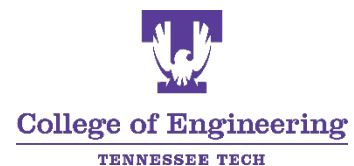


ANNUAL REPORT FY 2019—2020

Center for Manufacturing Research

College of Engineering

Tennessee Tech University



About the Cover

Developing an Electric Vehicle Demonstration Testbed in the Upper Cumberland Region of Tennessee, an Economy Distressed Rural Region

Sponsor: U.S. Department of Energy (DOE)

Principal Investigator: Pingen Chen, Ph.D., CMR Faculty Associate

Co-Principal Investigators: Stephen Canfield, Ph.D., Vahid Motevalli, Ph.D., Indranil Bhattacharya, Ph.D., Olorunfemi Ojo, Ph.D.

This project will create a proof-of-concept demonstration testbed for EVs and charging infrastructures in the Upper Cumberland region in Tennessee, which is a representative rural and economically distressed region, to provide the experience, research, demonstration and educational opportunities needed to address EV adoption issues. Comprehensive data will be collected and analyzed to report the operation cost, issues and performance of EV to help potential fleet owners and the public at large make informed decisions in EV adoption for rural areas before making significant financial investment.

The broad project impacts include: 1) accelerating EV adoption and promoting EV awareness in rural vehicle fleets and communities; 2) reducing transportation cost, fossil fuel consumption and greenhouse gas and harmful emissions, and improving fuel diversity and public health in rural areas; 3) enabling smooth and long-distance intercity transportation of goods and people with rural EV charging infrastructure; 4) helping Tennessee's corridor development initiatives and potentially boosting the economic development in the rural areas; and 5) facilitating collaborations between universities, automotive OEM and suppliers, DOE designated clean city coalition, and national lab for EV research and development, outreach and education.

Pictured (left to right): East Tennessee Clean Fuels Coalition Executive Director Jonathan Overly, TTU President Dr. Philip Oldham, Project PI and Assistant Professor of Mechanical Engineering Dr. Pingen Chen, and Seven States Power Corporation Director of Distributed Energy Resources Brad Rains all stand with the new direct current (DC) fast charging station that will serve the project and community.

Center for Manufacturing Research

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Tennessee Technological University Center for Manufacturing Research Annual Report – FY 2019 – 2020

Mission Statement (Unchanged since 2001)

“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.”

The Center for Manufacturing Research (CMR) at TTU was established in 1984 and named a THEC Established Center of Excellence in 1990.

Director

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CMR Faculty and Staff

Dr. Cynthia Rice, Associate Prof., ChE
Dr. Kwun-Lon Ting, Professor, ME

Brian Bates, R&D Engineer I
Jonathan Chappell, R&D Engineer I, (part-time, temporary)
Michelle Davis, Outreach Coordinator
Dr. Nan (Terry) Guo, R&D Engineer III
E. Wayne Hawkins, Material Science Lab Manager
Suzanne Henry, Center Manager
Giovanni Mainardi Neto, R&D Engineer I, (part-time, temporary)
Tammy Martin, Administrative Associate III (part-time, temporary)
Anysa Milum, Financial Associate VI
Mahdi Mohammedzadeh, Research Associate, (part-time, temporary)
Rob Reab, IT Systems Administrator (part-time, temporary)
Phyllis Stallion, Administrative Associate V
Darlene Wiegand, Financial Analyst (part-time, temporary)

CMR Faculty Associates*

Dr. Mohammad Albakri, Assistant Professor, ME
Dr. Ali Alouani, Professor, ECE
Dr. Steven Anton, Associate Professor, ME
Dr. Pedro E. Arce, Chair, Professor, ChE
Dr. Indranil Bhattacharya, Associate Professor, ECE
Dr. Joseph J. Biernacki, Professor, ChE
Dr. J. W. Bruce, Associate Professor, ECE
Dr. Stephen Canfield, Professor, ME
Dr. Pinggen Chen, Assistant Professor, ME
Dr. George Chitiyo, Professor, Curriculum & Instruction
Dr. Glenn Cunningham, Associate Professor, ME
Dr. William Eberle, Professor, CS
Dr. Ahmed ElSawy, Chair, Professor, MET
Dr. Ismail Fidan, Professor, MET
Dr. Melissa J. Geist, Professor, Nursing
Dr. Sheikh Ghafoor, Professor, CS
Dr. Manaak Gupta, Assistant Professor, CS
Dr. Syed Rafay Hasan, Associate Professor, ECE
Dr. Ada Haynes, Professor, Sociology & Political Science
Dr. Wayne Johnson, Retired Chair and Part-time Faculty Member, ECE
Dr. Stephanie Jorgensen, Instructor, ChE
Dr. Duck Bong Kim, Assistant Professor, MET
Dr. Ethan Languri, Assistant Professor, ME
Dr. Satish Mahajan, Professor, ECE; Director, CESR
Dr. Mohamed Mahmoud, Associate Professor, ECE
Dr. Vahid Motevalli, Assoc. Dean of Research and Innovation, College of Engineering; Professor, ME
Dr. Joseph Ojo, Professor, ECE
Dr. Jessica Oswalt, Professor, CE
Dr. Andy Pardue, Lecturer, ME
Dr. Akond Rahman, Assistant Professor, CS
Dr. Mohan Rao, Chair, Professor, ME
Dr. Jonathan (Robby) Sanders, Associate Professor, ChE
Dr. Steven Seiler, Associate Professor, Sociology & Political Science
Dr. Susmit Shannigrahi, Assistant Professor, CS
Dr. Ambareen Siraj, Professor, CS
Dr. Holly Stretz, Professor, ChE
Dr. Meenakshi Sundaram, Professor, ME
Dr. Andrea Arce-Trigatti, Instructor, Curriculum & Instruction
Dr. Doug Talbert, Associate Professor, CS
Dr. Dennis Ulybyshev, Assistant Professor, CS
Dr. Ahmedreza Vasselbehagh, Assistant Professor, ME
Dr. Chris Wilson, Chair GBE, Associate Professor, ME
Dr. Dale Wilson, Professor, ME
Dr. Jiahong (John) Zhu, Professor, ME

* CMR Faculty Associates are TTU faculty members who have been working with the CMR through serving as principal investigators, co-principal investigators or other senior personnel on externally-funded projects, or submitting proposals to seek external funding.

EXECUTIVE SUMMARY

As FY 2019-20 came to an end, the world was facing an unprecedented crisis. As we navigate these challenging times and reflect on the lessons we learned, as a state-funded Center for Manufacturing Research (CMR), it appears to us more important than ever to strengthen domestic manufacturing competitiveness and secure the U.S. for global leadership in advanced manufacturing. With a strong sense of mission, we are committed to supporting research and innovation of advanced manufacturing through academia-industry collaborations, and preparing the 21st century manufacturing workforce. To address some of the major challenges in advanced manufacturing research, the CMR has recently redefined its Research Focus Areas to center on “Digital Design & Manufacturing” and “Sustainable Materials and Manufacturing”.

In FY19-20, the CMR secured a total of \$2,830,562 in activated external funding. As the *Cybersecurity Education, Research and Outreach Center (CEROC)* continues to grow and expand, a decision was made by the College of Engineering for CEROC to start its operation independently. In this annual report, our annual activations are presented in both ways (with and without CEROC’s contribution) to reflect such operational change.

Regardless of the operational change, several nationally competitive grants in the areas related to advanced manufacturing were awarded to the CMR Faculty Associates, including two large grants from the Department of Energy (DOE). One of the DOE projects (total budget of \$1,559,686) led by Dr. Ping Chen aims to develop a demonstration test bed for electric vehicles in rural communities in the Upper Cumberland. The other DOE project (total budget of \$1,250,755) led by Dr. Ying Zhang (CMR Director), focuses on the development of innovative corrosion/erosion coatings for protecting steam turbine components in advanced ultra-supercritical power plants. A three-year proposal (\$424,259) submitted by Dr. Ali Alouani to Tennessee Valley Authority (TVA) was also selected for funding, and his team will design an intelligent robot for TVA substation inspection. In addition, Dr. Ying Zhang received a Defense University Research Instrumentation Program (DURIP) grant (\$315,000) from the Office of Naval Research (ONR) to synthesize high-quality metal powders for high-temperature coatings and next-generation metal additive manufacturing. In summary, a total of twenty projects were activated in FY19-20, which are funded by government agencies (e.g., National Science Foundation, DOE, ONR, TVA, etc.) and industrial sponsors.

Supporting manufacturing companies in Tennessee is always one of the top priorities of the CMR. The *Industrial Assessment Center (IAC)* led by Dr. Glenn Cunningham and Dr. Ethan Languri continually impacts small- and medium-sized manufacturers across the State of Tennessee through providing solutions and assistance in energy saving and waste reduction.

CMR Faculty Associates have been devoting themselves to manufacturing workforce education and training. In FY19-20, the CMR supported a total of 36 graduate students, 17 Ph.D. and 19 M.S. students. Our 2019-20 graduates with advanced degrees have been employed by various companies in Tennessee (e.g., Mobius, Electro-Active Technologies, Automation Tool Company, and Sauter Timber) and by Oak Ridge National Laboratory.

Center Research, Education and Outreach Areas

Digital Design and Manufacturing including (1) additive manufacturing, (2) advanced robotics and controls, and (3) cybersecurity in manufacturing.

Sustainable Materials and Manufacturing including (1) materials processing and modeling and (2) energy conversation / storage materials and devices.

Industry Support provides Tennessee manufacturers with technical expertise in problem-solving challenges faced in materials, design, testing, and processes.

Education and Outreach efforts enhance the Tennessee workforce development and outreach in the CMR's research areas in addition to such other activities as energy efficiency, waste reduction, and productivity improvements.

Selected Highlights from FY 2019 – 2020

External Funding Highlights

Twenty different research projects were funded for a total of \$2,830,562 from various funding agencies (i.e., National Science Foundation, National Institute of Health, Department of Defense, and Department of Energy).

