

# Center for Manufacturing Research ANNUAL REPORT FY 2012 - 2013



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

**ABOUT THE COVER:** Shown on the cover is Ph.D. candidate Antonio (Tony) Pistono (Chemical Engineering), working in Dr. Cynthia Rice's Fuel Cell and Electrochemistry Laboratory. Tony is making adjustments to a test cell attached to a fuel cell test stand as he prepares it for an experiment. Dr. Rice is the Co-Thrust Leader for the Energy Storage and Conversion Thrust within TN-SCORE (Tennessee Solar Conversion and Storage using Outreach, Research and Education). Initiated in September 2010, TN-SCORE is Tennessee's first Research Infrastructure Improvement award from the National Science Foundation's EPSCoR (Experimental Program to Stimulate Competitive Research) program.

Dr. Rice serves as the Principal Investigator for the Tennessee Tech contributions to the TN-SCORE collaborations including research conducted by Dr. Holly Stretz in Thrust 1 (Advanced Solar Conversion) and Dr. Ken Currie in Thrust 3 (Nanostructures for Energy Efficiency). Total anticipated expenditures over the five-year period of the grant is approximately \$600,000 with the majority of that amount focused on fuel cells and energy conversion of liquid fuels.

## **Center for Manufacturing Research**

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# Tennessee Technological University Center for Manufacturing Research Annual Report – FY 2012 – 2013

## Director

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***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.  
Dr. Zhen Hu, Postdoctoral Researcher  
Sue Richardson, Secretary II / Receptionist  
Mike Renfro, R&D Engineer II  
Joel Seber, Engr. Computer Support Mgr.  
Phyllis Stallion, Technical Clerk  
Dr. Patrick Urchaga, Postdoctoral Researcher  
Darlene Wiegand, Financial Analyst

## CMR Faculty Associates

Dr. Ali Alouani, Professor, ECE  
Dr. Adam Anderson, Asst. Professor, ECE  
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, MIT  
Dr. Ismail Fidan, Professor, MIT  
Dr. Sheikh Ghafoor, Asst. Professor, CS  
Dr. Syed Rafay Hasan, Asst. Professor, ECE  
Dr. Stephen Idem, Professor, ME  
Dr. Glen Johnson, Professor, ME  
Dr. Wayne Johnson, Prof. & Chair, ECE  
Dr. Wayne Liemer, Professor, Earth Science  
Kevin R. Liska, Director, Bus. Media Ctr.  
Dr. Y. (Jane) Liu, Professor, CEE  
Dr. Satish Mahajan, Professor, ECE  
Dr. Scott Northrup, Professor, Chemistry  
Dr. Joseph Ojo, Professor, ECE  
Dr. Sally Pardue, Assoc. Professor, ME/ Director,  
Millard Oakley STEM Center  
Dr. P. K. Rajan, Professor, ECE  
Dr. Jeffrey Rice, Asst. Professor, ChE  
Dr. Jonathan (Robby) Sanders, Asst. Prof., ChE  
Dr. Stephen Scott, Professor, CSC/ECE /  
Stonecipher & 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. Fred Vondra, Professor, MIT  
Dr. Chris Wilson, Assoc. Professor, ME  
Dr. Dale Wilson, Professor, ME  
Dr. Ying Zhang, Professor, ME  
Dr. John Zhu, Professor, ME

## Top 5 Highlights from FY 2012 – 2013

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 top five highlights of FY 2012 - 2013 are listed below:

**Dr. Qiu receives Caplenor Award for Outstanding Researcher at Tennessee Tech University** - A strong commitment to advancing the field of wireless communications, and involving students while he does it, has won Center for Manufacturing Research professor Robert Qiu the 2012 Caplenor Faculty Research Award at Tennessee Tech University. Qiu’s ongoing research projects include spectrum sensing, signal processing and machine learning; cognitive radar systems; large-scale cognitive networking and sensing; and wireless tomography. Qiu holds eight patents, has written 150 journal articles and conference papers and six book chapters. He has published two books and two more will be published soon. He received the TTU College of Engineering Kinslow Award in 2012 and the 2003 Sigma Xi award.

**Cognitive Radio Institute continues successful testbed** – Dr. Robert Qiu and his team of faculty researchers, staff, and students in the Wireless Networking Systems Lab (WNSL) have continued to attract external funding from the National Science Foundation and RNET Technologies as a subcontract via the Air Force Research Laboratories (AFRL). The AFRL project is exploring fundamental radar algorithms and techniques for complex Multiple Input, Multiple Output (MIMO) radar issues. The NSF grant is a collaboration with UT-K on the Design, Analysis and Implementation of Social Interactions in Cognitive Radio Networks. These projects follow-up on the heels of completing a \$760,000 legislative directed spending grant from ONR to establish the Cognitive Radio Institute to further enhance research in the next generation of wireless communications.

