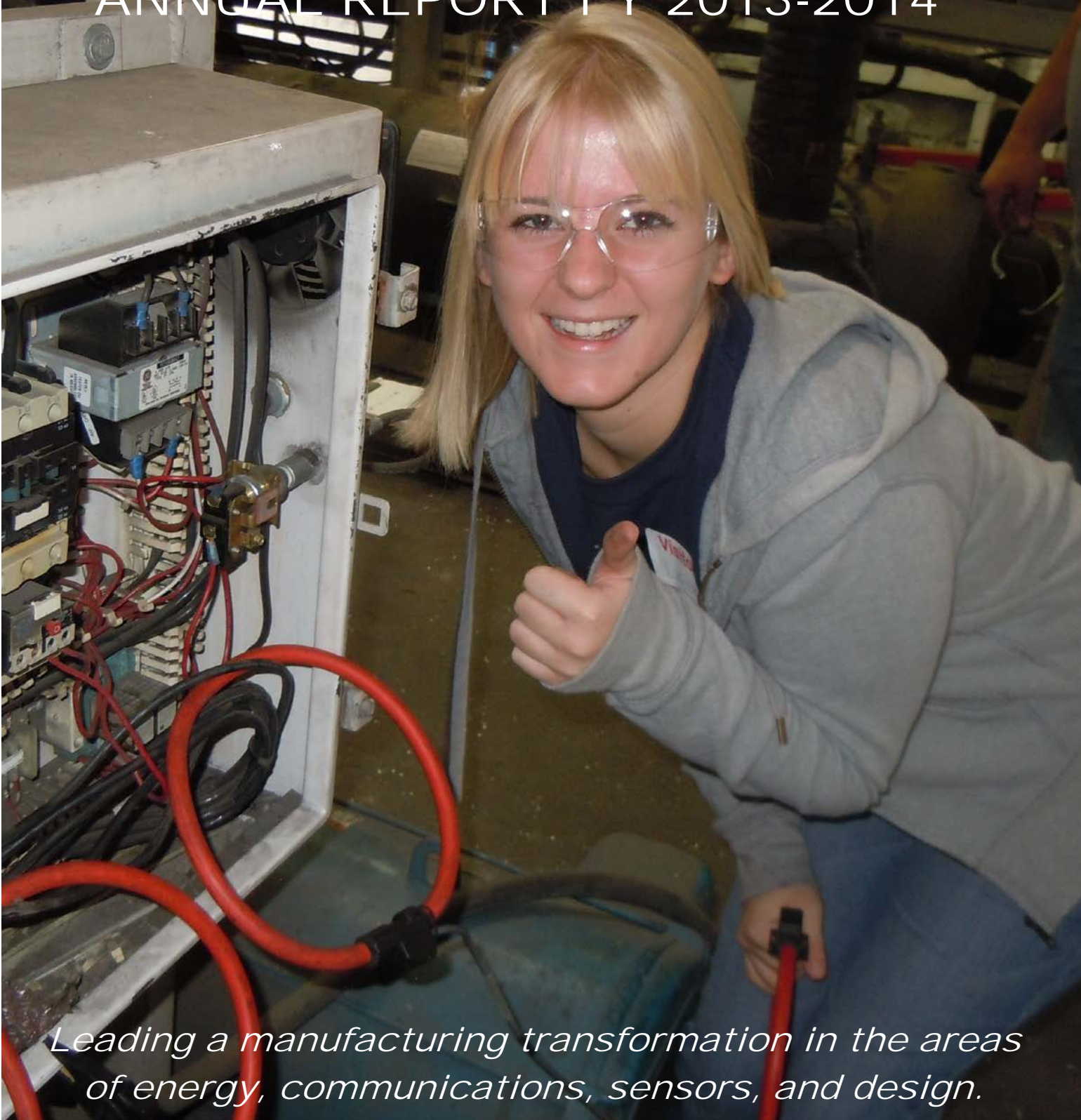


Center for Manufacturing Research ANNUAL REPORT FY 2013-2014



*Leading a manufacturing transformation in the areas
of energy, communications, sensors, and design.*

TTU TENNESSEE TECH
UNIVERSITY

COLLEGE OF ENGINEERING

ABOUT THE COVER: Shown on the cover is Industrial Assessment Center (IAC) undergraduate Electrical and Computer Engineering (ECE) student Lacy Robbins. Lacy is shown here collecting electrical data from equipment in order to make recommendations about possible energy savings.

The Tennessee 3-Star Industrial Assessment Center (IAC) provides no-cost, energy assessments of manufacturing plants across TN and portions of KY, VA, WV, NC, and AR. Engineering & Technology students, under the direction of faculty from Tennessee Technological University, East Tennessee State University, and University of Memphis, are receiving hands-on training to become the future energy engineers that manufacturing industry needs to stay competitive. Funded by a grant from the Advanced Manufacturing Office of the Department of Energy, the IAC Program recognizes students who have participated in six or more assessments with certificates. Under the capable leadership of Dr. Glenn Cunningham, the TN 3-Star IAC routinely leads the nation in student participation rate and number of certificates awarded.