CMR's new matching funds for the past FY were \$2,381,035. This amount excludes \$456,442 of indirect costs associated with this year's funded projects.

Twenty-nine research proposals totaling \$7,427,305 were submitted by CMR faculty and faculty associates.

CMR supported 36 graduate students during the past FY. Nineteen M.S. students and 17 Ph.D. students were funded from both State appropriations and external funding received by faculty. Specifically, external grants funded 14 of the M.S. students and five of the Ph.D. students. Thus, 53% of CMR graduate students supported was from external funding. Among the graduate students funded by CMR, three M.S. and three Ph.D. students were from underrepresented minorities.

CMR supported a total of 35 undergraduate students during this past fiscal year from both State Appropriations and externally funded projects.

Table 1. Summary of CMR Accomplishments

	FY 14-15	FY 15-16	FY 16-17	FY 17-18	FY 18-19	FY 19-20
Total External Activations	\$2,403,677	\$2,896,320	\$3,782,809	\$2,981,089	\$3,627,332	\$2,830,562
External Activations (Without CEROC's Contribution)	\$2,018,141	\$2,127,390	\$2,628,183	\$2,242,209	\$2,090,724	\$2,411,429
Number of Graduate Students Supported by External Funding and State Appropriations	32	55	55	46	33	36
Percentage of Graduate Students Supported by External Funding	53%	60%	49%	67%	55%	53%
Number of Undergraduate Students Supported by External Funding and State Appropriations	54	67	69	53	46	35

Table 1 summarizes CMR accomplishments in the past six years. The Center's annual external activations with and without CEROC's contribution are also presented in Figure 1. In FY 19-20, several nationally competitive grants in the areas related to advanced manufacturing were awarded to the CMR Faculty Associates, including two large DOE grants. A brief description of each of these funded projects can be found in the "Research Highlights" on page 7.

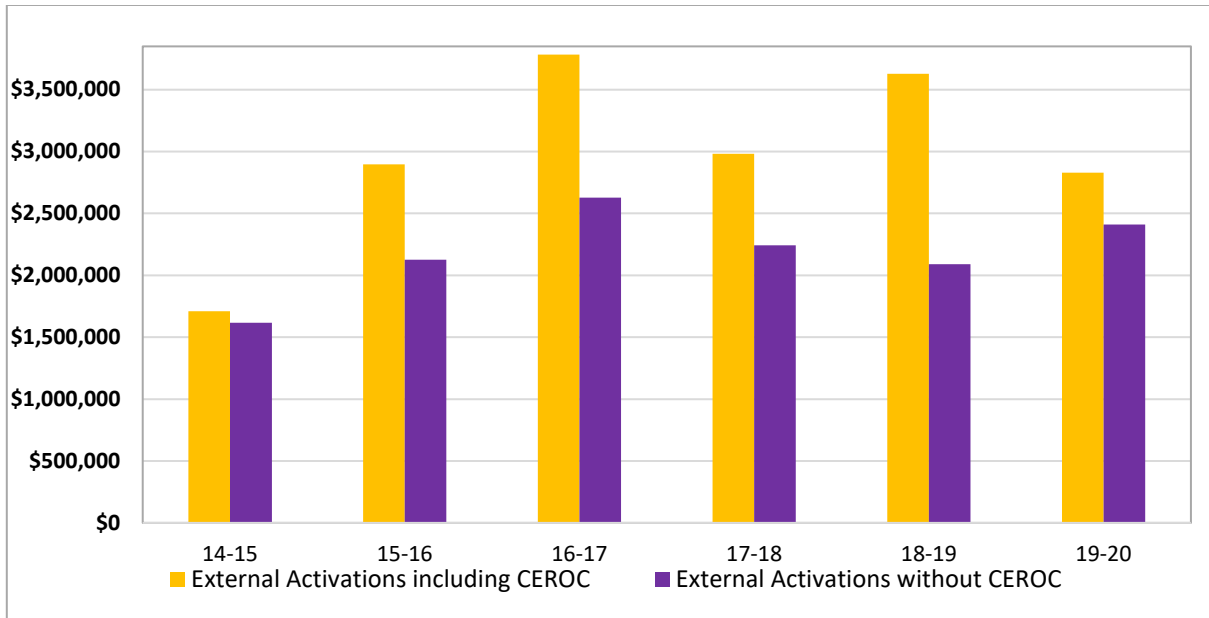


Figure 1 – Last 6 Years of External Funding

Table 2 shows various sources of external revenues for the past six years that were used to “release” or “free up” State appropriations for other strategic investment areas.

Table 2. Salary and Supplies Released by External Funding

Performance Metrics	FY 14-15	FY 15-16	FY 16-17	FY 17-18	FY 18-19	FY 19-20
CMR faculty and staff release time	\$99,224	\$128,231	\$142,801	\$101,464	\$86,717	\$129,844
Graduate student stipend and fees from external sponsors	\$325,719	\$282,994	\$481,254	\$428,579	\$287,144	\$157,179
Total of income resources (F&A return, testing income, GRA support, equipment usage, and release time)	\$558,390	\$552,393	\$796,950	\$614,388	\$412,454	\$304,220

Research Highlights

Dr. Pingen Chen, CMR Faculty Associate, was awarded \$476,703 for Year 1 of 3 (total three-year funding: DOE share \$ 779,823 + cost share \$779,863) from the Department of Energy for “Developing an Electric Vehicle Demonstration Testbed in the Upper Cumberland Region of Tennessee, an Economy Distressed Rural Region”. This project will create a proof-of-concept demonstration testbed for EVs and charging infrastructures in the Upper Cumberland region. Comprehensive data will be collected and analyzed to report the operation cost, issues and performance of EV to help potential fleet owners and the public at large make informed decisions in EV adoption for rural areas before making significant financial investment.



CMR Director Dr. Ying Zhang and CMR Faculty Associate Dr. Jiahong Zhu were awarded a grant of \$580,821 from the Department of Energy for Year 1 of 2 of the project “Development of Corrosion- and Erosion-Resistant Coatings for Advanced Ultra-Supercritical Materials”. The total award is \$1,250,755 (DOE share \$999,999 + cost share \$250,756). This work focuses on balancing the corrosion and erosion properties of the electro-codeposited coatings to protect steam turbine blades in advanced ultra-supercritical power plants.

The Office of Naval Research awarded Dr. Ying Zhang a DURIP grant of \$315,000 for a High-Performance Laboratory-Scale Gas Atomizer for Materials and Coatings Research. The gas atomizer will enable fabrication of high-quality metal powders with unique compositions and properties for emerging applications. The new equipment will have a direct impact on TTU research and education capabilities in disciplines important to DoD missions, especially in the areas of advanced coatings, additive manufacturing (AM) of new metals and alloys, and energy conversion devices. In spite of the potential that metal AM offers, to date, most applications rely on existing materials for feedstocks, which have not been designed and optimized for AM processes. There is a clear need for development of new feedstock materials that are created with AM in mind to provide advanced material properties capable of meeting next-generation design requirements and product applications.



Dr. Ali Alouani, CMR Faculty Associate, was awarded \$111,000 from the Tennessee Valley Authority to design and build an Intelligent Robot for TVA Substation Inspection. The total three-year grant is \$424,258. The objective of the TTU group for this research is to design an intelligent robot to collect relevant data while autonomously traveling across a substation for the Tennessee Valley Authority (TVA). The robot automatically communicates pertinent data to a maintenance team/control center/operator via a dashboard. Furthermore, the robot has onboard intelligence and learning capabilities, utilizing sensors data fusion to detect abnormal patterns and alert the appropriate individual/group in real-time. It will also detect visible wear and tear of a piece of equipment in the substation by analyzing acquired

images. The robot is to be utilized in different substations of different sizes and topologies.

CMR Faculty Associate Dr. Ambareen Siraj continues to serve as PI for the Tennessee CyberCorps: A Hybrid Program supported by NSF in Cybersecurity with Dr. Douglas Talbert serving as Co-PI. NSF provided additional funding of this Cybersecurity Program by awarding two separate supplemental components: 1) “A Series of Cyber Encounters to Address Gap in High School Cyber Education” for \$358,583 and 2) Community College Inclusion for \$93,154. This 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. The total award is \$5,058,651.



CMR Faculty Associate Ismail Fidan was awarded \$87,949 from the National Science Foundation for a project titled “Mobile Additive Manufacturing Platform for the 21st Century STEM Workforce Enhancement”. This project will bring additive manufacturing workshops and professional development activities directly to high schools, community colleges, and incumbent worker participants in the mid-South region. This will increase the number of AM-skilled technicians and position the region as an AM-ready location for manufacturing industries seeking to hire AM technicians.

The National Science Foundation awarded CMR Faculty Associates, Dr. Mohamed Mahmoud and Dr. Syed Hasan \$129,992 for Year 2 of a three-year program to host a Research Experiences for Undergraduates (REU) Site - Secure and Privacy Preserving Cyber Physical Systems at Tennessee Tech for a ten-week period in Summer 2020. This REU Program is focused on research related to security and privacy preservation in Smart Cities infrastructures, including smart power grid and smart traffic management, and provides undergraduate research experiences for a total of ten interns from different universities. Due to the pandemic, the Summer 2020 REU was cancelled.

CMR Faculty Associates and R&D engineers have published 35 journal papers, 45 conference papers, and four book chapters during the past year. They have received five patents.

Center Activities

Tennessee Three-Star Industrial Assessment Center

The Tennessee 3-Star Industrial Assessment Center (IAC) received an award of \$315,462 from the U.S. Department of Energy (DOE) to continue the IAC that was established in the CMR in 2006. The mission of the IAC is two-fold: 1) Assist small to medium sized manufacturers to become more energy efficient, and 2) Instruct engineering students in best practices of industrial energy efficiency to prepare them for the workforce. In thirteen years, 229 assessments have been performed by the students and faculty for companies of all sizes and industries in and around Tennessee, with total implemented persistent savings of \$63 million. One hundred and ninety students have participated in the IAC with 68 receiving DOE certification in the program. The IAC also offers 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. Tennessee Tech's IAC was the subject of an article in the September 2019 Compressed Air Best Practices magazine.