**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 & Devices for Energy Storage & Conversion) and is leading the TTU effort. Dr. Holly Stretz is supporting Thrust #1 (Advanced Solar Conversion & Innovation) and Dr. Ken Currie is supporting Thrust #3 (Nanostructures for Enhancing Energy Efficiency). In 2012-13, Dr. Rice was awarded \$181,597 for the third year of the five-year NSF-funded Research Infrastructure Improvement grant. Dr. Rice-York is responsible for \$106,824 of the total TTU received.

**National Governor’s Association (NGA) Policy Academy on Enhancing Industry through Energy Efficiency (IEE) and Combined Heat and Power (CHP)** – Tennessee has assembled a statewide team of experts to work with NGA toward the development of a strategic plan for Tennessee which will address barriers to IEE and CHP in the aforementioned areas. The Tennessee Team’s proposed effort will aim to achieve the following general goals: (1) Increase competitiveness and productivity of existing TN business through enhanced IEE and increased deployment of CHP; (2) Provide key industry clusters with tools and expertise necessary for them to evaluate IEE and CHP opportunities; (3) Create a forum to foster dialogue between utilities, State regulators and policymakers, private investors, industry members, and technical experts from IACs to work toward reducing regulatory and market barriers to IEE and CHP; (4) Promote innovative partnerships and peer-to-peer information sharing platforms; (5) Leverage expertise of the State Team to develop a State plan to enhance existing IEE and CHP programs in the State and inform development of future State IEE and CHP programs.

Dr. Ken Currie is representing Tennessee Tech University and the Industrial Assessment Center as a core member of the TN NGA team that includes the Industrial Energy Efficiency Network, Pathway Lending, TVA, and the State Energy Office. Dr. Glenn Cunningham is serving in an advisory role on the NGA team.

**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 90

**free** energy assessments in that time period with approximately \$3.6 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 sixty-five (75), with eighteen (18) of those students receiving DOE certification of participation in the IAC program. The CMR submitted a winning proposal in August 2011 entitled, "*Public-Private Partnership for a Comprehensive Workforce Development Plan to Stimulate Industrial Energy Efficiency and Demand Reduction*," striving to form a broad coalition of industry, non-profit, and government entities to create a systemic transformation of workforce development for industrial energy efficiency professionals. It is systemic in the sense that the plan is to develop the professional at the root (student engineer) such that the entire system (industrial energy efficiency) is affected including outreach to every tissue of the system through end-user training of efficient energy system practices.

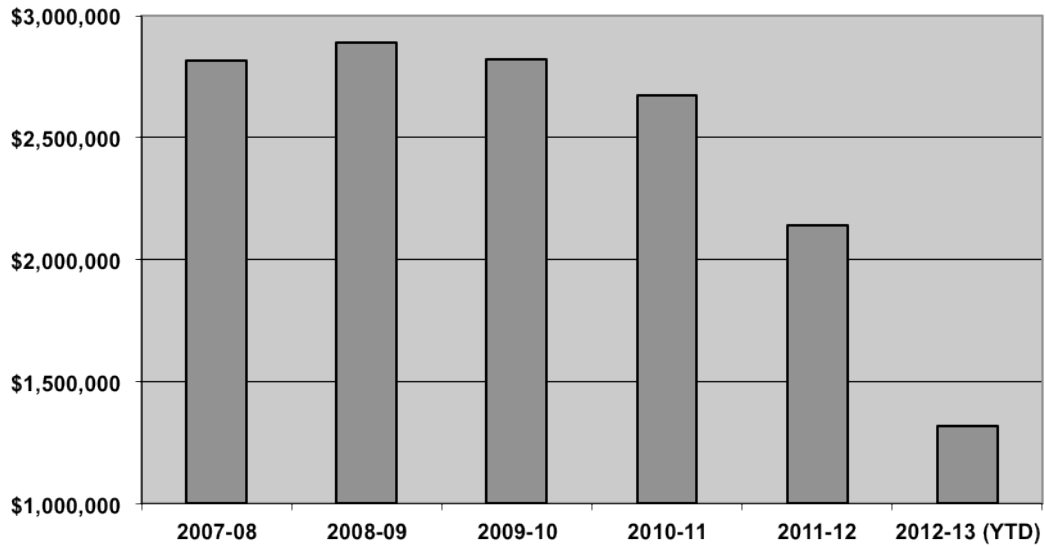
In addition to the outstanding service to Tennessee manufacturing entities, the IAC is foremost a workforce development program. The IAC has conducted sixteen half-day workshops across the State of TN focused on various facets of industrial energy efficiency. Dr. Currie was also recognized by the Institute 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.