Center for Manufacturing Research

Tennessee Tech University
115 West Tenth Street
Brown Hall 222, Box 5077
Cookeville, TN 38505

(931) 372-3362

(931) 372-6345 Fax

www.tntech.edu/engineering/research/cmr/

TABLE OF CONTENTS

Mission Statement.....	1
Faculty, Staff, and Associate Lists	1
Selected Highlights from FY 2013 – 2014.....	2
External Funding Highlights	3
Institutional Effectiveness Update.....	4
2013 – 14 Faculty, Staff and Student Accomplishments/Awards	9
2013 – 14 Faculty Research Grants	11
Schedule 7 – Budget	15
2015 – 2016 Budget Request and Justification	16

Tennessee Technological University Center for Manufacturing Research Annual Report – FY 2013 – 2014

Director *

Kenneth Currie, Ph.D., P.E.
Director & Professor
Center for Manufacturing Research
Tennessee Tech University
115 W. 10th St., Box 5077
Cookeville, TN 38505
(931) 372-3362 (931) 372-6345 Fax
www.tntech.edu/engineering/research/cmr/

***The Center for Manufacturing Research (CMR)
at TTU is a THEC Established Center of
Excellence and has been since 1990.***

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.”

CMR Faculty and Staff

Dr. Kenneth R. Currie, Director, Prof., ME
Dr. Robert Qiu, Professor, ECE
Dr. Cynthia Rice, Asst. Prof., ChE
Dr. Kwun-Lon Ting, Professor, ME

Brian Bates, R&D Engineer I
Michelle Davis, Outreach Coordinator
Dr. Nan (Terry) Guo, R&D Engineer III
E. Wayne Hawkins, Mat. Science Lab Mgr.
Suzanne Henry, Contract Compliance Asst.
Sue Richardson, Administrative Associate, II
Mike Renfro, R&D Engineer II
Joel Seber, Engr. Computer Support Mgr.
Phyllis Stallion, Administrative Associate, III
Darlene Wiegand, Financial Analyst

CMR Faculty Associates

Dr. Ali Alouani, Professor, ECE
Dr. Adam Anderson, Asst. Professor, ECE
Dr. Stephen Anton, Asst. Professor, ME

Dr. Pedro E. Arce, Chairperson, Professor, ChE
Dr. Joe J. Biernacki, Professor, ChE
Dr. Stephen Canfield, Professor, ME
Dr. Glenn Cunningham, Assoc. Professor, ME
Dr. Corinne Darvennes, Professor, ME
Dr. William Eberle, Assoc. Professor, CS
Dr. Omar ElKeelany, Assoc. Professor, ECE
Dr. Ahmed ElSawy, Chair, Professor, MET
Dr. Ismail Fidan, Professor, MIT
Dr. Sheikh Ghafoor, Asst. Professor, CS
Dr. Syed Rafay Hasan, Asst. Professor, ECE
Dr. Wayne Johnson, Prof. and Chair, ECE
Dr. Wayne Liemer, Professor, Earth Science
Kevin R. Liska, Director, Bus. Media Ctr.
Dr. Satish Mahajan, Professor, ECE
Dr. Mohamed Mahmoud, Asst. Professor, ECE
Dr. Vahid Motevalli, Assoc. Dean of Research and Innovation, College of Engineering & ME
Dr. Scott Northrup, Professor, Chemistry
Dr. Jennifer Pascal, Asst. Professor, ChE
Dr. Sally Pardue, Assoc. Professor, ME/ Director, Millard Oakley STEM Center
Dr. Awni Qasaimah, Asst. Prof., MET
Dr. Mohan Rao, Prof. and Chair, ME
Dr. Jeffrey Rice, Asst. Professor, ChE
Dr. Jonathan (Robby) Sanders, Asst. Prof., ChE
Dr. Stephen Scott, Professor, CSC/ECE / Stonecipher and Boeing Distinguished Professor of Computing
Dr. Ambareen Siraj, Asst. Professor, CS
Dr. Holly Stretz, Assoc. Professor, ChE
Dr. Meenakshi Sundaram, Professor, ME
Dr. Doug Talbert, Assoc. Professor, CS
Dr. Chris Wilson, Assoc. Professor, ME
Dr. Dale Wilson, Professor, ME
Dr. Jeanette Wolak, Asst. Prof., Earth Sciences
Dr. Ying Zhang, Professor, ME
Dr. John Zhu, Professor, ME

**Dr. Vahid Motevalli, Associate Dean for Research and Innovation in the College of Engineering is serving as the CMR Interim Director effective, July 31, 2014 due to Dr. Kenneth Currie's departure from TTU to join another university.*

Selected Highlights from FY 2013 – 2014

The Center for Manufacturing Research (CMR) has a growing portfolio of research projects that reinforce our vision, **“Leading a manufacturing transformation in the areas of energy, communications, sensors, and design.”** The selected highlights of FY 2013 - 2014 are listed below:

Dr. Cynthia Rice receives Kinslow Award for Outstanding Peer Reviewed Journal Article in the College of Engineering – The portable power industry is primarily focused on energy storage as a stop-gap measure for charging small portable devices, however energy conversion devices such as fuel cells are capable of charging devices for longer periods of time and without the need for access to the electrical grid. Dr. Rice’s paper entitled, **“Spontaneously Bismuth-decorated carbon supported Pt nanoparticles for formic acid electro-oxidation”** was selected as the 2014 Kinslow Award winning journal paper in the College of Engineering. The method detailed in the paper presents for the first time a method to spontaneously decorate catalyst surfaces with bi-atoms to enhance conversion activity. This process is also potentially scalable for mass-produced direct formic acid fuel cells.

Dr. Ambareen Siraj Organizes first “Women in CyberSecurity Conference (WiCyS)” in Nashville, TN – Security Professionals worldwide are expected to increase to nearly 4.2 million by 2015. However, despite the growing demand and tremendous opportunities in the job market, cybersecurity remains an area where there is significant shortage of skilled professionals regionally, nationally and internationally. Even worse, women’s representation in this male-dominated field of security is alarmingly low. Through the WiCyS community and activities TTU expects to raise awareness about the importance and nature of a cybersecurity career. The focus of the conference is to generate interest among students to consider cybersecurity as a viable and promising career option. With support from the National Science Foundation, Award #1303441 (Capacity Building in Cybersecurity: Broadening Participation of Women In Cybersecurity through the Women in Cybersecurity Conference and Professional Development), WiCyS is an effort to bring together women (students / faculty / researchers / professionals) in cybersecurity from academia, research and industry for sharing of

knowledge/experience, networking and mentoring. Reflecting the importance of this topic, Dr. Siraj raised \$63,000 in matching commitments for this conference from corporations such as Facebook, Google, Microsoft and other large IT focused companies. Over 350 individuals from 180 organizations and universities participated in the conference held March 11-12, 2014.