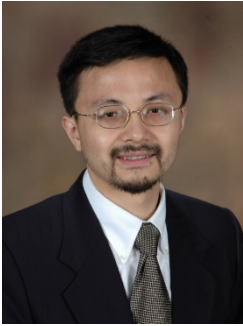


Materials Science Laboratory

The CMR's Materials Science Laboratory (MSL) was updated with a new ultra-high-resolution scanning electron microscope (Hitachi FE-SEM SU7000) that incorporates a large specimen chamber, enhanced versatility, and high throughput with simultaneous acquisition as well as analysis of various signal types. The SU7000 is equipped with EDAX Octane Elect Detector and APEX software for identifying and quantifying elemental compositions of a variety of materials. Scanning transmission electron microscope (STEM) imaging capabilities are also available. Tennessee Tech is the first university in North America to receive the Hitachi SU7000.

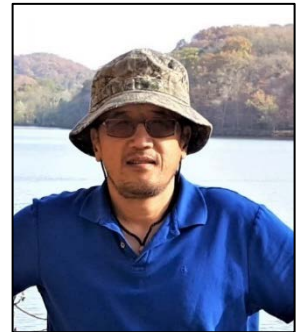


CMR Distinguished Speaker Series



Dr. Yan Wang (Associate Professor and George W. Woodruff Faculty Fellow in the Woodruff School of Mechanical Engineering, Georgia Institute of Technology, Callaway Manufacturing Center) was invited by the CMR to give a presentation titled “Physics-Based Data-Driven Predictive Analytics in Smart Manufacturing”.

Dr. Richard Mu (Associate Director of Advanced Materials Research in the TSU Interdisciplinary Graduate Engineering Research Institute in the College of Engineering at Tennessee State University) was invited to give a presentation titled “Building Mesostructured Sensory Systems with Nanomaterials – Function-by-Design”.



Dr. Deborah Chung (Professor in the Department of Mechanical and Aerospace Engineering’s Composite Materials Research Laboratory at the University of Buffalo, The State University of New York) was invited to give a presentation titled “Materials-Related Structural, Thermal, Electronic and Manufacturing Research”.

Seminar Presentations

Golden Eagle Additively Innovative Virtual Lecture Series

Fall 2019

“Generative Design Will Change the Future of Manufacturing”, Shashi Jain, Intel Corporation

“Sustaining Accessibility for Kids’ Creativity with Additive Manufacturing”, Dr. Pisut Koomsap, Asian Institute of Technology

“Design and Additive Manufacturing of Porous Titanium Scaffolds for Optimum Cell Viability in Bone Tissue Engineering”, Dr. Bingbing Li, California State University

“FDM based Metal Additive Manufacturing”, Dr. Haijun Gong, Georgia Southern University

Spring 2020

“New Functionalities for Metal AM by Embedded Intelligence”, Puukko Pasi, VTT Technical Research Centre of Finland, Ltd.

“Integrated Statistical / Experimental Methodologies for Rapid and Cost-Effective Optimization of Process Parameters in Additive Manufacturing”, Dr. Ehsan Toyserkani, University of Waterloo

“A Holistic Approach to Achieving the Best Possible Component Quality for AM Architectures for Vat Photopolymer and Laser Powder Bed Fusion Systems”, Dr. David Bue Pedersen, Technical University of Denmark

“Additive Manufacture with High Temperature Polymers”, Dr. Oana Ghita, University of Exeter

“From 3D Printing to Digital Manufacturing”, Dr. Wenchao Zhou, University of Arkansas

CMR Student Lightning Round Seminar Series

“Mechanical Characterization of Low-Cost Metal 3-D Printing”, Hao Lu, ME

“TechBot – A Mobile Multifunctional 3D Printing Platform”, Andreas Sauter, ME

“Synthesis and Characterization of MnCO₂O₄ Spinel as Solid Oxide Fuel Cell Cathode-Side Contact Application”, Yutian Yu, ME

“Multilabel Classification Method for Computer Vision on Edge Devices”, Ogheneuriri Oderhohwo, ECE

“Multi-Material Additive Manufacturing of Functionally Graded Composites”, Seymour Hasanov, ME

“Optimization of Engine Efficiency for Diesel Engine Equipped with EGR-VGT and Aftertreatment Systems”, Kuo Yang, ME

“Analyzing Compressor Performance Curves”, Josh Daugherty, ME

Faculty, Staff and Student Accomplishments and Awards



CMR Faculty Associate **Dr. Ismail Fidan** (Manufacturing & Industrial Technology), CMR R&D Engineer **Dr. Nan Guo**, and CMR Outreach Coordinator **Michelle Davis** were awarded the Leighton E. Sissom Innovation and Creativity Award for their work with the Golden Eagle Additively Innovative Virtual Lecture Series. This award was established to recognize innovation and creativity in scholarship, methodology, invention, technique, processes, or other unique contributions demonstrating innovation and creativity.

CMR Manager **Suzanne Henry** was awarded the College of Engineering's Outstanding Staff Award. Suzanne has worked for the CMR for twenty-nine years.





CMR Faculty Associate, **Dr. Steven Anton** (Mechanical Engineering), was awarded the Brown-Henderson Outstanding Engineering Faculty Award which rewards accomplishments that most closely reflect the mission of the College of Engineering – preparing graduates through a blend of education, research, and service.

Dr. Mohamed Mahmoud, CMR Faculty Associate in Electrical and Computer Engineering, was awarded the 2020 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. The paper is entitled “Efficient Privacy-Preserving Ride Sharing Organization for Transferable and Non-Transferable Services”, published in the IEEE Transactions on Dependable and Secure Computing (TDSC), 2019.



CMR-supported Electrical and Computer Engineering (ECE) graduate student **Tolulope Odetola** won the ECE Graduate (Masters) section of the Tennessee Tech Research and Creative Inquiry Day. Mr. Odetola’s paper was entitled “WORDA: A “6/3” Winograd Offline-Runtime Decomposition Algorithm for Faster Inference.”

In the Manufacturing and Engineering Technology (MET) section of the Tennessee Tech Research and Creative Inquiry Day, CMR-supported student **Hao Lu** won the Graduate (Masters) section with his paper “Mechanical Characterization of Low-Cost Metal Material Extrusion” and **Ankit Gupta** won the Graduate (PhD) section with his paper “Development of Methacrylate-Based Denture Reinforced with Short Glass Fibers Using the Fused Filament Fabrication Process”.

CMR-supported student **Eric Nolan** won the Mechanical Engineering Graduate (Masters) section of the Tennessee Tech Research and Creative Inquiry Day with his paper, “Electromechanical Impedance Based Structural Health Monitoring During a Dynamic Event”.

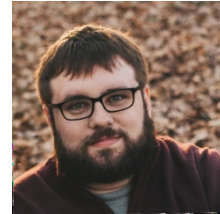
At the College of Engineering PhD Graduate Student Lightning Round Seminar, CMR-supported Mechanical Engineering students **David Chesson** presented his research “Characterization and Optimization of Ni-Fe and Mn-Co Spinel for Use in Cathode-side Contact Applications” and **Mahdi Mohammadizah** presented “3D-Printed Continuous Fiber Reinforced Thermoplastic Polymers, Mechanical and Thermal Analysis”.

Select 2019-20 CMR Alumni Employed in Tennessee

Mackenzie Hodge, M.S., Chemical Engineering, 2020
Chemical Engineer
Mobius
Knoxville, TN



Bryan Materi, Ph.D., Chemical Engineering, 2019
Research Engineer
Electro-Active Technologies, Inc.
Knoxville, TN



Aslan Nasirov, M.S., Mechanical Engineering, 2019
Research Intern
Oak Ridge National Laboratory
Knoxville, TN



Eric Nolan, M.S., Mechanical Engineering, 2020
Mechanical Engineer
Oak Ridge National Laboratory
Knoxville, TN



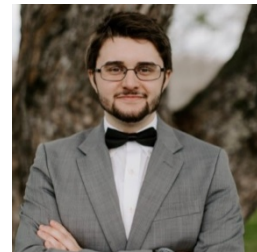
Micah Rentschler, M.S., Electrical & Computer Engineering, 2019
Controls Designer
Automation Tool Company
Cookeville, TN



Andreas Sauter, M.S., Electrical & Computer Engineering, 2019
Fabrication and Marketing
Sauter Timber
Rockwood, TN



Shane Terry, M.S., Mechanical Engineering, 2019
Technical Professional
Oak Ridge National Laboratory
Knoxville, TN



Publications of CMR Faculty Associates & Staff (January 2019 – December 2019)

