Electrical, and Mechanical Engineering. Thus, the refocusing of State Appropriations towards new faculty investment to support the College of Engineering and the University's Strategic Plan as well as the impact of new faculty hires since 2013 are becoming much more evident in proposal activities and external funding.

Included in the externally funded grants this past year were:

- The CMR experienced an all-time record-high year of external funding during the last fiscal year. Thirty-four different research projects were funded for a total of $3,782,809 from various funding agencies, i.e., U.S. Department of Energy, National Science Foundation, National Institute of Health, Air Force Office of Scientific Research, and Oak Ridge National Laboratory. In addition, 58 externally funded research proposals in the amount of $16,175,678 were submitted by 33 different Center faculty associates to be considered for funding.
- Dr. Glenn Cunningham, CMR Faculty Associate (Mechanical Engineering) received an award of $1,575,000 from the Department of Energy (DOE) for a five-year grant to fund an Industrial Assessment Center (IAC) entitled Public-Private Partnership to Promote Efficient Manufacturing and Workforce Development. This award will enable the CMR to continue administration of an IAC Center as they have done since the inception of the first IAC in 2006.
- The National Science Foundation (NSF) awarded Year 2 funding of $835,145 for the Tennessee CyberCorps: Scholarship for Service Program. CMR Faculty Associate Dr. Ambareen Siraj continues to serve as PI for the Program with Drs.

Mohammad Rahman and Douglas Talbert serving as Co-PI's. NSF provided additional funding of this Cybersecurity Program by awarding two separate supplemental components: 1) Bootcamp Funding Supplement for $48,889 and 2) Community College Inclusion for $104,815. Dr. Siraj was also awarded a grant from the National Security Agency for $99,653 for GenCyber Camp during the summer of 2017. This combined funding for Cybersecurity research continues to make Tennessee Tech one of the highly visible cyber defense education programs in the country as well as designation by both NSA and the Department of Homeland Security (DHS) as a National Center of Academic Excellence in Cyber Defense Education (CAE-CD) through AY 2021.

- CMR Faculty Associate Steven Anton was awarded funding of $417,372 for a three-year grant entitled "Self-Powered in Vivo Force and Implant Wear Sensing in Knee Arthroplasty" from the National Institute of Health. This research will help to determine if sensors can be used to record force and wear data, which in turn could develop better surgical procedures and implant designs in order to improve surgical outcomes and ultimately better public health.
- Dr. Ismail Fidan, CMR Faculty Associate, was awarded funding of $900,000 for a three-year NSF grant entitled "AM-WATCH: Additive Manufacturing - Workforce Advancement Training Coalition and Hub". The primary goal of AM-WATCH is to bridge the gap between industry needs and future workforce skills via the enhancement of high school and community college curriculum with Additive Manufacturing practices. This will be accomplished through the development of curriculum and the delivery of professional development.
- Dr. Ambareen Siraj, CMR Faculty Associate, continued to lead the Collaborative Research in Capacity Building in Cybersecurity with Tennessee Tech and the University of Arizona hosting the fourth annual Women in Cybersecurity Conference in Tucson, Arizona, that registered 785 participants in attendance. A total of $399,689 of financial support for the Conference was secured from registration fees as well as matching commitments paid from 55 different sponsorships, including Facebook, Cisco Systems, IBM, Fidelity Investments, Google, and other large IT-focused corporations as well as Universities including Mississippi State University and Carnegie Mellon University.
- CMR Faculty Associate, Dr. Chabum Lee, received funding of $184,866 from NSF for a three-year grant entitled "Supplement to Collaborative Research: Edge Surface Topography Characterization for Precision Sensing Technology". It is anticipated that this research will increase the performance envelope of the on-machine nanoscale surface measurement and machining methodology, producing new knowledge in high-precision, on-machine instrumentation.
- The CMR recruited two new Visiting International Researchers to Tennessee Tech during the past year--one joined the Center's Wireless Communications/Networking Systems Research Group and one conducted research with Automotive Fuel Cells Applications.

Goal 2: Results/Outcomes/Accomplishments

Goal/Objective/Outcome Number: Goal 2. Increase student, faculty, and staff capabilities

Results:

During this past year the CMR has achieved the following results for enhancing faculty, staff and student capabilities:

- Tennessee Tech University continues to hold the higher level of recognition under the Carnegie Classification to a "Doctoral Granting University, Limited Research" (previously classified as "Masters Granting - Large"). This recognition is in large part due to the increase in the number of PhD degrees awarded by the College of Engineering, which in turn has been largely supported by the research grants and state appropriation supporting the graduate students through CMR and CESR.
- Supported a total of 46 graduate students: 21 M.S. and 25 Ph.D. This accomplishment was possible with the Center's revenue provided from externally funded projects that was designated for graduate student support.
- During this past year, degrees were awarded to six Ph.D. students and fourteen M.S. students who were supported by the CMR, both from State Appropriations and externally funded grants.
- The CMR received total funded allotments of $471,321 this past fiscal year from the Department of Energy to continue the outreach to students and Tennessee industries via the Tennessee 3-Star Industrial Assessment Center (IAC) which has been in existence in the Center and at Tennessee Tech since its inception in 2006. A total of 159 students have been impacted by the IAC Program, with 55 of them receiving DOE certificates of achievement. To date, 210 no-cost energy efficiency assessments have been performed by the students and faculty for companies of all sizes and industries in and around Tennessee. This past year, the IAC began offering additional services such as water and wastewater assessments, consulting in Smart Manufacturing, ISO 50001 energy management systems, and cybersecurity assessments in collaboration with the Cybersecurity Education, Research, and Outreach Center (CEROC) at Tennessee Tech.
- The IAC contracted with the Tennessee Valley Authority (TVA) to provide assistance to them in achieving certification to the ISO 50001 Energy Management Standard for their Magnolia Combined Cycle Power Plant in Mississippi. This will be the first power plant in the country certified to this rigorous standard.

- The National Science Foundation awarded CMR Faculty Associates, Dr. Mohamed Mahmoud and Dr. Syed Hasan $121,103 for Year 3 to host a REU Site - Secure and Privacy Preserving Cyber Physical Systems at Tennessee Tech this summer for a ten-week period from June 4 to August 10, 2018. This REU Program will focus on research related to security and privacy preservation in Smart Cities infrastructures, including smart power grid and smart traffic management, and will provide undergraduate research experiences for a total of ten interns from ten different universities.
- CMR Faculty Associate Director, Dr. Stephen Canfield, continued to lead the Innovation Corps Sites Training Grant at Tennessee Tech during the second year.
- CMR-supported graduate students presented their research to their peers at a "Lightning Round" seminar series. The top student, based on peer rankings, was awarded a travel stipend to attend a conference.
- A Capstone grant funded for $15,000 was awarded from UT/CIS. This grant will allow students the opportunity to correlate their innovative ideas with various industries in a classroom environment.
- Faculty associates Dr. Ambareen Siraj, Dr. Mohammad Rahman, and Dr. Doug Talbert continue to administer the Tennessee CyberCorps: Scholarship for Service Program for the second consecutive year. This Program provides scholarships for undergraduate students. In addition, NSF provided additional funding for two separate supplemental components to enhance this Cybersecurity Program: 1) Bootcamp Program for $50,973 which funds a 2-day camp designed to offer new students with tips and resources to supplement their technical learning at their respective programs, and 2) the Community College Inclusion for $176,158 which will allow students at community colleges to have interactions with a Tennessee Tech liaison to ensure seamless transition into the Tennessee Tech program and will provide continuous monitoring of their progress.
- The fifth annual Women in Cybersecurity Conference held in Chicago, Illinois in March 2018 was led by Dr. Ambareen Siraj, CMR Faculty Associate. Cybersecurity students from Tennessee Tech as well as students from other universities such as Georgia Tech, University of Washington, and the Institutions of Carnegie Mellon University attended the conference. The conference registered 1100 participants in attendance.
- CMR staff, graduate and undergraduate students actively support the iMaker Space with extensive student use across campus.
- CMR staff support the Digital Manufacturing Demonstration Lab (DMDL).
- Travel funding has been provided to various faculty associates and graduate students to attend and present at international conferences.

Several faculty associates, staff, and students of the CMR have received significant honors and awards this past year with some of them being the direct result of successfully manufacturing related research and education supported via external funding.

- CMR Faculty Associate, Dr. Mohamed Mahmoud (Assistant Professor of Electrical and Computer Engineering), was awarded the Brown-Henderson Outstanding Engineering Faculty Award which rewards accomplishments that most closely reflect the mission of the College of Engineering, to prepare graduates through a blend of education, research and service.
- Mohamed Mahmoud was also awarded the Kinslow Engineering Research Award which is given for the best paper written by a TTU engineering faculty member and published in a refereed professional journal.
- Joseph Biernacki, CMR Faculty Associate, was awarded the highest faculty honor, the 2018 Caplenor Faculty Research Award.
- CMR Faculty Associate, Dr. Ambareen Siraj (CEROC Director) was selected as Cybersecurity Fellow by Cybersecurity Initiative of the New America.
- Dr. Siraj also received the 2018 Academic Leadership of the Year Educator Award from the Colloquium for Information Systems Security Education.
- CMR-supported Mechanical Engineering graduate student Farzin Mashali won the M.E. Graduate section of the Tennessee Tech Research and Creative Inquiry Day with his paper titled “Thermal Management Using Diamond Nanofluid”.
- CMR-supported Mechanical Engineering graduate student Mohsen Safaei won the Best Student Hardware Paper Competition and was runner up for the Best Student Paper Competition at the 2017 ASME Smart Materials Adaptive Structures and Intelligent Systems conference.