Tennessee EPSCoR (TN-SCORE) issues Sub-Award to CMR and Drs. Rice, Stretz, and Currie to Research Solar, Energy Conversion, and Energy Efficiency – In September 2010 the State of Tennessee EPSCoR committee was awarded a \$20 million Research Infrastructure Improvement grant from the National Science Foundation to research materials and devices focused on renewable energy and efficient energy conversions. Dr. Cynthia Rice is serving as a statewide co-thrust leader for Thrust #2 (Components and Devices for Energy Storage and Conversion) and is leading the TTU effort. Dr. Holly Stretz is supporting Thrust #1 (Advanced Solar Conversion and Innovation) and Dr. Ken Currie is supporting Thrust #3 (Nanostructures for Enhancing Energy Efficiency). In 2013-14, Dr. Rice was awarded \$164,000 for the fourth year of the five-year NSF-funded Research Infrastructure Improvement grant. Dr. Rice-York is responsible for \$106,824 of the total TTU received.

Center for Manufacturing Research and Tennessee Tech University partner with Auburn University and University of Alabama Huntsville to Create an Industry/University Collaborative Research Center (I/UCRC) for Advanced Vehicle Manufacturing – TTU, Auburn, and UAH have received a planning grant proposal from NSF to explore the feasibility of creating an I/UCRC in the southeast for an Advanced Vehicle Manufacturing Center. The Center will be supported primarily from industrial memberships with NSF funding for administrative overhead. The proposed Southern Alliance for Advanced Vehicle Manufacturing plans to focus on research that could save companies money through improved manufacturing processes. TTU’s primary expertise is in mass customization, smart manufacturing, and improving the linkage between technologies such as vision systems, robotics, material handling, and throughput/efficiency.

Industrial Assessment Center (IAC) Continues Outreach to Students and TN Industrial Facilities - The Tennessee 3-Star Industrial Assessment Center (TN 3-Star IAC) has been in

existence since 2006 and has conducted over 130 energy assessments in that time period at **no cost** to the requesting companies with approximately \$4.5 million of **implemented** energy-related savings. Anchored by faculty and students at Tennessee Tech University's Center for Manufacturing Research, the TN 3-Star IAC is also supported by satellite centers at the University of Memphis and East Tennessee State University. During that time the total number of students impacted has exceeded one hundred (100), with twenty-five (25) of those students receiving DOE certification of participation in the IAC program. The CMR and IAC personnel also participated in a widely successful Tennessee Energy Education Initiative sponsored by the Office of Energy Programs (OEP) within the Tennessee Department of Environment and Conservation (TDEC) with ARRA funding from DOE. The IAC presented six education presentations across the State of TN including seminars on Energy Management Systems, Lighting, Pumps and Fans, and 7 Habits of Highly Effective Energy Managers.

In addition to the outstanding service to Tennessee manufacturing entities, the IAC is foremost a workforce development program. The IAC has conducted sixteen half-day workshops across the State of TN focused on various facets of industrial energy efficiency. The Institute also recognized Dr. Currie for Energy Management Professionals as a Certified Practitioner for Superior Energy Performance, Performance Verifier – Industrial Sector. This certification is associated with the new ISO 50001 Energy Management Standard and DOE's Superior Energy Performance program.

Canfield Demonstrates Innovation Prowess among I-Corps Cohorts – Two different innovation teams led by Tennessee Tech University mechanical engineering professor Stephen Canfield have demonstrated that they are best in class when it comes to transitioning research ideas into viable start-up opportunities. The first team utilized a positioning technology for use with autonomous robots for industrial inspections of boiler applications. For Canfield, mentor Andy Pardue, and entrepreneurial lead Andrew Bryant, that work has paid off in the form of a \$50,000 grant from the National Science Foundation's I-Corps program. I-Corps gives entrepreneurs a chance to leverage their experience and expertise into developing products that will find their place in the market. TTU's team

was grouped with teams from more than 20 universities, including Stanford, University of Michigan, Brown University, Virginia Tech and Berkeley. TTU's team won the "Best Team of the Cohort" award. A second team headed by Canfield took a Learning Pedagogy developed by Canfield for teaching "Hands-on Programming Experiences for Engineering and Computer Science." The team composed of Kenneth Currie, Director of the CMR and Sally Pardue, Director of the STEM Center, was also selected as the "Best Team of the Cohort."

External Funding Highlights

The Center's external funding reversed a three year downward trend to post a 85% increase in year-over-year results at **\$1,711,145**. There was modest improvement in the generation of "Soft" funding of Center activities – 15% improvement year-over-year. Unfortunately, the Center's overall productivity in releasing salaries and supplies through funded activities, has continued to decline as Center faculty have had an uncharacteristically low producing year in individual or collaborative projects. However, there has been a significant rebound in the number of sponsor-funded graduate students and the percentage of total expenditures for graduate students that come from external sources (63%).

More information about past performance, trends, and strategic actions to continuously improve the Center's impact on the institution and the State is detailed in the next section of the report entitled, "Institutional Effectiveness Update."