Two students (George Gulas & James Leverette),

along with Dr. Currie, were also recognized as Qualified AIRMaster+ Specialists. This is quite an extensive training and test that uses AIRMaster+ software tool to analyze industrial compressed air systems. It is intended to enable users to model existing and future improved system operation, and evaluate savings from energy efficiency measures with relatively short payback periods. AIRMaster+ provides a systematic approach to assessing compressed air systems, analyzing collected data, and reporting results. Users include companies or distributors of compressed air equipment, compressor system auditors, industrial plant personnel, and utility representatives. Through the use of AIRMaster+, end users will achieve cost savings by improving the performance of compressed air systems.

### External Funding Highlights

The Center's external funding continued a downward trend as congressionally directed spending has been eliminated at the federal level and the number of faculty actively submitting competitive proposals has begun to level off after several key faculty departures during the last two years. The Center's overall productivity in releasing salaries and supplies through funded activities, was also adversely affected by a steep reduction in external activations. Figure 1 represents the 3-year moving average of external funding with the value of activations processed through the CMR for FY 2012-13 at approximately **\$925,789** or 74% of last year's level. Table 1 gives a historical perspective of various sources of external revenues that were used to "release" or free up State appropriations for other strategic investment areas.



**Figure 1 – Last 6 Years of External Funding (3-Year Moving Average)**

**Table 1. Salary and Supplies Released by External Funding**

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

# CENTER FOR MANUFACTURING RESEARCH

## Tennessee Technological University

### Strategic Plan Update

#### Strategic Plan

In the Fall of 2012 the College of Engineering Strategic Planning Committee completed the first ever College-wide Strategic Plan including the development of College Strategic Research Thrust Areas. The Strategic Research Thrust areas signaled an alignment of College of Engineering research/resources with the strategic direction of the Centers of Excellence at Tennessee Tech University. The Center for Manufacturing Research is shepherding three of the College's six Strategic Research Thrust Areas:

1. **Advanced Manufacturing** – Advanced manufacturing centers upon improving 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. Advanced machines, intelligent robotics, sensors, control systems and processes are included.
2. **Energy Storage & Conversion** – With rising instability of energy prices and sources, there is an ever-increasing need to develop the next generation of energy storage/conversion devices and energy efficiency technologies that are environmentally friendly and cost-effective compared to existing fossil fuel-based technologies.
3. **Networking & Sensing** – 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 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. Areas of research include:

These three areas are fully aligned with the CMR's 2011 strategic planning exercise that utilized manufacturing roadmap strategies<sup>1</sup> for the 21<sup>st</sup> Century along with feedback from existing faculty and a survey of university technical capabilities and laboratory infrastructure. The resulting vision centered along the concept of a “**Dark Factory.**” The original term “Dark Factory” was coined to refer to a discrete manufacturing facility with digitally driven process plans and automated workstation instructions for assembly/processing without human intervention. We have expanded this term to apply it to any manufacturing facility, which can literally be “Dark” in the sense that it is a net energy neutral facility with wireless sensors and communications to facilitate intelligent oversight and processing. The resultant manufacturing facility would be digitally modeled, controlled, and operated independent of personnel or grid requirements for oversight, power and communications. This has lead us to identify three key focus areas of expertise and investment:

1. **Materials and devices for cost effective energy storage/conversion/efficiency**
2. **Wireless Communications, Sensing, and Machine Learning**
3. **In-situ and Non-Invasive Sensing, Modeling, and Control of Systems and Processes (Fuel Cells, Manufacturing Processes, Biological Processes, etc.)**

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<sup>1</sup> “A Framework for Revitalizing American Manufacturing,” Executive Office of the President of the

<http://www.whitehouse.gov/sites/default/files/microsites/ostp/advanced-manuf-papers.pdf>



## Faculty, Staff and Student Accomplishments/Awards

### FY 2012 – 13

**Robert Qiu**, Professor of Electrical & Computer Engineering (ECE), was awarded the 2012 Caplenor Faculty Research Award at Tennessee Tech University for a body of research accomplishments that signify excellence in research among all active faculty.