Journal Publications

1. Ahmed, Asad, Osman Hasan, Falah Awwad, Nabil Bastaki, and **Syed Rafay Hasan**. "Formal Asymptotic Analysis of Online Scheduling Algorithms for Plug-In Electric Vehicles' Charging." *Energies* 12, no. 1 (2019): 19.
2. Ahsan, Md Rumman Ul, Ali Newaz Mohammad Tanvir, Taylor Ross, Ahmed Elsayy, Min-Suk Oh, and **Duck Bong Kim**. "Fabrication of bimetallic additively manufactured structure (BAMS) of low carbon steel and 316L austenitic stainless steel with wire+ arc additive manufacturing." *Rapid Prototyping Journal* (2019).
3. Alifui-Segbaya, Frank, Jasper Bowman, Alan R. White, Roy George, and **Ismail Fidan**. "Characterization of the Double Bond Conversion of Acrylic Resins for 3D Printing of Dental Prostheses." *Compendium of continuing education in dentistry (Jamesburg, NJ: 1995)* 40, no. 10 (2019): e7-e11.
4. Alsharif, Ahmad, Mahmoud Nabil, **Mohamed Mahmoud**, and Mohamed Abdallah. "EPDA: Efficient and privacy-preserving data collection and access control scheme for multi-recipient AMI networks." *IEEE Access* 7 (2019): 27829-27845.
5. Alsharif, M. Nabil, A. Sherif, **M. Mahmoud**, and M. Song, "MDMS: Efficient and privacy preserving multi-dimension and multi-subset data collection for AMI networks," *IEEE Internet of Things Journal (IoT)*, vol. 6, pp. 10363–10374, Dec. 2019.
6. Arce-Trigatti, Andrea, Melissa J. Geist, and J. **Robby Sanders**. "Analysis of Engineering and Nursing Student Communication Strategies in an Undergraduate, Cross-Disciplinary, Collaborative Course." *Journal for Research and Practice in College Teaching* 4, no. 1 (2019).
7. Baza, Mohamed, Nouredine Lasla, **Mohamed Mahmoud**, Gautam Srivastava, and Mohamed Abdallah. "B-ride: Ride sharing with privacy-preservation, trust and fair payment atop public blockchain." *IEEE Transactions on Network Science and Engineering* (2019).
8. Bonning, Bo, C. Jordan Blackburn, **Holly A. Stretz**, Christopher D. Wilson, and Wayne R. Johnson. "Superposition-based predictions of creep for polymer films at cryogenic temperatures." *Cryogenics* 104 (2019): 102979.
9. **Chen, Pinggen**, and Yao Ma. *Model Predictive NO_x Emission Control for a Biodiesel Engine Coupled with a Urea-based Selective Catalytic Reduction System*. No. 2019-01-0734. SAE Technical Paper, 2019.
10. **Fidan, Ismail**, Astrit Imeri, Ankit Gupta, Seymour Hasanov, Aslan Nasirov, Amy Elliott, Frank Alifui-Segbaya, and Norimichi Nanami. "The trends and challenges of fiber reinforced additive manufacturing." *The International Journal of Advanced Manufacturing Technology* 102, no. 5-8 (2019): 1801-1818.
11. Ford, Vitaly, and **Ambareen Siraj**. "GenCyberCoin: an engaging, customizable, and gamified web platform for cybersecurity summer camps and classrooms." *Journal of Computing Sciences in Colleges* 35, no. 3 (2019): 87-96.
12. Hailesellasie, Muluken Tadesse, and **Syed Rafay Hasan**. "Mulnet: A flexible cnn processor with higher resource utilization efficiency for constrained devices." *IEEE Access* 7 (2019): 47509-47524.

13. Kamali, Saeed, Chih-Jung Chen, **Brian Bates**, C. E. Johnson, and R. K. Chiang. "Size-dependent magnetic properties of γ -Fe₂O₃ nanocrystallites." *Journal of Physics: Condensed Matter* 32, no. 1 (2019): 015302.
14. **Kim, Duck Bong**. "An approach for composing predictive models from disparate knowledge sources in smart manufacturing environments." *Journal of Intelligent Manufacturing* 30, no. 4 (2019): 1999-2012.
15. Lin, Qinghua, and **Pingen Chen**. "Estimation of Ammonia Storage Nonuniformity for Urea-Based Selective Catalytic Reduction Systems." *Journal of Dynamic Systems, Measurement, and Control* 141, no. 4 (2019).
16. Mashali, Farzin, **Ethan Mohseni Languri**, Jim Davidson, David Kerns, **Wayne Johnson**, Kashif Nawaz, and **Glenn Cunningham**. "Thermo-physical properties of diamond nanofluids: A review." *International Journal of Heat and Mass Transfer* 129 (2019): 1123-1135.
17. Mathende, A., A. Arce-Trigatti, S. Jorgensen, **J. R. Sanders**, and P. E. Arce, "Leveraging Observation to Evaluate Student-Centered Learning: A Theory Based Analysis of Observational Models Applied to a Curricular Redesign," *Emerging Voices in Education*. 2019
18. **Mahmoud, M.**, K. Rabieh, A. Sherif, E. Oriero, M. Ismail, E. Serpedin, and K. Qaraqe. "Privacy-Preserving Fine-Grained Data Retrieval Schemes for Mobile Social Networks." *IEEE Annals of the History of Computing* 05 (2019): 871-884.
19. Maynard, Daniel S., Mark A. Bradford, Kristofer R. Covey, Daniel Lindner, Jessie Glaeser, **Douglas A. Talbert**, Paul Joshua Tinker, Donald M. Walker, and Thomas W. Crowther. "Consistent trade-offs in fungal trait expression across broad spatial scales." *Nature Microbiology* 4, no. 5 (2019): 846-853.
20. Methende, A. Arce-Trigatti, S. Jorgensen, **J. R. Sanders**, and **P. E. Arce**, "A theory based analysis of observational models applied to a curricular redesign," *Emerging Voices in Education*, Oct. 2019.
21. Mohammadzadeh, M., A. Imeri, **I. Fidan**, and M. Elkelany. "3D printed fiber reinforced polymer composites-Structural analysis." *Composites Part B: Engineering* 175 (2019): 107112.
22. Nabil, Mahmoud, Muhammad Ismail, **Mohamed MEA Mahmoud**, Waleed Alasmay, and Erchin Serpedin. "PPETD: Privacy-preserving electricity theft detection scheme with load monitoring and billing for AMI networks." *IEEE Access* 7 (2019): 96334-96348.
23. Nabil, Mahmoud, Ahmed Sherif, **Mohamed Mahmoud**, Ahmad Alsharif, and Mohamed Abdallah. "Efficient and privacy-preserving ridesharing Organization for Transferable and non-transferable services." *IEEE Transactions on Dependable and Secure Computing* (2019).
24. Oriero, Enahoro, and **Syed Rafay Hasan**. "Survey on recent counterfeit IC detection techniques and future research directions." *Integration* 66 (2019): 135-152.
25. Pascal, Jennifer A., Koteswara Rao Medidhi, Mario A. Oyanader, **Holly A. Stretz**, and **Pedro E. Arce**. "Understanding Collaborative Effects between the Polymer Gel Structure and the Applied Electrical Field in Gel Electrophoresis Separation." *International Journal of Polymer Science* 2019 (2019).
26. Pistono, Antonio O., and **Cynthia A. Rice**. "Subzero water distribution in proton exchange membrane fuel cells: Effects of preconditioning method." *International Journal of Hydrogen Energy* 44, no. 39 (2019): 22098-22109.
27. Ponder, Robert I., Mohsen Safaei, and **Steven R. Anton**. "Fabrication and selection of surrogate knee implant bearings for experimental evaluation of embedded in-vivo sensors." *Journal of the Mechanical Behavior of Biomedical Materials* 91 (2019): 237-246.

28. Safaei, Mohsen, Sylvain Dupre, Elias Hoummadi, and **Steven R. Anton**. "Design, analysis, and fabrication of a piezoelectric force tray for total knee replacements." *Journal of Intelligent Material Systems and Structures* 30, no. 20 (2019): 3163-3176.
29. Safaei, Mohsen, Henry A. Sodano, and **Steven R. Anton**. "A review of energy harvesting using piezoelectric materials: state-of-the-art a decade later (2008–2018)." *Smart Materials and Structures* 28, no. 11 (2019): 113001.
30. Tanvir, A. N. M., Md RU Ahsan, Changwook Ji, **Wayne Hawkins**, **Brian Bates**, and **Duck Bong Kim**. "Heat treatment effects on Inconel 625 components fabricated by wire+ arc additive manufacturing (WAAM)—part 1: microstructural characterization." *The International Journal of Advanced Manufacturing Technology* 103, no. 9-12 (2019): 3785-3798.
31. Wazirali, Ranyiah, Waleed Alasmay, **Mohamed MEA Mahmoud**, and Ahmad Alhindi. "An Optimized Steganography Hiding Capacity and Imperceptibly Using Genetic Algorithms." *IEEE Access* 7 (2019): 133496-133508.
32. Yang, Kuo, and **Pingen Chen**. *A Real-Time Control Framework for Integrated Diesel Engine and Selective Catalytic Reduction System*. No. 2019-01-1287. SAE Technical Paper, 2019.
33. Yao, Yuhong, **Terry N. Guo**, Zhe Chen, and Chong Fu. "A Fast Multi-Source Sound DOA Estimator Considering Colored Noise in Circular Array." *IEEE Sensors Journal* 19, no. 16 (2019): 6914-6926.
34. **Zhang, Ying**, **Brian Bates**, Jason Steward, and Sebastien Dryepondt. "Oxidation and hot corrosion performance of NiCoCrAlY coatings fabricated via electrolytic codeposition." *Oxidation of Metals* 91, no. 1-2 (2019): 95-112.
35. Zolghadr, Ali, Clark Templeton, and **Joseph J. Biernacki**. "Biomass Fast Pyrolysis Using a Novel Microsphere Microreactor Approach: Model-Based Interpretations." *Energy & Fuels* 33, no. 11 (2019): 10999-11008.