**CENTER FOR MANUFACTURING
RESEARCH**
**Tennessee Technological
University**
Institutional Effectiveness Update

Institutional Effectiveness Plan

In Spring of 2014 the Center for Manufacturing Research completed an Institutional Effectiveness Plan in support of the University's SAACS accreditation efforts. The plan is part of the institution's continuous improvement efforts towards effectiveness as measured against the university's strategic plan. Listed below is a short summary from the original plan.

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 Algorithms for Big Data. The list below includes key word descriptors:

Advanced Manufacturing - Advanced manufacturing seeks to improve the performance of US industry through the innovative application of technologies, processes and methods to product design and production. This topic makes extensive use of computer, high precision, and information technologies integrated with a high performance work force into a production system capable of furnishing a heterogeneous mix of products in small or large volumes with both the efficiency of mass production and the flexibility of custom manufacturing in order to respond rapidly to customer demands.

Materials and Devices for Energy Storage and Conversion - With rising instability of energy prices and sources, there is an ever-increasing need to develop energy storage/conversion devices or energy efficiency technologies that can be environmentally friendly at a competitive cost to existing fossil fuel sources. Research in this thrust will focus on the following areas; Fuel Cells and Batteries, Photovoltaic, Physics-based Energy Conversion, Thermal Coatings, and Wind

Turbines, Combined Heat and Power (CHP), and Heat Recovery.

Networking and Algorithms for Big Data - Cognitive radios, the next-generation wireless systems, are fully programmable wireless devices that can sense their environment and dynamically adapt their transmission waveform, spectrum access method, and network protocols. The recent trend of smart phones, such as iPhone or Android, shows that wireless phones are essentially "small computers." As a result, high data rate wireless distributed computing is the distinctive feature, while "Big Data" is the crosscutting theme. From a manufacturing vantage point, wireless communications, smart sensors, and ubiquitous data generation are coming realities that will enhance decision-making and improve quality feedback loops.

The CMR's mission statement has been reviewed and only moderately revised during the last 30 years, remaining consistent with the mission of the University. The following excerpts from the University mission are core principles that drive the CMR's mission:

“. . . to provide leadership and outstanding programs in engineering, the sciences, and related areas that benefit the people of Tennessee and the nation. The University is engaged in scholarly activity, especially basic and applied research, creative endeavors, and public service, with special emphasis on community and economic development.”

“The University's three interdisciplinary Accomplished Centers of Excellence in Energy Systems Research, Manufacturing, and Water Resources and Chairs of Excellence in Business Administration strengthen the instructional, research, and service mission of the University.”

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.

CMR Vision

To lead a manufacturing transformation in the areas of energy, communications, sensors, and design.

CMR Goals and Objectives

The CMR has identified three overarching goals that are in alignment with both the College of Engineering Strategic Plan as well as the University's Flight Plan.

Goal #1 – Increase national and international recognition for TTU manufacturing research

Objective 1a. Increase externally funded research and service funding by 25% over a five-year period using the three-year moving average centered at FY 2011-12 as a baseline (\$1,331,496)

Objective 1b. Increase the valuation of proposals submitted by 25% over a five-year period using the three-year moving average centered at FY 2011-12 as a baseline (\$10,072,301)

Goal #2 – Expand student, faculty and staff capabilities

Objective 2a. Double the number of certificates awarded to students, faculty & staff from external agencies (e.g. Industrial Assessment Center Program Student Certificates of Participation, Department of Energy certifications, SolidWorks / ProEngineer certification, etc.) by FY 2017. FY 2011-12 used as a baseline (6 certificates)

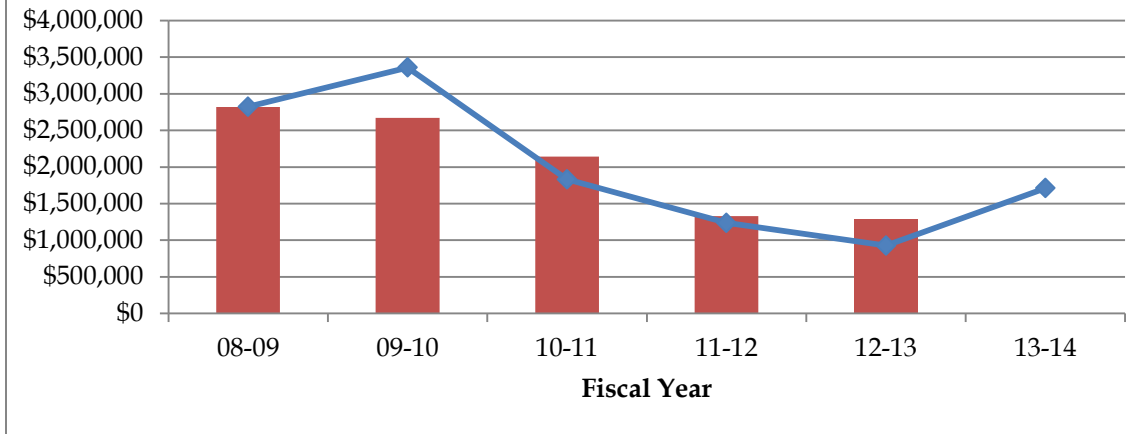
Goal #3 – Increase resources of the CMR to allow for research expansion

Objective 3a. Increase the amount of income (resources), both internally and externally, that can be used to expand research in the CMR strategic research focus areas. Potential sources of extra income comes from release of personnel time, 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% by FY 2017 using the three-year moving average centered at FY 2011-12 as a baseline (\$524,870).