### Scholarly Publications and Presentations

### FY 2012 – 13

CMR faculty and staff published twelve (12) journal publications, thirty-three (31) national and international conference or invited presentations, one (1) book chapter, and Dr. Robert Qiu published a book entitled, "Cognitive Radio Communication and Networking: Principles and Practice," published by John Wiley and Sons.

### Robert Qiu

#### *Journal Publications*

Raghuram Ranganathan, **Robert Qiu**, Zhen Hu, Shujie Hou, Zhe Chen, Marbin Pazos-Revilla, and Nan Guo, "Cognitive Radio Network for Smart Grid," in book *Communication and Networking in Smart Grids*, Auerbach Publications, Taylor & Francis Group, CRC, 2012.

H. Li, L. Lai, and **R. C. Qiu**, "Scheduling of Wireless Metering for Power Market Pricing in Smart Grid," *IEEE Transactions on Smart Grid*, vol. 3, no. 4, pp. 1611-1620, 2012.

P. Zhang and **R. C. Qiu**, "GLRT-Based Spectrum Sensing with Blindly Learned Feature under Rank-1 Assumption," *IEEE Transactions on Communications*, no. 99, pp. 1-10, 2012.

H. Li, S. Gong, L. Lai, Z. Han, **R. C. Qiu**, and D. Yang, "Efficient and Secure Wireless Communications for Advanced Metering Infrastructure in Smart Grids," *IEEE Transactions on Smart Grid*, vol. 3, no. 3, pp. 1540-1551, September 2012.

**R. C. Qiu**, C. Zhang, Z. Hu, and M. C. Wicks, "Towards A Large-Scale Cognitive Radio Network

Testbed: Spectrum Sensing, System Architecture, and Distributed Sensing," *Journal of Communications*, vol. 7, no. 7, pp. 552-566, July 2012.

Y. Song, N. Guo, **R. C. Qiu**, and M. C. Wicks, "Real Time UWB MIMO System with Programmable Transmit Waveforms: Architecture, Algorithms and Demonstrations," *IEEE Transactions on Antennas & Propagation*, vol. 60, issue 8, pp 3933-3940, 2012.

F. Lin, **R. C. Qiu**, Z. Hu, S. Hou, J. P. Browning, and M. C. Wicks, "Generalized FMD Detection for Spectrum Sensing Under Low Signal-to-Noise Ratio," *IEEE Communications Letters*, vol. 16, issue 5, pp 604-607, 2012.

#### *Conference Presentations*

X. Li, Z. Hu, **R. C. Qiu**, and M. C. Wicks, "Experimental Demonstration of Cognitive Radar for Target Localization under Strong Interference," *IEEE Military Communications Conference*, Orlando, FL, October 29 - November 1, 2012.

F. Lin, **R. C. Qiu**, J. P. Browning, and M. C. Wicks, "Target Detection with Function of Covariance Matrices under Clutter Environment," *IET International Conference on Radar Systems*, Glasgow, UK, October 22- 25, 2012.

F. Lin, Z. Hu, **R. C. Qiu**, and M. C. Wicks, "A Combination of Quickest Detection with Oracle Approximating Shrinkage Estimation and Its Application to Spectrum Sensing in Cognitive Radio," *IEEE Military Communications Conference*, Orlando, FL, October 29 - November 1, 2012.

Z. Chen, C. Zhang, F. Lin, J. Yu, X. Li, Y. Song, R. Ranganathan, N. Guo, and **R. C. Qiu**, "Towards A Large-Scale Cognitive Radio Network: Testbed, Intensive Computing, Frequency Agility and Security," *IEEE International Conference on Computing, Networking and Communications*, Maui, Hawaii, January, 2012.

Z. Hu, M. C. Wicks, and **R. C. Qiu**, "Wireless Tomography for Sparse Point Targets," *IEEE*

*Waveform Diversity and Design Conference 2012*, Kauai, Hawaii, January 22 - 27, 2012.

Z. Hu, M. C. Wicks, and **R. C. Qiu**, "Consensus-Based Wireless Tomography," *IEEE Waveform Diversity and Design Conference 2012*, Kauai, Hawaii, January 22 - 27, 2012.

J. Bonior, Z. Hu, S. Hou, S. Corum, B. McNew, N. Guo, **R. C. Qiu**, G. Scalzi, and M. C. Wicks, "Prototyping of a Wireless Tomography System using Software-Defined Radio," *IEEE Waveform Diversity and Design Conference 2012*, Kauai, Hawaii, January 22 - 27, 2012.