Conference Publications

1. Adams, B., A. Arce-Trigatti, and **P. Arce**. "Understanding Learning Environments at the Graduate Level: A Theoretical Analysis of Doctoral Engineering Education Programs." *Proceeding of the 12th International Conference of Education, Research and Innovation*, Nov. 11-13, 2019, Seville, Spain.
2. Alkhalidi, Faisal, and **Ali Alouani**. "Development of a Generic Model for Large-Scale Healthcare Organizations." In *2019 IEEE 19th International Symposium on High Assurance Systems Engineering (HASE)*, pp. 200-207. IEEE, 2019.
3. Allred, A. Nastasia, Samantha Blanton, **J. Robby Sanders**, and **Pedro E. Arce**. "Electrokinetic-Hydrodynamics: Bridging the Gap." In *Proceedings from the American Society for Engineering Education Southeastern Conference*. 2019.
4. Allred, A. Nastasia, Yung-Way Liu, **J. Robby Sanders**, and **Pedro E. Arce**. "Integral-Spectral Methods Applied to Healthcare Engineering: A Student-Focused Pedagogical Approach." In *Proceedings from the American Society for Engineering Education Southeastern Conference*. 2019.
5. Alsharif, Ahmad, Ahmed Shafee, Mahmoud Nabil, **Mohamed Mahmoud**, and Waleed Alasmay. "A Multi-Authority Attribute-Based Signcryption Scheme with Efficient Revocation for Smart Grid Downlink Communication." In *2019 International Conference on Internet of Things (iThings) and IEEE Green Computing and Communications (GreenCom) and IEEE Cyber, Physical and Social Computing (CPSCom) and IEEE Smart Data (SmartData)*, pp. 1025-1032. IEEE, 2019.
6. Amiri, Al Wesam, Mohamed Baza, Karim Banawan, **Mohamed Mahmoud**, Waleed Alasmay, and Kemal Akkaya. "Privacy-preserving smart parking system using blockchain and private information

- retrieval." In *2019 International Conference on Smart Applications, Communications and Networking (SmartNets)*, pp. 1-6. IEEE, 2019.
7. Arce-Trigatti, Andrea, Stephanie Jorgensen, **J. Robby Sanders**, Hunter Kaller, and Pedro E. Arce. "The Promotion of a Revised TPACK Model (TSPACK): Lessons Learned from the Foundry Inspired Steelcase Active Learning Space Project." In *Proceedings 2019 ASEE Annual Conference and Exposition*. 2019.
 8. Ayub, Md Ahsan, Steven Smith, and **Ambareen Siraj**. "A Protocol Independent Approach in Network Covert Channel Detection." In *2019 IEEE International Conference on Computational Science and Engineering (CSE) and IEEE International Conference on Embedded and Ubiquitous Computing (EUC)*, pp. 165-170. IEEE, 2019.
 9. Baza, Mohamed, Mahmoud Nabil, Nouredine Lasla, Kemal Fidan, **Mohamed Mahmoud**, and Mohamed Abdallah. "Blockchain-based firmware update scheme tailored for autonomous vehicles." In *2019 IEEE Wireless Communications and Networking Conference (WCNC)*, pp. 1-7. IEEE, 2019.
 10. Bhattarai, Uddhav, and **Ali T. Alouani**. "Hybrid navigation information system for minimally invasive surgery: Offline sensors registration." In *Science and Information Conference*, pp. 205-219. Springer, Cham, 2019.
 11. Bhuiyan, F. A., M. B. Sharif, P. J. Tinker, **W. Eberle**, **D. A. Talbert**, S. K. Ghafoor, and L. Frey, "Gene Selection and Clustering of Breast Cancer Data," *International Conference of the Florida AI Research Society (FLAIRS)*, May 2019.
 12. Bima, Muhammad Enagi, Indranil Bhattacharya, and **Syed Rafay Hasan**. "Comparative Analysis of Magnetic Materials, Coil Structures and Shielding Materials for Efficient Wireless Power Transfer." In *2019 IEEE International Symposium on Electromagnetic Compatibility, Signal & Power Integrity (EMC+ SIPI)*, pp. 95-100. IEEE, 2019.
 13. Brown, Katherine E., and **Douglas A. Talbert**. "Estimating Uncertainty in Deep Image Classification [Poster]." In *Proceedings of the American Medical Informatics Association Annual Symposium (AMIA)*. 2019.
 14. Brown, Katherine E., and **Douglas A. Talbert**. "Heuristically Reducing the Cost of Correlation-based Feature Selection." In *Proceedings of the 2019 ACM Southeast Conference*, pp. 24-30. 2019.
 15. England, Brandon S., and **Ali T. Alouani**. "Multiple Loads-Single Smart Meter for Measurement and Control of Smart Grid." In *2019 IEEE Innovative Smart Grid Technologies-Asia (ISGT Asia)*, pp. 2440-2444. IEEE, 2019.
 16. **Fidan, Ismail**, George Chitiyo, Eric N. Wooldridge, and Thomas Singer. "Multi-Institutional Collaboration in Additive Manufacturing." In *ASEE Annual Conference proceedings*. 2019.
 17. **Fidan, Ismail**, Melissa Geist, Yunbo Zhang, and George Chitiyo, "The Development and Implementation of an Interdisciplinary Additive Manufacturing for Healthcare Innovation Course," *Proceedings of the 2019 ASEE Annual Conference, Tampa, FL*, June 16-19, 2019.
 18. **Guo, Terry**, Animesh Dahal and **Ambareen Siraj**, "Precise Feature Selection and Case Study of Intrusion Detection in an Industrial Control System (ICS) Environment," *15th International Conference on Machine Learning and Data Mining MLDM 2019*, July 20-25, 2019.
 19. Gupta, Ankit, Seymour Hasanov, and **Ismail Fidan**. "PROCESSING AND CHARACTERIZATION OF 3D-PRINTED POLYMER MATRIX COMPOSITES REINFORCED WITH DISCONTINUOUS FIBERS." In *Proceedings of the 30th Annual International Solid Freeform Fabrication Symposium-An Additive Manufacturing Conference, Austin, TX*. 2019.

20. Hailesellasie, Muluken, **Syed Rafay Hasan**, and Otmame Ait Mohamed. "MulMapper: towards an automated FPGA-Based CNN processor generator based on a dynamic design space exploration." In *2019 IEEE International Symposium on Circuits and Systems (ISCAS)*, pp. 1-5. IEEE, 2019.
21. Hailesellasie, Muluken, Jacob Nelson, Faiq Khalid, and **Syed Rafay Hasan**. "VAWS: Vulnerability Analysis of Neural Networks using Weight Sensitivity." In *2019 IEEE 62nd International Midwest Symposium on Circuits and Systems (MWSCAS)*, pp. 650-653. IEEE, 2019.
22. Islam, S. R., **W. Eberle**, S. C. Bundy, and S. Ghafoor, "Infusing Domain Knowledge in AI-based "black box" Models for Better Explainability with Application in Bankruptcy Prediction," Workshop on Anomaly Detection in Finance," *SIGKDD Conference on Knowledge Discovery and Data Mining (KDD)*, August 2019.
23. Jorgensen, Stephanie, Andrea Arce-Trigatti, A. Mathende, S. B. Cain, A. H. Harris, **J. R. Sanders**, and **P. E. Arce**. "An Activity to Illustrate Teamwork: An Introduction to the Renaissance Foundry Model through Mindful Abstraction." In *Proceedings 2019 ASEE Annual Conference and Exposition*. 2019.
24. Jorgensen, Stephanie, Andrea Arce-Trigatti, **J. Robby Sanders**, and **Pedro E. Arce**. "Promoting innovative learning strategies: A collaborative curricular re-design at the undergraduate level." In *Proceedings from the American Society for Engineering Education Southeastern Conference*. 2019.
25. Kamal, M, J Bivens, **DA Talbert**. "Never Ending Learner for Malware Analysis (NELMA) [Poster]." *National Women in Cybersecurity Conference*, 2019.
26. Lin, Qinghua, and **Pingen Chen**. "A Torque Balance Method for Multi-Cylinder Gasoline Engines With Non-Uniform Cylinder-to-Cylinder Combustion Strategies." In *Dynamic Systems and Control Conference*, vol. 59155, p. V002T11A005. American Society of Mechanical Engineers, 2019.
27. Lin, Qinghua, **Pingen Chen**, Michael Haas, and Pardis Khayyer. "A Tailpipe NO_x Sensor Decoupling Algorithm for Integrated SCR and AMOX Systems." In *2019 American Control Conference (ACC)*, pp. 1605-1610. IEEE, 2019.
28. Mamun, Mohammad Mahbubur Rahman Khan, and **Ali Alouani**. "Using Photoplethysmography & ECG Towards a Non-Invasive Cuff less Blood Pressure Measurement Technique." In *2019 IEEE Canadian Conference of Electrical and Computer Engineering (CCECE)*, pp. 1-4. IEEE, 2019.
29. Mohammadzadeh, M., **I. Fidan**, "Thermal Analysis of 3D Printed Continuous Fiber Reinforced Thermoplastic Polymers for Car Part Applications," In *Proceedings of the 30th Annual International Solid Freeform Fabrication Symposium-An Additive Manufacturing Conference*, pp. 899-906, Austin, TX, August 12-14, 2019.
30. Mohammed, Hawzhin, Tolulope A. Odetola, **Syed Rafay Hasan**, Sari Stissi, Isaiah Garlin, and Falah Awwad. "(HIADIoT): Hardware intrinsic attack detection in Internet of Things; Leveraging power profiling." In *2019 IEEE 62nd International Midwest Symposium on Circuits and Systems (MWSCAS)*, pp. 852-855. IEEE, 2019.
31. Nabil, Mahmoud, **Mohamed Mahmoud**, Muhammad Ismail, and Erchin Serpedin. "Deep Recurrent Electricity Theft Detection in AMI Networks with Evolutionary Hyper-Parameter Tuning." In *2019 International Conference on Internet of Things (iThings) and IEEE Green Computing and Communications (GreenCom) and IEEE Cyber, Physical and Social Computing (CPSCom) and IEEE Smart Data (SmartData)*, pp. 1002-1008. IEEE, 2019.
32. Nasirov, A., S. Hasanov, and **I. Fidan**. "Prediction of mechanical properties of fused deposition modeling made parts using multiscale modeling and classical laminate theory." In *Proceedings of the 30th Annual International Solid Freeform Fabrication Symposium-An Additive Manufacturing Conference, Austin, TX*, vol. 1376. 2019.