Institutional Effectiveness Reporting

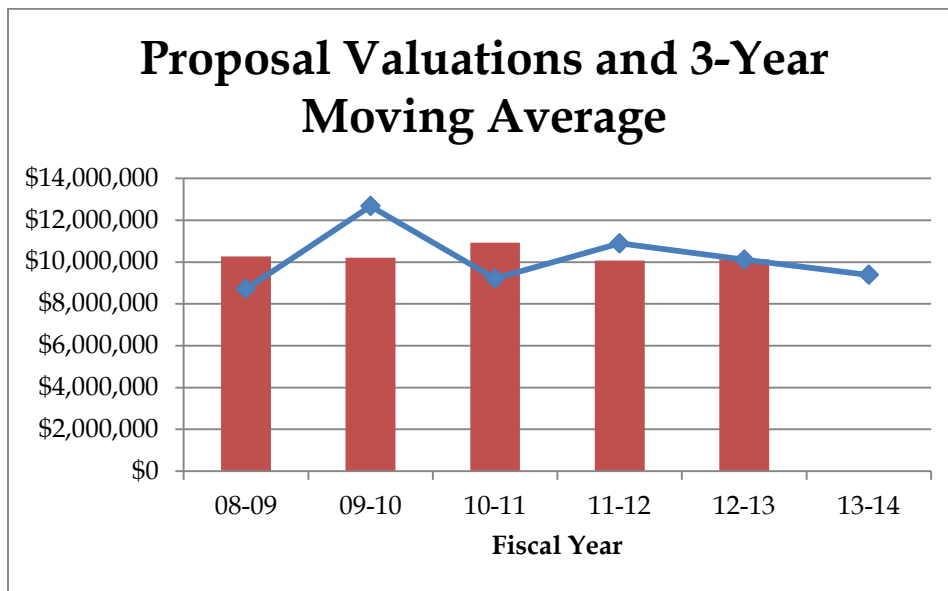
Based on the Goals and Objectives established from the Institutional Effectiveness plan, a number of graphs and tables are listed below that provide a historical performance for each Objective.

External Activations and 3-Year Moving Average



FY Year	08-09	09-10	10-11	11-12	12-13	13-14
■ 3 Year Moving Average	\$2,819,801	\$2,671,969	\$2,142,862	\$1,331,496	\$1,291,253	
— External Activations	\$2,824,148	\$3,359,888	\$1,831,872	\$1,236,826	\$925,789	\$1,711,145

Proposal Valuations and 3-Year Moving Average



FY Year	08-09	09-10	10-11	11-12	12-13	13-14
■ 3 Year Moving Average	\$10,265,452	\$10,200,287	\$10,927,246	\$10,072,301	\$10,130,421	
— External Proposals	\$8,714,399	\$12,673,820	\$9,212,641	\$10,895,277	\$10,108,985	\$9,387,001

Table 1. Certificates Awarded

Performance Metric	FY 2009-10	FY 2010-11	FY 2011-12	FY 2012-13	FY 2013-14
IAC Student Participation Certificates	3	3	3	3	10
Faculty & Staff Certification	1	0	3	4	0
Student Development Certificates	0	0	0	0	0
Total	4	3	6	7	10

Table 2. Salary and Supplies Released by External Funding

Performance Metric	FY 2010-11	FY 2011-12	FY 2012-13	FY 2013-14
Faculty & Staff Release Time*	\$353,026	\$220,338	\$120,651	\$83,621
Graduate Student Stipend & Fees from External Sponsors	\$212,645	\$160,122	\$108,803	\$265,734
Percentage of GRA Support from External Sponsors	53%	44%	27%	63%
Total "Soft Money" (F&A return, Testing income, GRA support, Equip. usage, and Release Time)	\$678,705	\$499,477	\$396,429	\$457,172

Goal # 1 – Increase national and international recognition for TTU manufacturing research –

The Center for Manufacturing Research has implemented a strategy of heavily investing in new faculty hired within the College of Engineering to foster new proposals and also to increase external activations. Simultaneously, the CMR has increased efforts in forming regional partnerships with southeast institutions to submit larger, more nationally competitive proposals. Not included in the Figure on Proposal Valuations is the development of two, collaborative proposals to establish TTU as the lead TN institution in consortiums competing for the National Network for Manufacturing Institutes for Digital Manufacturing and Design Innovation. These efforts had the potential to bring in approximately \$3 million/year for five years (with half that amount committed from the State of TN), and would have significantly increased the research infrastructure within the CMR. Although these proposal efforts were not successful, it facilitated broader collaborations that have borne fruit in another possible collaboration – an Industry/University Collaborative Research Center (I/UCRC) in partnership with Auburn University and University of Alabama – Huntsville. Focused on Advanced Manufacturing for Vehicular Manufacturing, TTU and the other partnering universities have been awarded a small amount of funds to begin the planning phase of recruiting manufacturing entities to pay membership fees as collaborators in the I/UCRC. The full proposal is slated for submission in March 2015.

Modifications to Strategies – The CMR is continuing to heavily invest in new faculty members as four (4) new faculty have been hired into the College of Engineering with some type of manufacturing-related focus. The I/UCRC effort is of prime importance to the CMR and efforts are currently being investigated within the TTU administration to improve industry support through education and outreach. These efforts will reinforce existing and future proposal activities. Although the 3-year moving-average for external activations continues to decline, this is primarily due to the influence of the uncharacteristically low FY 2012-13 activations amount. The year-over-year increase in external activations is a very

promising 85%. In addition, the proposal valuations, although somewhat lower, has seen a marked improvement of conversion rate from proposal to activation.

Goal # 2 – Expand student, faculty, and staff capabilities (Table 1) –

Performance this year is markedly better than this past year and we are fast approaching the target set to double the number of certificates or certifications achieved by CMR faculty, staff, and students. Efforts are currently underway to work with software vendors such as PTC, National Instruments, Dessault, and others to see if we can provide additional training for our students to enhance their capabilities as well as their marketability within the manufacturing job market. These new training opportunities will roll out in FY 2015.