S. Hou, **R. C. Qiu**, J. P. Browning, and M. C. Wicks, "Spectrum Sensing in Cognitive Radio with Subspace Matching," *IEEE Waveform Diversity and Design Conference 2012*, Kauai, Hawaii, January 22 - 27, 2012.

S. Hou, **R. C. Qiu**, J. P. Browning, and M. C. Wicks, "Spectrum Sensing in Cognitive Radio with Robust Principal Component Analysis," *IEEE Waveform Diversity and Design Conference 2012*, Kauai, Hawaii, January 22 - 27, 2012.

Z. Hu, R. Ranganathan, C. Zhang, **R. C. Qiu**, M. Bryant, M. C. Wicks, and L. Li, "Robust Non-Negative Matrix Factorization for Joint Spectrum Sensing and Primary User Localization in Cognitive Radio Networks," *IEEE Waveform Diversity and Design Conference 2012*, Kauai, Hawaii, January 22 - 27, 2012.

X. Li, Z. Hu, **R. C. Qiu**, N. Guo, G. Scalzi, and M. C. Wicks, "Waveform Diversity for Closed-loop Wide-band Cognitive Sensing System," *IEEE Waveform Diversity and Design Conference 2012*, Kauai, Hawaii, January 22 - 27, 2012.

C. Zhang, Z. Hu, N. Guo, **R. C. Qiu**, K. Currie, "Cognitive Radio Network as Wireless Sensor Network (III): Passive Target Intrusion Detection and Experimental Demonstration," *IEEE Radar Conference 2012*, Atlanta, Georgia, May 7 - 11, 2012.

Z. Hu, M. Bryant, and **R. C. Qiu**, "Multi-path SAR Change Detection," *IEEE Radar Conference 2012*, Atlanta, Georgia, May 7 - 11, 2012.

S. Hou, **R. C. Qiu**, J. P. Browning, and M. C. Wicks, "Target Detection with Linear and Kernel

Subspaces Matching in the Presence of Strong Clutter," *IEEE Radar Conference 2012*, Atlanta, Georgia, May 7 - 11, 2012.

F. Lin, **R. C. Qiu**, Z. Hu, S. Hou, L. Li, J. P. Browning, and M. C. Wicks, "Cognitive Radio Network as Sensors: Low Signal-to-Noise Ratio Collaborative Spectrum Sensing," *IEEE Waveform Diversity and Design Conference 2012*, Kauai, Hawaii, January 22 - 27, 2012.

N. Guo, X. Li, J. Pogge, Y. Song, **R. C. Qiu**, S. Hong, and S. Hary, "Unique Measurement and Modeling of Total Phase Noise in Wideband Receiver," *IEEE Waveform Diversity and Design Conference 2012*, Kauai, Hawaii, January 22 - 27, 2012.

### **Book**

**R. C. Qiu**, Zhen Hu and Husheng Li "Cognitive Radio Communication and Networking: Principles and Practice," John Wiley and Sons, 500 pages, 2012.

### **Kwun-Lon Ting**

#### **Journal Publications**

Bowen Yu and **Kwun-lon Ting**, "Conjugate Curve Design with Spline Contact Path", *Computer-Aided Design and Applications*, 2012. Vol 9.1.

Bowen Yu and **Kwun-lon Ting**, "Free-Form Conjugation and Gear Tooth Profile Design", JMR-11-1144 *ASME Journal of Mechanisms and Robotics*, 5(1),011001(Oct 01, 2012).

Huimin Dong, **Kwun-Lon Ting**, Bowen Yu, Jian Liu, and Delun Wang, "Differential Contact Path and Conjugate Properties of Planar Gearing Transmission", *ASME Journal of Mechanical Design*, 2012, Vol 134(6).

#### **Conference Presentations**

Bowen Yu, **Kwun-lon Ting**, "Conjugate Curve Design with Spline Contact Path", CAD'2011, Taipei, Taiwan.

Bowen Yu, **Kwun-lon Ting**, "Free-form Conjugation Theory", ASME 2011 IDETC/CIE Conference DETC2011/MECH-48337

## Cynthia Rice

### *Journal Publications*

Bauskar, A., **Rice, C.A.** "Direct Formic Acid Fuel Cells with Pore-Formers for Improved Mass Transport," *Electrochimica Acta*, **2012**, 62(0), 36-41.

### *Conference Presentations*

P. Urchaga, S. Goli, **C. A. Rice**, 'Study of the Cathode Catalyst Layer Degradation Mechanisms in PEM Fuel Cell', **Oral Presentation, Electrochemical Society** – Honolulu, HI Oct. **2012**.