33. Nolan, Eric C., Mohsen Safaei, and **Steven R. Anton**. "Evaluation of SHM With the Electromechanical Impedance Method Using a High Voltage Excitation Signal in High Frequencies." In *Smart Materials, Adaptive Structures and Intelligent Systems*, vol. 59131, p. V001T05A003. American Society of Mechanical Engineers, 2019.
34. Paudel, Ramesh, Prajwal Kandel, and **William Eberle**. "Detecting spam tweets in trending topics using graph-based approach." In *Proceedings of the Future Technologies Conference*, pp. 526-546. Springer, Cham, 2019.
35. Paudel, Ramesh, Peter Harlan, and **William Eberle**. "Detecting the onset of a network layer dos attack with a graph-based approach." In *The Thirty-Second International Conference of the Florida AI Research Society (FLAIRS)*, May. 2019.
36. Paudel, Ramesh, Timothy Muncy, and **William Eberle**. "Detecting DoS Attack in Smart Home IoT Devices Using a Graph-Based Approach." In *2019 IEEE International Conference on Big Data (Big Data)*, pp. 5249-5258. IEEE, 2019.
37. Radi, Eman Mohammed, Nouredine Lasla, Spiridon Bakiras, and **Mohamed Mahmoud**. "Privacy-Preserving Electric Vehicle Charging for Peer-to-Peer Energy Trading Ecosystems." In *ICC 2019-2019 IEEE International Conference on Communications (ICC)*, pp. 1-6. IEEE, 2019.
38. Roberts, Jesse, and **Douglas Talbert**. "Biologically Extending the Gen 2 ANN Model." In *The Thirty-Second International Conference of the Florida AI Research Society (FLAIRS)*, May. 2019.
39. Strange, Dakota, **Pingen Chen**, Vitaly Y. Prikhodko, and James E. Parks. "Optimization of Combustion Mode Duration for Lean Gasoline Engine with NO_x Storage-Capable Passive Selective Catalytic Reduction System." In *2019 American Control Conference (ACC)*, pp. 1599-1604. IEEE, 2019.
40. Tantawi, Khalid Hasan, **Ismail Fidan**, and Anwar Tantawy. "Status of smart manufacturing in the United States." In *2019 IEEE 9th Annual Computing and Communication Workshop and Conference (CCWC)*, pp. 0281-0283. IEEE, 2019.
41. Terry, S., **I. Fidan**, K. Tantawi, "Dimensional Analysis of Metal Powder Infused Filament – Low Cost Metal 3D Printing," In *Proceedings of the 30th Annual International Solid Freeform Fabrication Symposium-An Additive Manufacturing Conference*, pp. 533-541, Austin, TX, August 12-14, 2019.
42. Velampalli, Sirisha, Lenin Mookiah, and **William Eberle**. "Discovering Suspicious Patterns Using a Graph Based Approach." In *The Thirty-Second International Conference of the Florida AI Research Society (FLAIRS)*, May. 2019.
43. Yang, Kuo, and **Pingen Chen**. "Optimization of Engine Efficiency for Diesel Engine Equipped With EGR-VGT and Aftertreatment Systems." In *Internal Combustion Engine Division Fall Technical Conference*, vol. 59346, p. V001T05A007. American Society of Mechanical Engineers, 2019.
44. Zhang, Zhicheng, and **Ismail Fidan**. "Failure Detection of Fused Filament Fabrication via Deep Learning." In *Proceedings of the 30th Annual International Solid Freeform Fabrication Symposium-An Additive Manufacturing Conference*, pp. 2156-2164, Austin, TX, August 12-14, 2019.
45. Zoodsma, J., J. Dean, S. Spry, J. Dickinson, **S. R. Hasan**, **T. Guo**, "An Intelligent and Secure Cloud Controlled Robotic Arm with Sensor Feedback Feature", *IEEE SouthEast Conference*, 2019.

Book Chapters

1. **Languri, E.** and **G. Cunningham**, Thermal Energy Storage Systems, Advances in Sustainable Energy, Editors: Vasel A. and Ting D., Springer, April 2019.

2. Imeri, A. and **I. Fidan**, “Fatigue Life Prediction of Composites and Composite Structures,” Woodhead Publishing Series in Composites Science and Engineering, pp. 335-348, 2019, (*Book Chapter*), <https://doi.org/10.1016/B978-0-08-102575-8.00009-7>.
3. **Fidan, I.**, “Section: Research and Development, Academic Activities and Capabilities in Additive Manufacturing,” pp. 314-329, Wohlers Report 2019, (*Book Chapter*), ISBN: 978-0-9913332-5-7.
4. Terry, S., **I. Fidan**, Y. Zhang, and K. Tantawi, “Smart Manufacturing for Energy Conservation and Savings,” First Edition, CENGR 126-SEL-19, (*Booklet*) Tennessee Tech University, Cookeville, TN, 2019. Approved by Tennessee Tech University Intellectual Property Advisory Committee, Office of Research and Economic Development, and Office of Communications and Marketing.

Patents

1. Altalhi, A., S. B. Cain, A. Haris, Y.-L. Lee, and **R. Sanders**, “Pipet Stabilization Attachment,” Disclosure filed with the TTU Office of Research. October 2017. Provisional patent application filed with the USPTO on October 9, 2019.
2. Arce, P., **R. Sanders**, and A. Haris, “Modifying Hydrogels by Applied Electrical Field,” Disclosure filed with the TTU Office of Research. May 2018. Provisional patent application filed with the USPTO on September 25, 2019.
3. **Fidan, I.**, A. Imeri, N. Russell, Y. Chen, C Rios, and K. Wendt, “Fiber-Reinforced Additively Manufactured Snap-Fit Connected Medical Boot,” Provisional US Patent #: 62/912,401, October 17, 2019 (initial approval was 2017. renewed in 2019). K. Wendt was a Mechanical Engineering Undergraduate.
4. **Fidan, I.**, A. Sauter, A. Nasirov, C. Welcome, M. Allen, “TechBot - Mobile Multitasking 3D Printer,” Provisional US Patent #: 62/836,370, April 29, 2019. C. Welcome was a MET Undergraduate.
5. **Fidan, I.**, C. Welcome, E. Wooldridge, J. Kemper, and T. Singer, “Additive Manufactured Universal Bottle Opener,” Provisional US Patent #: US 62/840,498, May 7, 2019. C. Welcome was a MET Undergraduate.

External Activations

Project Description	P.I.	Department	Total Funds
1 Reference-free Longitudinal Rail Stress and Neutral Temperature Measurement Utilizing Multidirectional Elastic Waves Virginia Tech University (via Federal Railroad Administration funds) - Subaward 451358-19C95 Account #: 5-32603 832MC	Mohammad Albakri	ME	\$32,000
2 Intelligent Robot for TVA Substation Inspection Tennessee Valley Authority (TVA) Account #: 532605 836MC-Y1	Ali Alouani	ME	\$111,000
3 Project-based Learning for Educating Next-Generation Automotive Engineers at Tennessee Tech Denso North America Foundation Account #: 5-35917 814MC-A	Pingen Chen Stephen Canfield Vahid Motevalli Mohan Rao	ME COE	\$45,000
4 Developing an EV Demonstration Testbed in the Upper Cumberland Region of Tennessee, an Economy Distressed Rural U.S. Department of Energy - Award DE-EE0008888 - Year 1 of 3 Account #: 5-32601 821MC-Y1	Pingen Chen Stephen Canfield Vahid Motevalli Indranil Bhattacharya Joseph Ojo	ME ME/COE	\$476,703
5 Public-Private Partnership to Promote Efficient Manufacturing and Workforce Development Department of Energy, Office of Energy Efficiency and Renewable Energy - Award DE-EE007702 - Modification #10 Account #: 5-32278 658-M10	Glenn Cunningham Ethan Languri	ME ME	\$30,000
6 Public-Private Partnership to Promote Efficient Manufacturing and Workforce Development Department of Energy, Office of Energy Efficiency and Renewable Energy - Award DE-EE007702 - Modification #11 Account #: 5-32278 658-M11	Glenn Cunningham Ethan Languri	ME ME	\$100,000
7 Public-Private Partnership to Promote Efficient Manufacturing and Workforce Development Department of Energy, Office of Energy Efficiency and Renewable Energy - Modification #12 - Award DE-EE007702 Account #: 5-32278 658-M12	Glenn Cunningham Ethan Languri	ME ME	\$185,462
8 SMART2 Smart Manufacturing for America's Revolutionizing Technological Transformation Motlow State Community College (via NSF Award 1801120) - Year 2 of 3 Account #: 5-31297 745MC-Y2	Ismail Fidan	MET	\$73,661

	Project Description	P.I.	Department	Total Funds
9	Mobile Additive Manufacturing Platform for the 21st Century STEM Workforce Enhancement Somerset KY via National Science Foundation Funds Account #: 5-31314 786MC-Y1	Ismail Fidan	MET	\$87,949
10	Establishment of Near-optimal process parameters for Wire+Arc Additive Manufacturing via Thermo-Mechanical Korea Institute of Industrial Technology Account #: 535236 809MC-Y2	Duck Bong Kim	MET	\$11,437
11	Development of Surrogate Machine Learning Models for Anomaly Detection and Classification in Metal Additive Manufacturing Process Industry-Academic Cooperation Foundation, Chosun University Account #: 5-35236 810MC-Y1	Duck Bong Kim	MET	\$46,000
12	Southeast Combined Heat and Power Technical Assistance Partnership (CHP TAP) North Carolina State University via DOE funds - Award DE-EE0008273 Year 2 of 5 Account #: 5-32817 723MC-Y2	Ethan Languri	ME	\$38,914
13	REU Site: Secure and Privacy-Preserving Cyber Physical Systems: Software and Hardware Approaches National Science Foundation - Award 1852126 - Year 2 of 3 Account #: 5-31299 784MC-Y2	Mohamed Mahmoud Syed Hasan	ECE ECE	\$119,992
14	Traffic Optimization System Based on Secured Crowd Sourced Data Umm Al-Qura University (IQO) - Award Year 1 of 3 Account #: 5-35273 792MC-R	Mohamad Mahmoud	ECE	\$44,259
15	Supplement to: REU Site: Secure and Privacy-Preserving Cyber Physical Systems: Software and Hardware Approaches - Award National Science Foundation - Award 1852126 Account #: 5-31299 826S-Y1	Mohamed Mahmoud Syed Hasan	ECE ECE	\$10,000
16	AFRL University Senior Design Challenge DOD via Dzyne Technologies Account #: 5-23401 849MC	Andy Pardue	ME	\$25,000
17	Supplement to Tennessee Cybercorps: A Hybrid Program In Cybersecurity - Community College Inclusion - 2018-2021 National Science Foundation - Award 1565562 Account #: 5-31279 727C-CC3	Ambareen Siraj Doug Talbert	CSC CSC	\$34,230
18	Supplement to Tennessee Cybercorps: A Hybrid Program In Cybersecurity - Community College Inclusion - 2018-2021 National Science Foundation - Award 1565562 Account #: 5-31279 782C-CC2	Ambareen Siraj Doug Talbert	CSC CSC	\$26,320