The three Center faculty and two R&D engineers have published ten journal papers, nine conference papers, and four technical presentations during the past year.

Goal 2: Results/Outcomes/Accomplishments

Goal/Objective/Outcome Number: Goal 2. Increase student, faculty, and staff capabilities

Results:

During this past year the CMR has achieved the following results for enhancing faculty, staff and student capabilities:

- Tennessee Tech University achieved a higher level of recognition under the Carnegie Classification to a "Doctoral Granting University, Limited Research" (previously classified as "Masters Granting - Large") in December 2015. This reclassification is in large part due to the increase in the number of PhD degrees awarded by the College of Engineering, which in turn has been largely supported by the research grants and state appropriation supporting the graduate students

through CMR and CESR.

- Supported a total of 55 graduate students: 29 M.S. and 26 Ph.D. This accomplishment was possible with the Center's revenue provided from externally funded projects that was designated for graduate student support.
- During this past year, degrees were awarded to three Ph.D. students and fifteen M.S. students who were supported by the CMR, both from State Appropriations and externally funded grants.
- The CMR received total funded allotments of $112,922 this past fiscal year from the Department of Energy to continue the outreach to students and Tennessee industrial facilities via the Tennessee 3-Star Industrial Assessment Center (IAC) which has been in existence in the Center and at Tennessee Tech since the inception of the first IAC in 2006. This funding allowed the CMR to finalize and closeout the previous IAC in December 2016 as well as initiate the outreach duties of the newly funded IAC award of $1,575,000 in October 2016 for the establishment of a new IAC five-year grant until August 31, 2021. A total of 151 students have been impacted by this Outreach Program while ten of them have been placed in energy-related summer internships with Tennessee manufacturers and 190 no-cost energy assessments have been conducted for manufacturers with 12 of those being conducted during the existence of the new IAC.
- The National Science Foundation awarded Dr. Joseph Rencis, Dean, College of Engineering, and Dr. Vahid Motevalli, Interim Director of the Center and the Associate Dean of Research and Innovation in the College of Engineering, a grant of $125,009 to host for the third consecutive year a Research Experiences for Undergraduate (REU) Site - Manufacturing and Techno-Entrepreneurship at Tennessee Tech this summer from June 5 to August 11, 2017. This REU Program will focus on manufacturing-related research and provide techno-entrepreneurship experiences for a total of eleven interns from ten different universities.
- The National Science Foundation awarded CMR Faculty Associates, Dr. Mohamed Mahmoud and Dr. Syed Hasan $119,835 for Year 2 to host a REU Site - Secure and Privacy Preserving Cyber Physical Systems at Tennessee Tech this summer for a ten-week period from June 5 to August 11, 2017. This REU Program will focus on research related to security and and privacy preservation in Smart Cities infrastructures, including smart power grid and smart traffic management, and will provide undergraduate research experiences for a total of ten interns from seven different universities.
- Travel funding has been provided to various faculty associates and graduate students to attend and present at international conferences.
- CMR-supported graduate students presented their research to their peers at a "Lightning Round" seminar series. The top student, based on peer rankings, was awarded a travel stipend to attend a conference.
- CMR staff, graduate and undergraduate students actively support the iMaker Space with extensive student use across campus.
- CMR staff support the newly established Digital Manufacturing Demonstration Lab (DMDL).
- A Capstone grant funded for $15,000 was awarded from UT/CIS. This grant will allow students the opportunity to correlate their innovative ideas with various industries in a classroom environment.
- Faculty associates Dr. Ambareen Siraj, Dr. Mohammad Rahman, and Dr. Doug Talbert continue to administer the Tennessee CyberCorps: Scholarship for Service Program for the second consecutive year. This Program provides scholarships for undergraduate students. In addition, NSF provided additional funding for two separate supplemental components to enhance this Cybersecurity Program: 1) Bootcamp Program for $48,889 which funds a 2-day camp designed to offer new students with tips and resources to supplement their technical learning at their respective programs, and 2) the Community College Inclusion for $104,815 which will allow students at community colleges to have interactions with a Tennessee Tech liaison to ensure seamless transition into the Tennessee Tech program and will provide continuous monitoring of their progress.
- The fourth annual Women in Cybersecurity Conference held in Tuscon Arizona in March 2017 was led by Dr. Ambareen Siraj, CMR Faculty Associate. Cybersecurity students from Tennessee Tech as well as students from other universities such as Mississippi State University and Carnegie Mellon University attended the conference. The conference registered 785 participants in attendance.
- Several faculty associates and staff of the CMR have received significant honors and awards this past year with some of them being the direct result of successfully manufacturing related research and education supported via external funding.