A. Pistono, **C. A. Rice**, J. Lewis, V. Ramani, 'Subzero Degradation Analysis of Membrane Electrode Assemblies Fabricated Using Two Common Techniques', **Poster Presentation, Electrochemical Society** – Honolulu, HI Oct. **2012**.

A. Pistono, **C. A. Rice**, J. Lewis, V. Ramani, 'Subzero Degradation Analysis of Membrane Electrode Assemblies Modified with Additives', **Oral Presentation, Electrochemical Society** – Honolulu, HI Oct. **2012**.

**C. Rice**, A.S. Bauskar, 'Anode Catalyst Layers for Direct Formic Acid Fuel Cells', **Oral Presentation, Electrochemical Society**–Honolulu, HI Oct. **2012**.

A.S. Bauskar, **C.A. Rice**, A.B. Papandrew, T.A. Zawodzinski, 'Carbon supported PtPd catalyst for formic acid electro-oxidation', **Poster Presentation, TN-SCORE Thrust II annual retreat** – Knoxville, TN July 25<sup>th</sup>, **2012**.

S. Saeed, M. Brooks, A. Morgan, **C.A. Rice**, 'Efficient Removal of CO<sub>2</sub> in a Direct Formic Acid Fuel Cell,' **Poster Presentation, TN-SCORE Thrust II annual retreat** – Knoxville, TN July 25<sup>th</sup>, **2012**.

A.S. Bauskar, **C.A. Rice**, A.B. Papandrew, T.A. Zawodzinski, Carbon supported PtPd catalyst for formic-acid electro-oxidation, **Poster Presentation, TN-SCORE Annual Conference 'Creating a Culture of Collaboration'** – Nashville, TN May 17<sup>th</sup>-18<sup>th</sup> **2012**.

S.M. Goli, A.S. Bauskar, **C.A. Rice**, Impact of Potential Cycling on Catalyst Durability of Automotive Fuel Cell, **Poster Presentation, TN-SCORE Annual Conference 'Creating a Culture of Collaboration'** – Nashville, TN May 17<sup>th</sup>-18<sup>th</sup> **2012**.

A.S. Bauskar, **C.A. Rice**, Bi-modified carbon supported Pd catalyst for formic acid electro-oxidation, **Poster Presentation, TTU Student Research Day** – April **2012**.

S.M. Goli, A.S. Bauskar, **C.A. Rice**, Ex-situ Investigation of potential cycling on catalyst durability of AUTOMOTIVE FUEL Cell, **Poster Presentation, TTU Student Research Day** – April **2012**.

S. Saeed, A. Morgan, **C.A. Rice**, 'Efficient Removal of CO<sub>2</sub> in a Direct Formic Acid Fuel Cell,' **Poster Presentation, TTU Student Research Day** – April **2012**.

A.S. Bauskar, **C.A. Rice**, Bi-modified carbon supported Pd catalyst for formic acid electro-oxidation, **Poster Presentation, Electrochemical Energy Storage and Conversion Forum cosponsored by TN-SCORE** – Knoxville, TN, April 19<sup>th</sup>, **2012**.

S.M. Goli, A.S. Bauskar, **C.A. Rice**, Ex-situ Investigation of potential cycling on catalyst durability of AUTOMOTIVE FUEL Cell, **Poster Presentation, Electrochemical Energy Storage and Conversion Forum cosponsored by TN-SCORE** – Knoxville, TN, April 19<sup>th</sup>, **2012**.

## Nan "Terry" Guo

### *Journal Publications*

**T. N. Guo**, "Unique Measurement and Modeling of Total Phase Noise in RF Receiver," *IEEE Transactions on Circuits and Systems II*.

### *Book Chapter*

**Terry Guo**, "Boosting Secondary-User Performance: Challenges, Potential Solutions, and Expectations," in *Cognitive Radio and Interference Management: Technology and Strategy*, edited by Meng-Lin Ku and Jia-Chin Lin, Information Science Reference (an imprint of IGI Global).