	Project Description	P.I.	Department	Total Funds
19	Supplement to: TENNESSEE CYBERCORPS: A HYBRID PROGRAM IN CYBERSECURITY - A Series of "Cyber Encounters" to Address Gap in High School Cyber Education National Science Foundation - Award 1565562 - Special Program Account #: 5-31279 828MC	Ambareen Siraj Doug Talbert	CSC CSC	\$358,583
20	Center for Manufacturing Testing & Design - FY 2019-2020 (Activated at end of fiscal year) Various Industries Account #: 5-38585 100MC-17	Ying Zhang	CMR	\$3,203
21	Electro-codeposition of MCrAlY Coatings for Advanced Gas Turbine Applications AESF-Foundation Account #: 5-32438 768MC-Y3	Ying Zhang	CMR	\$25,000
22	High Performance Laboratory-Scale Gas Atomizer for Materials and Coatings Research The Department of Defense (DoD) - Office of Naval Research - Award N00014-19-1-2538 Account #: 5-31399 780MC	Ying Zhang	CMR	\$315,000
23	Development of Corrosion- and Erosion- Resistant Coatings for Advanced Ultra- Supercritical Materials US Department of Energy - Award DE- FE0031820 - Year 1 of 2 Account #: 5-32600 816MC-Y1	Ying Zhang Jiahong Zhu	CMR ME	\$580,821
24	Supplement #2 to: Development & Validation of Low-Cost, Highly-Durable, Spinel-Based Contact Materials for SOFC Cathode-Side Contact Application US Department of Energy (DOE), Office of Fossil Energy - Cooperative Agreement DE- FE0031187 Account #: 5-32289 824MC	Jiahong Zhu	ME	\$50,028

External Activations in FY 2019-2020 \$2,830,562

Schedule 7

CENTERS OF EXCELLENCE ACTUAL, PROPOSED, AND REQUESTED BUDGET

Institution	Tennessee Technological University						Center	Center for Manufacturing Research		
	FY 2019-20 Actual			FY 2020-21 Proposed			FY 2021-22 Requested			
	Matching	Appropri.	Total	Matching	Appropri.	Total	Matching	Appropri.	Total	
Expenditures										
Salaries										
Faculty	266,265	288,385	554,650	350,000	357,985	707,985	375,000	300,000	675,000	
Other Professional	104,683	328,646	433,329	75,000	432,225	507,225	75,000	425,000	500,000	
Clerical/ Supporting	0	48,675	48,675	0	46,857	46,857	0	50,000	50,000	
Assistantships	86,210	158,075	244,285	250,000	321,936	571,936	250,000	300,000	550,000	
Hourly Students	30,840	46,553	77,393	50,000	56,769	106,769	50,000	50,000	100,000	
Total Salaries	487,998	870,334	1,358,332	725,000	1,215,772	1,940,772	750,000	1,125,000	1,875,000	
Fringe Benefits	172,055	350,109	522,164	275,000	418,762	693,762	275,000	390,000	665,000	
Total Personnel	660,053	1,220,443	1,880,496	1,000,000	1,634,534	2,634,534	1,025,000	1,515,000	2,540,000	
Non-Personnel	NOTE: Appropriation Expenditures in Fringe Benefits include \$115,821 for Graduate Student Fees in FY 2019-20.									
Travel	59,689	6,597	66,286	75,000	23,866	98,866	75,000	15,000	90,000	
Software	0	675	675	0	5,000	5,000	0	6,000	6,000	
Books & Journals	0	0	0	0	0	0	0	0	0	
Other Supplies	288,069	37,658	305,727	314,063	172,886	486,749	350,000	34,200	384,200	
Equipment	390,440	115,369	505,809	125,000	125,000	250,000	150,000	25,000	175,000	
Maintenance	0	14,552	14,552	0	35,000	35,000	0	0	0	
Scholarships for Service	170,141	0	170,141	500,000	0	500,000	500,000	0	500,000	
Consultants/Subcontracts	538,944	3,750	542,694	288,880	0	288,880	275,000	0	275,000	
Renovation	0	3,338	3,338	0	0	0	0	0	0	
Seminars/Workshops/Con	206,690	0	206,690	150,000	5,000	155,000	125,000	0	125,000	
Total Non-Personnel	1,633,973	181,939	1,815,912	1,452,943	366,552	1,819,495	1,475,000	80,200	1,555,200	
GRAND TOTAL	2,294,026	1,402,382	3,696,408	2,452,943	2,001,086	4,454,029	2,500,000	1,595,200	4,095,200	
Revenue	NOTE: Actual Matching Funds do not include Indirect Costs of \$456,442 for FY 2019-2020.									
New State Appropriation	0	1,576,400	1,576,400	0	1,595,200	1,595,200	0	1,595,200	1,595,200	
Carryover State Appropriation	0	231,868	231,868	0	405,886	405,886	0	0	0	
New Matching Funds	2,381,035	0	2,381,035	2,250,000	0	2,250,000	2,500,000	0	2,500,000	
Carryover from Previous Matching Funds	115,934	0	115,934	202,943	0	202,943	0	0	0	
Total Revenue	2,496,969	1,808,268	4,305,237	2,452,943	2,001,086	4,454,029	2,500,000	1,595,200	4,095,200	

NOTE: Carryover funds of \$405,886 are committed to: 1) beginning investigators and early-career faculty (to build a foundation of leadership in manufacturing-related research); 2) graduate student support; 3) cost-sharing for external grants; and 4) laboratory upgrades.

FY 2021 – 2022 Budget Request and Justification

The Center for Manufacturing Research would certainly benefit from an increase in the FY 2021-2022 budget, due to increased research activities and increased operational cost. However, we also understand the economic impacts of this pandemic and will not request any funding increase for FY 2021-2022. We stand ready to help the State in advanced manufacturing to counteract the negative impact of this pandemic on our State.

Should a budget increase be given in State Appropriations for FY 2021-2022, it would be used to support funding for graduate students, provide cost sharing for external grants, promote new research initiatives, incentivize faculty for research activities, and pursue industry engagement in advanced manufacturing.

SUPPORTING MATERIALS

CMR Supported Graduate Students Degrees Awarded in 2019-2020 Fiscal Year

Masters

Adams, Bobby G.

Fall 2019

Chemical Engineering

Chappell, Jonathan Ryan

Fall 2019

Mechanical Engineering

Daugherty, Joshua

“Using Pressure Power Graphs to Analyze Compressor Systems”

Spring 2020

Advisor: Dr. Glenn Cunningham

Mechanical Engineering

Gothard, Daniel Wesley

“Microstructural and Damage Characterization of Electronic Packages After Cryogenic Thermal Cycling”

Fall 2019

Advisor: Dr. Christopher Wilson

Mechanical Engineering

Hodge, Mackenzie B.

Spring 2020

Chemical Engineering

Hott, Daniel C.

“Coefficient of Thermal Expansion Characterization of Printed Circuit Board Components at Cryogenic Temperatures and Applications in Finite Element Analysis”

Fall 2019

Advisor: Dr. Christopher Wilson

Mechanical Engineering

Nasirov, Aslan

“Multiscale Modeling of Fused Filament Fabricated Specimens”

Fall 2019

Advisor: Dr. Ismail Fidan

Mechanical Engineering

Nolan, Eric Caleb

“Electromechanical Impedance Based Structural Health Monitoring for Rapid State Detection”

Spring 2020

Advisor: Dr. Steven Anton

Mechanical Engineering

Rentschler, Micah David

“Optimal Junction Parameters to Improve the Quantum Efficiency of Multi-Junction Perovskite/III-V Solar Cells”

Fall 2019

Advisor: Dr. Indranil Bhattacharya
Electrical and Computer Engineering

Sauter, Andreas

“Techbot – A Multimaterial Mobile 3D Printing Platform”

Fall 2019

Advisor: Dr. Ismail Fidan
Mechanical Engineering

Tanvir, Ali Newaz Mohammad

“Wire + Arc Additive Manufacturing of High-Performance Alloys”

Fall 2019

Advisor: Dr. Duck Bong Kim
Mechanical Engineering

Terry, Shane M.

“Innovating the Fused Filament Fabrication Process Meta Powder Polylactic Acid Printing”

Summer 2019

Advisor: Dr. Ismail Fidan
Mechanical Engineering

**CMR Supported Graduate Student Degrees Awarded
in 2019-2020 Fiscal Year**

Ph.D.

Li, Lilly Liman

“Approaches to Low SNR Spectrum Sensing in Cognitive Radio Networks: Kernelized Testing, Random Matrix Theory, and Statistical Learning”

Fall 2019

Advisor: Dr. Adam L. Anderson

Computer Science

Lin, Qinghua

“Non-Uniform Combustion Control and Configuration Design for Lean Gasoline Aftertreatment System”

Spring 2020

Advisor: Dr. Ping Chen

Mechanical Engineering

Materi, Bryan Evans

“Advances in Approaches Towards the Development of New Diagnostic Protocols for the Detection of Alpha-1-Antitrypsin Deficiency”

Summer 2019

Advisor: Dr. J. Robby Sanders

Chemical Engineering

Yu, Yutian

“The Performance of Spinel-Based Interconnect Coating and Contact Layer for SOFC Cathode-Side Application”

Spring 2020

Advisor: Dr. J. Zhu

Mechanical Engineering

CMR Graduate Students Supported from State Appropriations

Masters

Nathan Ghattas

Advisor: Dr. Steve Anton
Mechanical Engineering

O. (Dorothy) Oderhohwo

Advisor: Dr. Syed Rafay Hasan
Electrical & Computer Engineering

Hollee Sadler

Advisor: Dr. Glenn Cunningham
Mechanical Engineering

Andreas Sauter

Advisor: Dr. Ismail Fidan/Dr. Steve Canfield
Mechanical Engineering

Ali Tanvir

Advisor: Dr. Duck Bong Kim
Mechanical Engineering

Ph.D.

