Mechanical Engineering
Auburn University
Research Overview

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Mechanical Engineering Snapshot

- **Programs:** Mechanical Engineering and Materials Engineering, 28 Faculty
- **Undergraduate Enrollment:** 884 (Fall 2010) - Largest in University
  738 (Fall 2009) - Largest in University
- **Graduate Enrollment:** 155 (Fall 2010) - Largest in University (Non-Prof)
  150 (Fall 2009) - Largest in University (Non-Prof)
- **Program Highlights**
  - Curricula are Rigorous with Significant Innovation.
  - Students are Hard Working and Passionate about What They Do
  - World-Wide Extremely Successful Alumni
  - Research Thrusts: Transportation/Vehicles, Sensors, Detection, and Food Safety, Electronic Packaging
  - National Recognized Outreach Efforts: AETAP, LITEE - Case Studies
- **Extracurricular Activities:** Excellence at a National Level
  - Solar Car Race (3rd - 2005)
  - Student Paper Contests: 5 National Champions in Past 30 Years
- **Research Awards:** $ 8.18M (2009-10) - Largest in University
  $ 6.63M (2008-09) - 2nd Largest in University
  ~10% of Total University Awards
Faculty
Department of Mechanical Engineering

Beale  Burch  Bevly  Bhavnani  Cheng  Chin  Choe  Crocker  Dyer

Fergus  Flowers  Harris  Hong  Jackson  Jones  Kim  Knight  Khodadadi

Lall  Mackowski  Madsen  Marghitu  Mishra  Payton  Prorok  Overfelt  Raju

Simonian  Sinha  Suhling  Tippur  Thakur  Zee

C. T. Liu
(NAE Member)

Joined AU Faculty
January 2009
Facilities
AU Mechanical Engineering

Ross Hall
Renovated 2006

Wilmore Hall
Renovated 2002

L Building

Shop Buildings
Facilities
AU Mechanical Engineering

College of Engineering Buildings
Facilities
Shelby Center – Phase 2 (February 2011)
Research Metrics
AU Mechanical Engineering

ME Research Awards

$0
$2,000,000
$4,000,000
$6,000,000
$8,000,000
$10,000,000
$12,000,000


Academic Year

$6-10M per Year
Average per Faculty Member
$200-333K Per Year

2009-10: $8.18M
# Research Metrics
AU Mechanical Engineering

## Research Awards ($Millions)

<table>
<thead>
<tr>
<th></th>
<th>FY05</th>
<th>FY06</th>
<th>FY07</th>
<th>FY08</th>
<th>FY09</th>
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<td>AU</td>
<td>$69.3</td>
<td>$70.5</td>
<td>$69.0</td>
<td>$57.1</td>
<td>$94.0</td>
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<tr>
<td>Eng</td>
<td>$36.3</td>
<td>$37.2</td>
<td>$32.0</td>
<td>$25.9</td>
<td>$46.6</td>
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<tr>
<td>ME</td>
<td>$6.3</td>
<td>$7.8</td>
<td>$6.5</td>
<td>$6.6</td>
<td>$8.2</td>
</tr>
</tbody>
</table>

The ME Department Faculty Bring in Approximately:
10% of AU Research Awards, and
20% of Engineering Research Awards
Research Metrics
AU Mechanical Engineering

ME Research Expenditures

Dollars

$0

$1,000,000

$2,000,000

$3,000,000

$4,000,000

$5,000,000

$6,000,000

$7,000,000

$8,000,000

Academic Year

2001-02
2002-03
2003-04
2004-05
2005-06
2006-07
2007-08
2008-09
2009-10

$6-7M per Year

2009-10: $6.74M
Research Areas
AU Mechanical Engineering
Research Areas
AU Mechanical Engineering