Modifications to Strategies – No modifications needed at this time with the exception of advertising and offering intercession training opportunities in popular software packages.

Goal # 3 – Increase resources of the CMR to allow for research expansion (Table 2) –

Our external or “soft” money return had both encouraging trends and some continued areas that need work. The overall soft money return increased by about 15% compared to previous year. A significant increase was attained in the graduate students supported by external funds (63%), as opposed to Center resources, was the key factor. This represents the second best year on record and is also indicative of the increase in overall external activations. The percentage of students on external funds is scheduled to drop significantly due in large part to our strategies to invest in new faculty and their graduate student requests. The area that needs additional work is the release of Center faculty and staff. Continued efforts will be put in place to increase the level of release time through inclusion of staff and faculty in externally funded proposals.

Modifications to Strategies – Each proposal signed off by the Director of the CMR will ensure that ample release time is provided for faculty and staff.

Faculty, Staff and Student Accomplishments/Awards

FY 2013 – 14

Cynthia Rice, Assistant Professor of Chemical Engineering (ChE), was awarded the 2014 Kinslow Award for the College of Engineering's Outstanding Peer Reviewed Journal article entitled, "**Spontaneously Bismuth-decorated carbon supported Pt nanoparticles for formic acid electro-oxidation.**"

Scholarly Publications and Presentations

FY 2013 – 14

CMR faculty and staff published four (4) journal publications, six (6) national and international conference or invited presentations, two (2) book chapters, and Dr. Robert Qiu published a book entitled, "Cognitive Networked Sensing and Big Data," published by Springer.

Robert Qiu

Book

R. C. Qiu and M.C. Wicks, Cognitive Networked Sensing and Big Data, Springer, 614+ pages, 2013.

Kwun-Lon Ting

Journal Publications

Zhang, Y.B. and **Kwun-lon Ting**, "Design and Analysis of a Spatial 3-DOF Parallel Manipulator with 2T1R-type", *International Journal of Advanced Robotic Systems*, 2013, 10: (SCI : 137YM, EI: 20132616451254) **ISSN: 1729-8806**

Conference Presentations

Bowen Yu and **Kwun-lon Ting**, "*Equivalent Linkages and Dead Center Positions of Planar Single-DOF Complex Linkages*," ASME 2013 International Mechanical Engineering Congress & Exposition, IMECE2013-62306.

Bowen Yu and **Kwun-lon Ting**, "*Manifold Conjugation and Discrete Gear Design*," ASME 2013 IDETC.

Bowen Yu and **Kwun-lon Ting** "*Compensated Conjugation and Gear Tooth Modification*," ASME 2013 IDETC.

Wang, Jun and Ting, K.L. "*Equivalent Linkages and Dead Center Positions of Planar Single-DOF Linkages*," ASME IMCE 2013

Invited Speaker

Ting, Kwun-Lon, "CAD of Harmonic Drive Tooth Profiles," Industrial Technology Research Institute, Hsinchu, Taiwan, January 2013.

Ting, Kwun-Lon, "On Ting's Rotatability Laws of N-bar Linkages," A National Taiwan University, Taipei, January 2013

Ting, Kwun-Lon, "Harmonic Drives," Industrial Technology Research Institute, Hsinchu, Taiwan, December 2013

Cynthia Rice

Journal Publications

Bauskar, A.S. and **Rice, C.A.**, *Electrochimica Acta* 'Spontaneously Bi decorated carbon supported Pd nanoparticles for formic acid electro-oxidation', **2013**, 107, 562.

Bauskar, A.S. and **Rice, C.A.**, *Electrochimica Acta* 'Spontaneously Bi decorated carbon supported Pt nanoparticles for formic acid electro-oxidation', **2013**, 93, 152.

Book Chapters

Rice, C.A., Wieckowski, A. "Electrocatalysis of Formic Acid Oxidations" *Electrocatalysis in Fuel Cells: A Non and Low Platinum Approach*, Chapter 3 Editor Minhua Shao, **43-68. 15.G.10**

Rice, C.A., Bauskar, A., Pickup, P. "Recent Advances in Electrocatalysis of Formic Acid Oxidation" *Electrocatalysis in Fuel Cells: A Non and Low Platinum Approach*, Chapter 4 Editor Minhua Shao, **69-87.**

Cynthia Rice (continued)

Technical Presentations

Electrochemical Society – San Francisco, CA
Oct. 2013

P. Urchaga and C. Rice (Presenter) 'Ex-Situ Accelerated Stress Tests of Pt/C Cathode Catalysts: The Importance of Standard Test Procedures', **Oral**

P. Urchaga, S. Rinaldo, J. Hu, W. Lee, J. Stumper, M. Eikerling, C. Rice (Presenter), 'Platinum Durability in Cathode Catalyst Layers of PEM Fuel Cells: An Ex-Situ Diagnostic Approach', **Oral**

Poster Presentations

TTU Student Research Day – April 2014

J. Cisco, C. Burke, C. Wilson, B. Adams, A. Pistono, C.A. Rice "Catalyst Layers Structure in a Direct Formic Acid Fuel Cell' **Poster WINNER.**

S. Saeed, A. Pistono, C.A. Rice, M.. Mench (ME UTK) 'Novel Flow Field Design for Efficient Removal of CO₂ in a Direct Formic Acid Fuel Cell', **Poster WINNER.**

Invited Seminars and Presentations

C. Rice, P. Moody, A. Bauskar, P. Mandal, S. Litster, 'Increased Porosity of Anodes in Direct Formic Acid Fuel Cells', Electrochemical Society Annual Conference, San Francisco, CA, Oct 2013, **Oral.**

Brian Bates

Journal Publications

B. Bates, Y. Zhang, S. Dryepontd, B. Pint, *Surface Coating Technologies* 240 (2014) 32.

Nan "Terry" Guo

Conference Presentation

N.T. Guo, "OFDM Waveform Design Compromising Spectral Nulling, Side-lobe Suppression and Range Resolution," *2014 IEEE Radar Conference*, Cincinnati, OH, May 19-23, 2014.