Abayomi I. Adeleke

Advisor: Dr. Cynthia Rice
Chemical Engineering

Rumman Ahsan

Advisor: Dr. Duck Bong Kim
Mechanical Engineering

Emmanuel A. Boateng

Advisor: Dr. J. W. Bruce
Electrical & Computer Engineering

Kurt Dunham

Advisor: Dr. Pedro Arce
Chemical Engineering

Ankit Gupta

Advisor: Dr. Ismail Fidan
Mechanical Engineering

Anfal Harris

Advisor: Dr. Robbie Sanders
Chemical Engineering

Astrit Imeri

Advisor: Dr. Chris Wilson
Mechanical Engineering

Maxavier Lamantia

Advisor: Dr. Ping Chen
Mechanical Engineering

Qinghua Lin

Advisor: Dr. Ping Chen
Mechanical Engineering

Tolulope Odetola

Advisor: Dr. Syed Rafay Hasan
Electrical & Computer Engineering

Hajar Taheri-Afarani

Advisor: Dr. Joe Biernacki
Chemical Engineering

Ph.D.

Kuo Yang

Advisor: Dr. Pinggen Chen
Mechanical Engineering

CMR Graduate Students Supported from External Funds

Masters

Mohammad Alshaikh Ali

Advisor: Dr. Steve Anton
Mechanical Engineering

Aaron Bain

Advisor: Dr. Ethan Languri
Mechanical Engineering

Jonathan Chappell

Advisor: Dr. Chris Wilson
Mechanical Engineering

Abigail Collier

Advisor: Dr. Chris Wilson
Mechanical Engineering

Joshua Daugherty

Advisor: Dr. Glenn Cunningham
Mechanical Engineering

Daniel Gothard

Advisor: Dr. Chris Wilson
Mechanical Engineering

Jacob Ryan Hayes

Advisor: Dr. Jiahong (John) Zhu
Mechanical Engineering

Daniel Hott

Advisor: Dr. Chris Wilson
Mechanical Engineering

Joshua Hooper

Advisor: Dr. Glenn Cunningham
Mechanical Engineering

Kade Howard

Advisor: Dr. Glenn Cunningham
Mechanical Engineering

Haoli Lu

Advisor: Dr. Ismail Fidan
Mechanical Engineering

Ph.D.

Mahmoud Mohamed Badr

Advisor: Dr. Mohamed Mahmoud
Electrical & Computer Engineering

Mohamed Baza

Advisor: Dr. Mohamed Mahmoud
Electrical & Computer Engineering

Seymur Hasanov

Advisor: Dr. Ismail Fidan
Mechanical Engineering

Mohamed Ibrahim

Advisor: Dr. Mohamed Mahmoud
Electrical & Computer Engineering

Yutian Yu

Advisor: Dr. Jiahong (John) Zhu
Mechanical Engineering

Masters

Aslan Nasirov

Advisor: Dr. Ismail Fidan
Mechanical Engineering

Eric Nolan

Advisor: Dr. Steve Anton
Mechanical Engineering

Shane Terry

Advisor: Ismail Fidan
Mechanical Engineering

External Funding – Proposals Submitted

Status	Title	P.I.	Department	Total Funds
1 832MC 31(19-20) 5-32603	Reference-free Longitudinal Rail Stress and Neutral Temperature Measurement Utilizing Multidirectional Elastic Waves Virginia Tech University (via Federal Railroad Administration funds) - Subaward 451358-19C95	Mohammad Albakri	ME	\$32,000
2 843MC	Cyber-Physical System Integrity and Security with Impedance Signatures Virginia Tech (via NSF Funds)	Mohammad Albakri	ME	\$74,946
3 864MC 6/26/2020	Collaborative Research: Indirect Electro-mechanical Impedance Part Qualification via Meta-fixtures National Science Foundation	Mohammad Albakri	ME	\$324,855
4 836MC 87201920	Intelligent Robot for TVA Substation Inspection TVA	Ali Alouani	ECE	\$333,204
5 860MC 161(19-20)	BioFoundry Design: Leveraging Biomimicry to Advance Environmental and Social Sustainability Innovation in Prototypes Developed in Foundry-Guided Undergraduate Chemical Engineering Courses Venturewell	Pedro Arce Robby Sanders Arce-Trigatti/Jorgensen	ChemE ChemE C&I/ChemE	\$30,000
6 827MC	Investigating Optical Characteristics, Current Matching and Carrier Transport Mechanisms in High-Efficiency Perovskite Multijunction Solar Cells US Department of Energy	Indranil Bhattacharya	ECE	\$159,196
7 831MC	Aging Diagnostic Algorithm Development for Cummins SCR Systems Purdue University (via Cummins funds)	Pingen Chen	ME	\$113,370
8 852MC 4/27/2020	Medium-duty eTruck: Pilot Electrified Fleets in Urban and Regional Applications Department of Energy	Pingen Chen Stephen Canfield	ME ME	\$197,172
9 855MC 4/17/2020	Pilot Training and Education in Automated, Connected and Electric Vehicles (CACEV) Denso North American Foundation	Pingen Chen Stephen Canfield Multi	ME ME Multi	\$200,000
10 838MC 11/8/2019 46201920	Collaborative Research: III: Small: Mining Temporal Patterns and Anomalies from Dynamic Graphs National Science Foundation	William Eberle	CSC	\$224,267
11 829MC	Manufacturing for the Future (M4F) Tunxis Community-Technical College (via NSF funds)	Ismail Fidan	MET	\$1,061,726
12 833MC 10/3/2019 34(19-20)	Making Manufacturing Accessible to All (M2A2) National Science Foundation	Ismail Fidan Jason Beach	MET CI	\$381,230

	Status	Title	P.I.	Department	Total Funds
13	846MC 2/7/2020 9420(19-20)	Supportive Incontinence Protection (SIP) Pad_TennesseeTechnologicalUniversity Eteamapplication Venturewell	Melissa Geist Robby Sanders Andy Pardue	Nursing ChemE ME	\$5,000
14	834MC 11/15/2019 51(19-20)	Collaborative Research: CNS CORE: Small: Edge Intelligence in Mobile Nodes: Real-Time Pipelining, Deep Neural Network Inference and mmWave Connection National Science Foundation	Syed Hasan Terry Guo	ECE CMR	\$299,736
15	850MC 4/23/2020 135(19-20)	Electrical Mechanical Computer Engineering and Computer Science (EMC2) Scholarship Program National Science Foundation	Syed Hasan Ahmad Vasselbehagh JW Bruce & D.Ulbyshv	ECE ME ECE/CSC	\$1,000,000
16	823MC 7/10/2019	CAREER: Digital Twin-driven Qualification in wire + Arc Additive Manufacturing: The Realization of "Certify-As-You-Build" National Science Foundation	Duck Bong Kim	MET STEM	\$500,246
17	825MC 7/1/2019	Fatigue Prediction for Additive Manufactured (AM) Metallic Components Imagars LLC	Duck Bong Kim	MET	\$48,000
18	830MC 7/18/2019	Machine Learning for accelerating the Design of additively-manufactured Turbine Blades Yielding Ultra-high energy Efficiency Department of Energy	Duck Bong Kim	MET	\$160,000
19	837MC 10/27/2019	Fabrication, Mechanical Behavior, and Phase Evolution in Additively-Manufactured High- Energy Alloys Department of Defense-Air Force via UTK	Duck Bong Kim Ying Zhang	ME CMR	\$200,000
20	840MC 12/18/2019	Fundamental Study on Surface waviness Formation Mechanisms of Wire + Arc Additively- Manufactured High-Performance Alloy Structures National Science Foundation	Duck Bong Kim	MET	\$225,181
21	851MC 3/31/2020	Development of Hybrid Learning-Driven Predictive Inspection-Methodology and Control Methods for Quality Assurance on Additive Manufacturing Institute for Information and Communications Technology	Duck Bong Kim	MET	\$115,000
22	859MC 6/15/2020	Process Development of Wire + Arc Additively Manufactured Refractory Alloy Structures for Extreme Temperature Application NASA	Duck Bong Kim Ying Zhang	MET CMR	\$649,978
23	845MC 2/7/2020 9520(19-20)	Skin-to-Skin Simulator for Micro-Premies and Unstable Pre-Mature Infants in the NICU_TennesseeTechnologicalUniversity Eteamapplication Venturewell	Andy Pardue Robby Sanders Melissa Geist	ME ChemE Nursing	\$5,000

	Status	Title	P.I.	Department	Total Funds
24	849MC 3/25/2020 119(19-20) 5-23401	AFRL University Senior Design Challenge DOD via Dzyne Technologies	Andy Pardue	ME	\$25,000
25	844MC 2/7/2020 9320(19-20)	SeriousAsAHeartAttack _ TennesseeTechnologicalUniversity _ Eteamapplication Venturewell	Robby Sanders Melissa Geist Andy Pardue	ChemE Nursing ME	\$5,000
26	828MC 8/9/2019 1516s52 5-31279	Supplement to: TENNESSEE CYBERCORPS: A HYBRID PROGRAM IN CYBERSECURITY - A Series of "Cyber Encounters" to Address Gap in High School Cyber Education National Science Foundation - Award 1565562 - Special Program	Ambareen Siraj Doug Talbert	CSC CSC	\$358,583
27	841MC 11/14/2019 52201920	III: Small: Multimodal collaborative Intelligence Support for Omics Team Science National Science Foundation	Doug Talbert	CSC	\$498,587
28	848MC 3/5/2020 10820(19-20)	Development of Optical Sensors with Metal Oxide Mesostructures for Harsh Environment Applications Tennessee State University (via Department of Energy, Office of Fossil Energy funds)	Ying Zhang	CMR	\$150,000
29	824MC 6/21/2019 5-32289	Supplement #2 to: Development & Validation of Low-Cost, Highly-Durable, Spinel-Based Contact Materials for SOFC Cathode-Side Contact Application US Department of Energy (DOE), Office of Fossil Energy - Cooperative Agreement DE-FE0031187	Jiahong Zhu	ME	\$50,028

Proposals Submitted in FY 2019-2020 \$7,427,305