## Faculty Research Grant

<b>Center for Manufacturing Research FY 2012 – 2013 Project Summary</b>					
<b>Project Description/ Source/ Acct. No.</b>		<b>Principal Investigators</b>	<b>Activated Amount</b>	<b>Project Duration</b>	<b>Estimated 12-month Expenses</b>
1.	Manufacturing Center Testing & Design - FY 2012-13 Various Industries Account #: 5-38585	Kenneth Currie	\$26,293	7/1/2012 – 6/30/2013	\$46,002
2.	University of Tennessee Center for Industrial Services (UT-CIS) – FY 2012-13 UT-CIS Account #: 5-33517	Kenneth Currie	\$60,000	7/1/2012 – 6/30/2013	\$58,194
3.	University of Tennessee Center for Industrial Services (UT-CIS) – FY 2012-2013 – 2 <sup>nd</sup> Allocation UT-CIS Account #: 5-33517	Kenneth Currie	\$4,000	7/1/2012 – 06/30/2013	\$0
4.	Public Private Partnership for a Comprehensive Workforce Development Plan to Stimulate Industrial Energy Efficiency and Demand Reduction - Allocation #3 Award DE-EE0005533 U.S. Department of Energy Account #: 5-32290	Glenn Cunningham Kenneth Currie	\$102,000	9/30/2011 – 05/31/2013	\$102,000
5.	Public Private Partnership for a Comprehensive Workforce Development Plan to Stimulate Industrial Energy Efficiency and Demand Reduction – Allocation #4 Award DE-EE0005533 U.S. Department of Energy Account #: 5-32290	Glenn Cunningham Kenneth Currie	\$34,000	9/30/2012 – 9/29/2013	\$34,000
6.	Collaborative Research: Design, Analysis and Implementation of Social Interactions in Cognitive Radio Networks – Award CNS-1247778 - Year 1 National Science Foundation Account #: 5-31212	Robert Qiu	\$15,175	10/01/2012 – 9/30/2013	\$15,175

**Center for Manufacturing Research  
FY 2012 – 2013 Project Summary**

	<b>Project Description/ Source/ Acct. No.</b>	<b>Principal Investigators</b>	<b>Activated Amount</b>	<b>Project Duration</b>	<b>Estimated 12-month Expenses</b>
7.	Components and Devices for Energy Storage and Conversions, Advanced Solar Conversion and Innovation – Contract A11-0171-001.04 – Amendment #3  University of Tennessee (via NSF funds)  Account #: 5-31228	Cynthia Rice	\$5,500	10/7/2011–10/7/2012	\$0
8.	An Alternative Low-Cost Process for Deposition of MCrAlY Bond Coats for Advance Syngas and Hydrogen Turbine Applications Award DE-FE0007332 Year 2 of 3  U.S. Department of Energy  Account #: 5-32275	Ying Zhang	\$121,312	9/12/2012 – 9/11/2013	\$105,298
9.	TUES: SecKnitKit (Security Knitting Kit): Integrating Security into Traditional Computer Science Courses – Award DUE-1140864 – Year 1  National Science Foundation  Account #: 5-31275	Ambareen Siraj  Sheikh Ghafoor	\$105,004	8/1/2012 – 7/31/2013	\$100,350
10.	Task Order 4 – Fundamental Radar Algorithms and Techniques – Subcontract CIRE – Task 4 – TennTech – Year 1 of 2  RNET Technologies Inc. (via AFRL/RV funds)  Account #: 5-32402	Robert Qiu	\$39,758	7/10/2012–7/9/2013	\$39,758
11.	Components and Devices for Energy Storage and Conversions, Advanced Solar Conversion and Innovation & Nanostructures for Enhancing Energy Efficiency Contract A11-0171-001.04 Amendment #4  University of Tennessee (via NSF Award EPS-1004083)  Account #: 5-31228	Cynthia Rice	\$176,097	10/7/2012 – 10/7/2013	\$115,000

**Center for Manufacturing Research  
FY 2012 – 2013 Project Summary**

Project Description/ Source/ Acct. No.		Principal Investigators	Activated Amount	Project Duration	Estimated 12-month Expenses
12.	Heat Recovery Water Heater Demonstration Project – Fall Creek Falls State Park – SBC 126/026-01-2012  STATE of Tennessee, Department of Environment & Conservation  Account #: 5-34200	Kenneth Currie	\$135,700	7/01/2012 – 06/30/2015	\$190
13.	Technology Advisory Support – Contract 13-ENG-202609-TennTech  Auburn University (via federal funds)  Account #: 5-32314	Wayne Johnson	\$61,215	2/1/2013 – 8/31/2013	\$61,215
14.	Subcontract from University of South Florida – Virtually Transparent Epidermal Imagery Subagreement 2108-1039-00-A – Year 2  University of South Florida (via NSF funds)  Account #: 5-32398	Adam Anderson	\$25,174	9/1/2012– 8/31/2014	\$25,174
15.	Subcontract from University of South Florida - Impedance Changes as an Indicator of Successful Skin Electroporative DNA Delivery – Subagreement #2107-1060-00-A – Modification #1  University of South Florida (via NIH funds)  Account #: 5-32397	Adam Anderson	\$14,561	1/1/2012– 12/31/2012	\$14,347
<b>TOTALS</b>			<b>\$925,789</b>		<b>\$716,703</b>

The CMR is currently *not* accredited nor has it received any special recognition by any disciplinary association or other national or international source since July 2008.