Faculty Research Grants

Center for Manufacturing Research FY 2013 – 2014 Project Summary					
Project Description/ Source/ Acct. No.		Principal Investigators	Activated Amount	Project Duration	Estimated 12-month Expenses
1.	Manufacturing Center Testing & Design - FY 2013-14 Various Industries Account #: 5-38585	Kenneth Currie	\$26,703	7/1/2013 – 6/30/2014	\$29,524
2.	University of Tennessee Center for Industrial Services (UT-CIS) – FY 2013-14 UT-CIS Account #: 5-33516	Meenakshi Sundaram	\$60,000	7/1/2013 – 6/30/2014	\$40,955
3.	Joint Faculty Agreement—Stephen Scott; Subcontract #4000102091 - Modification #5 Oak Ridge National Laboratory Account #: 5-39305	Doug Talbert	\$52,788	5/12/2013– 8/12/2013	\$52,788
4.	Public Private Partnership for a Comprehensive Workforce Development Plan to Stimulate Industrial Energy Efficiency and Demand Reduction - Allocation #5 U.S. Department of Energy Golden Field Office Account #: 5-32290	Glenn Cunningham Kenneth Currie	\$64,000	9/30/2012– 9/30/2014	\$64,000
5.	Public Private Partnership for a Comprehensive Workforce Development Plan to Stimulate Industrial Energy Efficiency and Demand Reduction – Allocation #6 U.S. Department of Energy Golden Field Office Account #: 5-32290	Glenn Cunningham Kenneth Currie	\$112,000	9/30/2012– 9/30/2014	\$112,000
6.	Collaborative Research: Design, Analysis and Implementation of Social Interactions in Cognitive Radio Networks – Award CNS-1247778 - Year 2 of 3 National Science Foundation Account #: 5-31212	Robert Qiu	\$47,031	10/1/2013– 9/30/2014	\$28,808

**Center for Manufacturing Research
FY 2013 – 2014 Project Summary**

	Project Description/ Source/ Acct. No.	Principal Investigators	Activated Amount	Project Duration	Estimated 12-month Expenses
7.	<p>Components and Devices for Energy Storage and Conversions, Advanced Solar Conversion and Innovation – Contract OR-A11-0171-001.04 – Amendment #6</p> <p>University of Tennessee (via NSF EPSCoR funds)</p> <p>Account #: 5-31228</p>	Cynthia Rice	\$176,097	10/7/2013–10/7/2014	\$90,000
8.	<p>An Alternative Low-Cost Process for Deposition of MCrAlY Bond Coats for Advanced Syngas and Hydrogen Turbine Applications Award DE-FE0007332 - Year 3 of 3</p> <p>U.S. Department of Energy</p> <p>Account #: 5-32275</p>	Ying Zhang	\$130,046	9/12/2013 – 9/11/2014	\$105,000
9.	<p>TUES: SecKnitKit (Security Knitting Kit): Integrating Security into Traditional Computer Science Courses – Award DUE-1140864 – Year 2 of 2</p> <p>National Science Foundation</p> <p>Account #: 5-31275</p>	Ambareen Siraj	\$94,868	8/14/2013 – 7/31/2014	\$93,493
10.	<p>Collaborative Research: A Multi-Scale Environmental and Kinetics Study on the Pyrolysis of Sustainable Biomass Feedstock – Award CBET 1337033 - Year 1 of 3</p> <p>National Science Foundation</p> <p>Account #: 5-31222</p>	Joseph Biernacki Scott Northup	\$154,526	9/1/2013 – 8/31/2014	\$107,525
11.	<p>Technology Advisory Support – Subagreement - 13-ECE-202623</p> <p>Auburn University</p> <p>Account #: 5-32313</p>	Wayne Johnson	\$105,278	2/01/2014 – 11/30/2014	\$105,278
12.	<p>Joint Faculty Agreement--Stephen Scott, Subcontract #4000102091; Modification #6</p> <p>Oak Ridge National Laboratory</p> <p>Account #: 5-39305</p>	Doug Talbert	\$54,644	8/01/2013 – 5/12/2014	\$54,644

**Center for Manufacturing Research
FY 2013 – 2014 Project Summary**

Project Description/ Source/ Acct. No.	Principal Investigators	Activated Amount	Project Duration	Estimated 12-month Expenses
13. Collaborative Research: Planning Grant: I/UCRC for Advanced Vehicle Manufacturing – Award No. IIP-1361774 National Science Foundation Account #: 5-31204	Stephen Canfield Kenneth Currie	\$11,500	1/1/2014– 12/13/2014	\$11,500
14. Collaborative Proposal: Capacity Building in Cybersecurity: Broadening Participation of Women in Cybersecurity through Women in Cybersecurity Conference and Professional Development Award DUE-1303441 Year 1 of 2 National Science Foundation Account #: 5-31273	Ambareen Siraj	\$123,343	9/15/2013 – 9/14/2014	\$75,436
15. Resiliency Techniques for Large-Scale and Heterogeneous Environments – Subcontract #4000112013, Modification #4 Oak Ridge National Laboratory Account #: 5-39362	Stephen Scott	\$38,000	1/1/2014 – 12/31/2014	\$38,000
16. Public Private Partnership for a Comprehensive Workforce Development Plan to Stimulate Industrial Efficiency and Demand Reduction – Award DE-EE0005533 Modification #7 US Department of Energy Golden Field Office Account #: 5-32290	Glenn Cunningham Kenneth Currie	\$88,000	9/30/2012 – 9/30/2014	\$50,000
17. III: Small: Collaborative Research: Anomaly Detection in Graph Streams – Award IIS-1318957; Year 1 of 3 National Science Foundation Account #: 5-31271	William Eberle	\$68,518	9/15/2013– 9/14/2014	\$47,747

