

UTMCEC Measurement and Control Engineering Center (MCEC)

University of Tennessee (lead institution) and Oklahoma State University

Enhanced measurement techniques in process control optimization will improve productivity

A National Science Foundation Industry/University Cooperative Research Center since 1986

Center Mission

The mission of the Measurement and Control Engineering Center (MCEC) is to accelerate the overall pace of measurement and control technology development and implementation in industry by serving as a national center for research and teaching in these technologies in response to and in support of the needs of its industrial members.

The association between the MCEC member companies and the Center is characterized by a high interaction at each level of progress in a Center project:

1. There will be active and frequent solicitation of input from member companies to accurately determine their needs.
2. The project goals will be generated as a result of collaborative interaction—there will be a free exchange of information, data, and ideas to formulate a working hypothesis.
3. Member participation will frequently involve on-site testing or evaluation of the products of MCEC research as a means of implementation and technology transfer.

Research and Development Program

MCEC's research program is truly industry-driven. The partnership between industry and the Center is formalized through the role of the Industrial Advisory Board (IAB). The IAB advises MCEC management on all aspects of the Center, from research selection and evaluation to strategic planning. The IAB meets twice a year for a two-day meet-

ing, at which time reviews of the progress in research projects are conducted. A business meeting follows the reviews and provides an opportunity of formal feedback regarding suggested funding allocations and policy recommendations. Each company has one vote on the Board and designates an official representative; however, multiple representatives of a company are encouraged to attend the meetings and to participate in the research planning.

Since the program was initiated in 1985, faculty representing nine academic departments at the University of Tennessee (UT) and Oklahoma State University (OSU) have been involved in research supported by MCEC. In addition, Oak Ridge National Laboratory (ORNL) has been heavily involved in the center's research since its inception. The current research program emphasizes two areas of technology: Analytical Instruments and Process Control; Optimization, and Modeling. Researchers at other universities participate in MCEC, including current participation by East Carolina University and Transylvania University. Research projects have been completed at Vanderbilt University and Purdue University. Numerous collaborative projects have existed with a variety of institutions, including Lehigh University, the University of Washington, and the University of Colorado. Research topics are listed below under the area of specialization. Project co-directors include representatives of ORNL and local industry. The Center's cooperative, interdisciplinary approach ensures that it has the personnel, equipment, financing, and industry-oriented direction necessary to accomplish research leading to significant improvements in measurement and control.

Analytical Instruments

- On-line rheological property sensors
- Process and polymer mass spectrometry
- In-line polymer rheology and polymer composition monitoring
- Spectrometric acid, base, and ion sensors
- Elongational flow characterization of polymer melts and solutions
- Quantitative analysis using low-field NMR signals in the time domain
- Completely automated open-path FT-IR spectrometry.

Process Control, Optimization, and Modeling

- Applied process automation laboratory
- Experimental batch optimization



The Science and Engineering Research Facility (SERF) at The University of Tennessee.



The Advanced Technology Research Center (ATRC) at Oklahoma State University

- Batch monitoring and control
- Control and analysis of non-linear dynamics for industrial engineering systems
- Visual and auditory data-assisted process control and monitoring
- Control to economic optimum
- Automatic initiation of process model adjustment
- Health monitor for automation.

Research Facilities

MCEC research is performed in departmental research facilities. Analytical instrument testing is initiated on campus and often extends to a member company's production facilities. Extensive computational resources are available on each MCEC campus in support of the modeling and image processing projects.

At UT, the research program is implemented in space assigned to academic departments in numerous campus buildings. In addition, the recently completed Science and Engineering Research Facility (SERF) contains a 900-square foot laboratory reserved exclusively for Center projects. SERF is the largest building on the Knoxville campus and is among the most advanced in the nation.

MCEC research activities at OSU involve several engineering departments and use existing experimental and computing facilities. Some of the MCEC research will be conducted in the Advanced Technology Research Center (ATRC).

This new facility houses 30 offices and 30 laboratories and makes state-of-the-art analytical instruments available to MCEC researchers.

Special Center Activities

One successful project involving sensors and sensor placement was a multiphase sensor development project. This project was partly funded by the Department of Energy to develop a fiber-optic-based chemical composition sensor using Raman spectroscopy. The sensor has been employed initially in distillation column analysis.

The Center was also involved in engineering development work for new sensors. An FT-Raman fiber-optic spectrometer was modified to meet the needs of a plant floor environment. The device was brought on-line at a member company, where it provided useful information to plant operators. This device resulted in enough energy savings to cover the cost of the instrument. Improved control had the added benefit of increased plant production.

A variety of software tools have been developed in the Center. Using these tools, one member company worked with MCEC researchers in modeling studies of a distillation column, considering specifically the impact of sensor type and placement. The research identified sources of variation in the process and resulted in a savings of approximately \$300,000 to the company.

Currently, the Center is involved in the development of a laboratory instrument for *in-situ* measurement and characterization of batch reactions with a member company and a small, independent company. This research is being funded separately by NSF through a Small Firms Collaborative Research and Development grant.

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