## Schedule 7

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

Institution Tennessee Technological University Center Center for Manufacturing Research

	FY 2012-13 Actual			FY 2013-14 Proposed			FY 2014-15 Requested		
	Matching	Appopr.	Total	Matching	Appopr.	Total	Matching	Appopr.	Total
Expenditures									
<b>Salaries</b>									
Faculty	203,390	280,055	483,445	250,000	411,791	661,791	180,000	438,000	618,000
Other Professional	35,800	557,082	592,882	35,000	426,950	461,950	100,000	412,000	512,000
Clerical/ Supporting	0	60,743	60,743	0	64,506	64,506	10,000	70,000	80,000
Assistantships	72,300	143,711	216,011	75,000	150,000	225,000	125,000	150,000	275,000
Hourly Students	83,220	40,227	123,447	57,200	37,000	94,200	65,000	40,000	105,000
<b>Total Salaries</b>	<b>394,710</b>	<b>1,081,818</b>	<b>1,476,528</b>	<b>417,200</b>	<b>1,090,247</b>	<b>1,507,447</b>	<b>480,000</b>	<b>1,110,000</b>	<b>1,590,000</b>
Fringe Benefits	96,063	426,143	522,206	195,000	331,000	526,000	200,000	354,000	554,000
<b>Total Personnel</b>	<b>490,773</b>	<b>1,507,961</b>	<b>1,998,734</b>	<b>612,200</b>	<b>1,421,247</b>	<b>2,033,447</b>	<b>680,000</b>	<b>1,464,000</b>	<b>2,144,000</b>
<b>Non-Personnel</b>									
Travel	64,418	22,084	86,502	50,000	20,000	70,000	50,000	20,000	70,000
Software	135	660	795	0	0	0	4,000	0	4,000
Books & Journals	4,310	0	4,310	4,000	0	4,000	1,000	0	1,000
Other Supplies	126,885	45,033	171,918	104,710	28,753	133,463	200,000	30,100	230,100
Equipment	46,539	0	46,539	125,000	0	125,000	440,000	0	440,000
Maintenance	0	239	239	10,000	0	10,000	25,000	0	25,000
Scholarships	0	0	0	0	0	0	0	0	0
Consultants/Subcontracts	153,500	0	153,500	150,000	0	150,000	100,000	0	100,000
Renovation	0	0	0	0	0	0	0	0	0
Other (Seminars/Conf.)	60	0	60	0	0	0	0	0	0
<b>Total Non-Personnel</b>	<b>395,847</b>	<b>68,016</b>	<b>463,863</b>	<b>443,710</b>	<b>48,753</b>	<b>492,463</b>	<b>820,000</b>	<b>50,100</b>	<b>870,100</b>
<b>GRAND TOTAL</b>	<b>886,620</b>	<b>1,575,977</b>	<b>2,462,597</b>	<b>1,055,910</b>	<b>1,470,000</b>	<b>2,525,910</b>	<b>1,500,000</b>	<b>1,514,100</b>	<b>3,014,100</b>
<b>Revenue</b>									
New State Appropriation	0	1,482,900	1,482,900	0	1,470,000	1,470,000	0	1,514,100	1,514,100
Carryover State Appropriation	0	93,077	93,077	0	0	0	0	0	0
New Matching Funds	840,081	0	840,081	1,055,910	0	1,055,910	1,500,000	0	1,500,000
Carryover from Previous Matching Funds	46,539	0	46,539	0	0	0	0	0	0
<b>Total Revenue</b>	<b>886,620</b>	<b>1,575,977</b>	<b>2,462,597</b>	<b>1,055,910</b>	<b>1,470,000</b>	<b>2,525,910</b>	<b>1,500,000</b>	<b>1,514,100</b>	<b>3,014,100</b>

## **FY 2013-14 Budget Request and Justification**

The CMR is requesting a 3% increase in the FY 2013-14 State appropriations to account for increasing salaries, supplies, and travel costs. Despite the state of the economy, prices for supplies, benefits, and travel continue to increase on a yearly basis and inflation is threatening to erode the CMR's ability to continue a high-level of research and service to Tennessee manufacturing industries.