**Center for Manufacturing Research
FY 2013 – 2014 Project Summary**

	Project Description/ Source/ Acct. No.	Principal Investigators	Activated Amount	Project Duration	Estimated 12-month Expenses
18.	Advancing Precision Manufacturing in Non-Factory Environments with Low-Cost Positioning Sensor – Award IIP-1359581 National Science Foundation Account #: 5-31278	Stephen Canfield	\$50,000	10/01/2013 – 3/31/2014	\$50,000
19.	Joint Faculty Agreement—Stephen Scott; Subcontract #4000102091; Modification #8 Oak Ridge National Laboratory Account #: 5-39305	Doug Talbert	\$53,803	5/13/2014– 8/31/2014	\$53,803
20.	Development of Marinized Pt-Modified MCrA1X Coatings with Improved Hot Corrosion and Oxidation Resistance Synthesized via a Low-Cost Electrodeposition Process, Award N00014-14-1-0341, Modifications 1,2,3 Office of Naval Research Account # 5-32367	Ying Zhang	\$120,000	3/25/2014- 3/24/2015	\$120,000
21.	Healthcare 180 Visualizer Healthcare 180 LLC, A Tennessee Company Account # 5-36212	William Eberle Doug Talbert	\$80,000	6/3/2014- 8/31/2014	\$80,000
TOTALS			\$1,711,145	\$1,410,501	

Schedule 7

CENTERS OF EXCELLENCE/CENTERS OF EMPHASIS ACTUAL, PROPOSED, AND REQUESTED BUDGET

Institution Tennessee Technological University Center Center for Manufacturing Research

	FY 2013-14 Actual			FY 2014-15 Proposed			FY 2015-16 Requested		
	Matching	Appropriations	Total	Matching	Appropriations	Total	Matching	Appropriations	Total
Expenditures									
Salaries									
Faculty	447,838	513,375	961,213	375,000	372,722	747,722	400,000	380,000	780,000
Other Professional	35,429	396,876	432,305	35,000	398,458	433,458	50,000	350,000	400,000
Clerical/ Supporting	0	63,536	63,536	0	54,057	54,057	10,000	30,000	40,000
Assistantships	184,500	97,038	281,538	180,000	197,961	377,961	250,000	220,000	470,000
Hourly Students	82,958	14,639	97,597	70,000	42,362	112,362	90,000	40,000	130,000
Total Salaries	750,725	1,085,464	1,836,189	660,000	1,065,560	1,725,560	800,000	1,020,000	1,820,000
Fringe Benefits	208,216	362,934	571,150	225,000	416,742	641,742	300,000	425,000	725,000
Total Personnel	958,941	1,448,398	2,407,339	885,000	1,482,302	2,367,302	1,100,000	1,445,000	2,545,000
Non-Personnel									
Travel	82,617	19,867	102,484	75,000	24,280	99,280	70,000	30,000	100,000
Software	0	705	705	0	0	0	0	0	0
Books & Journals	4,310	0	4,310	4,000	0	4,000	1,000	0	1,000
Other Supplies	266,512	23,902	290,414	220,000	27,846	247,846	250,000	36,810	286,810
Equipment	31,885	0	31,885	354,114	20,000	374,114	200,000	0	200,000
Maintenance	0	0	0	0	0	0	0	0	0
Scholarships	0	0	0	0	0	0	0	0	0
Consultants/Subcontracts	120,500	0	120,500	125,000	0	125,000	150,000	0	150,000
Renovation	0	0	0	0	0	0	0	69,700	69,700
Seminars/Workshops/Conf	26,000	0	26,000	35,000	0	35,000	30,000	0	30,000
Total Non-Personnel	531,824	44,474	576,298	813,114	72,126	885,240	701,000	136,510	837,510
GRAND TOTAL	1,490,765	1,492,872	2,983,637	1,698,114	1,554,428	3,252,542	1,801,000	1,581,510	3,382,510
Revenue	NOTE: ACTUAL MATCHING DOES NOT INCLUDE INDIRECT COSTS OF \$342,274 FOR FY 2013-2014.								
New State Appropriation	0	1,541,100	1,541,100	0	1,506,200	1,506,200	0	1,581,510	1,581,510
Carryover State Appropriation	0	0	0	0	48,228	48,228	0	0	0
New Matching Funds	1,490,765	0	1,490,765	1,674,000	0	1,674,000	1,801,000	0	1,801,000
Carryover from Previous Matching Funds	0	0	0	24,114	0	24,114	0	0	0
Total Revenue	1,490,765	1,541,100	3,031,865	1,698,114	1,554,428	3,252,542	1,801,000	1,581,510	3,382,510

FY 2015-16 Budget Request and Justification

The CMR is requesting a 5% increase in the FY 2015-16 State appropriations to account for increasing salaries, supplies, and travel costs. The increase is particularly important to allow CMR to pay the graduate student salaries at a level consistent with the College of Engineering and be competitive with other universities in Tennessee. Attracting and retaining quality graduate students is key to CMR's ability to continue a high-level of research and service to Tennessee manufacturing industries.

Costs for supplies, benefits, and travel continue to increase on a yearly basis and inflationary increases also need to be considered in the budget adjustment.