    1. CMR Faculty Associate, Dr. Mohamed Mahmoud (Assistant Professor of Electrical and Computer Engineering), was one of four authors to win a highly competitive international paper award at the Institute of Electrical and Electronics Engineers Wireless Communications and Networking Conference 2016.
    2. CMR Faculty Associate, Dr. Joe Biernacki (Professor of Chemical Engineering), recently received two international distinctions from the American Ceramic Society.

3. CMR Faculty Associate, Dr. Ambareen Siraj (Associate Professor of Computer Science), is serving as the Director of Tennessee Tech's Cybersecurity Education, Research, and Outreach Center (CEROC). She was invited to the White House this past year to participate in a meeting on developing the K-12 computer science and technology education pipeline for the national security industry. Dr. Siraj was also selected as a Cybersecurity Fellow by the Cybersecurity Initiative of New America, a think tank and civic enterprise committed to renewing American politics, prosperity, and purpose in the Digital Age.
4. CMR Faculty Associate Director, Dr. Stephen Canfield, led Mechanical Engineering students in ASME's International Additive Manufacturing 3D Challenge (IAM3D) this past year. Two teams made the finalists to present at the ASME IDETC/AM3D Conference in Charlotte, NC. One team, led b y Micah Hardyman and Jonathan Zieger, won the most innovative award while Tennessee Tech's graduate students won an impromptu design challenge and one was finalist in a NSF poster on design.
5. Two of our former graduate students supported by the IAC grant received awards. Ian Swagerty graduated with a Masters' degree in ME in 2016 and received an IAC Alumnus of the Year Award at the recent Annual Directors' Conference. Anthony Taylor graduated with Master's degree in ME this past May and received IAC Student of the Year Award. Anthony was one of two students receiving this award and Ian was one of five alumni. There are 28 IAC's across the country with hundreds of students and thousands of alumni.

- The three Center faculty published seven journal papers, four conference papers, one book, and one patent during the past year.

Goal 3: Results/Outcomes/Accomplishments

Goal/Objective/Outcome Number: Goal 3. Increase Resources of the CMR to Allow for Research Expansion

Results:

During this past year, the Center received the following salaries and supplies in release time from externally funded projects:

1. Faculty & Staff Release Time: $101,464

   Note: Six Center faculty and staff had some portion of their salary release from external funds. The CMR Interim Director is continuing to make an effort to ensure that ample release time is provided for all Center faculty and staff in proposals submitted for external funding.

2. Graduate Students Stipend & Fees: $458,759

   Note: This level of external funding for graduate students supported 74% of the CMR's students for this past year.

3. The CMR received revenue in our Testing Services Account income this past year of $70,010. This revenue is a direct result of the expanded capabilities of the CMR's staff and resources available in CMR Laboratories.
4. A total of $614,388 of "Soft Money" was received this past year by the CMR in the areas of F&A Return, Testing Services Income, Graduate Student Support, Equipment Usage, and Release Time. This supplemental income allowed the CMR to expand capabilities and resources while also refocusing State appropriations towards the investment of new faculty hires to support the College of Engineering and University Strategic Plan.

Goal 3: Results/Outcomes/Accomplishments

Goal/Objective/Outcome Number: Goal 3. Increase Resources of the CMR to Allow for Research Expansion

Results:

During this past year, the Center received the following salaries and supplies in release time from externally funded projects:

1. Faculty & Staff Release Time: $142,801

Note: Six of ten Center faculty and staff had some portion of their salary release from external funds. The CMR Interim Director is continuing to make an effort to ensure that ample release time is provided for all Center faculty and staff in proposals submitted for external funding.

2. Graduate Students Stipend & Fees: $481,254

Note: This level of external funding for graduate students supported 60% of the CMR's students for this past year.

3. The CMR received revenue in our Testing Services Account income this past year of $52,151. This revenue is a direct result of the expanded capabilities of the CMR's staff and resources available in CMR Laboratories.

4. A total of $796,950 of "Soft Money" was received this past year by the CMR in the areas of F&A Return, Testing Services Income, Graduate Student Support, Equipment Usage, and Release Time. This supplemental income allowed the CMR to expand capabilities and resources while also refocusing State appropriations towards the investment of new faculty hires to support the College of Engineering and University Strategic Plan.

During the past year the CMR experienced a 30.6% increase in research project activations. The total value of the proposals submitted last year was a 23% decrease from 2015-2016 due to the high dollar value of proposals generated that year.

CMR Faculty Associate Director, Dr. Stephen Canfield, continued to lead the Innovation Corps Sites Training Grant at Tennessee Tech during the second year.