- Acoustics
- Advanced Powertrains
- Automotive Design
- Biohazard Detection
- Biomechanics
- Casting
- CFD
- Coatings and Thin Films
- Combustion
- Composite Materials
- Design of Machinery
- Dynamic Stability
- Electrical Connectors
- Electronics Cooling
- Electronic Packaging
- Electro-Optics
- Energy Harvesting Devices
- Energy Storage Devices
- Energy Sustainability
- Experimental Mechanics
- Finite Element Analysis
- Fluid Mechanics
- Flywheels
- Food Safety
- Fracture Mechanics
- Fuel Cells
- Gas Turbines
- GPS Guidance and Control
- Graded Materials
- Heat Pipes
- Heat Transfer
- HVAC
- Impact Dynamics
- Interferometry
- Magnetic Bearings
- Materials Processing
- MEMS
- Microfluidics/Nanofluidics
- Microscopy
- Motion Analysis
- Nanotechnology
- NDT/NDE
- Noise Control
- Nonlinear Optics
- Nonlinear Systems
- Optical Metrology
- Organic Semiconductors
- Prognostics (PHM)
- Radiation
- Robotic Welding
- Robotics
- Rotor Dynamics
- Sensors (Biological)
- Sensors (Chemical)
- Sensors (Magnetostrictive)
- Sensors (MEMS)
- Sensors (Piezoelectric)
- Sensors (Piezoresistive)
- Smart Materials
- Solar Energy
- Sound and Vibration
- Test Chips
- Thermal Systems
- Tribology
- Unmanned Vehicles (UAV)
- Vehicle Stability Control
Research
AU Mechanical Engineering

- **Research Thrusts**
  - **Materials** (Sensors, Bio/Nano, Detection and Food Safety)
  - **Electronic Packaging** (Reliability in Harsh Environments)
  - **Vehicle Technology** (Unmanned/Autonomous; Dynamics, Stability, and Controls; Advanced Powertrains: Fuel Cell and Hybrid)

- **Research Centers**
  - MREC (Materials Research and Education Center)
  - AUDFS (Auburn University Detection and Food Safety Center)
  - ACER (Air Cabin Environmental Research)
  - **CAVE**³ (Center for Advanced Vehicle and Extreme Environment Electronics)
Food safety is a national priority that affects everyone. As many as 76 million Americans become ill annually due to food borne pathogens and toxins with an estimated cost of up to $ 30 billion.

AUDFS’s mission is to develop the science and engineering required to rapidly identify, pinpoint and characterize problems that arise in the food supply chain through the integration of sensors and information systems technology.

Technical focus
- Detection of food contamination
- Biosensors for monitoring pathogens
- Phage as an alternative for antibodies

Director: Bryan A. Chin,
E-mail: bchin@eng.auburn.edu

AUDFS Accomplishments
- $11.2M in total USDA funding
- 20 awarded patents
- 6 commercial products
- Graduated 57 MS students
- Graduated 67 PhD students
- More than 300 peer-reviewed articles
- Spun off one commercial company
- Spun off one additional center
“Dust Sensors” for direct detection of bacteria on fresh produce

Dust Sensors: A newly developed and patented sensing technology enabling the wireless, in-field detection of bacteria.

1. Distribute Sensors (5 minutes)

Sprinkle 55 sensors (50 measurement, 5 control) onto the watermelon, wait 5 minutes for binding to occur.

2. Measure (<1 minute)

Measure wirelessly and simultaneously the 55 sensors. Less than 1 minute.
ACER
Airline Cabin Environment Research

- ACER’s mission is to undertake the critical R&D necessary to ensure a safe, healthy and comfortable environment for passengers and crew in commercial airliners.
- ACER started in August 2004
- FAA Cooperative Agreement renewed last year
- $18.8M in total FAA funding to date
- Auburn ~ $7.6M
- Technical focus
  - Air quality sensing
  - Air purification

Director: Tony Overfelt
E-mail: overfra@auburn.edu
ACER
Airline Cabin Environment Research

University Collaborators
Auburn University, Boise State University
Harvard University, Kansas State University
Purdue University, University of California - Berkeley
University of Medicine & Dentistry of New Jersey

Industrial Members/Sponsors
Honeywell
Delta
Singapore Airlines
United
Southwest Airlines
Boeing
Steris
Air Transport Association
Donaldson
Keddeg
Goodrich
ANSYS
AeroClave
MITRE
Battelle
Berkeley Lab
Lawrence Berkeley National Lab
Pall Corporation
Intergraph
Us Airways

16
CAVE$^3$
NSF Center for Advanced Vehicle and Extreme Environment Electronics

- A National Science Foundation Industry/University Cooperative Research Center (I/UCRC)
- **Objective:** Research and Development (in Collaboration with Industry) on Electronic Packaging in Harsh Environments
- **Demographics:**
  - 20 Member Companies
  - 15 Faculty, 5 Staff
  - 35 Graduate Students
  - 10 Laboratories

**Director:** Pradeep Lall
E-mail: lallpra@auburn.edu
CAVE³
NSF Center for Advanced Vehicle and Extreme Environment Electronics

Automotive - Aerospace - Military - Computing - Portable - Other

Harsh Environments: Extreme High/Low Temperatures, Large Temperature Changes, Vibration/Drop/Shock, Corrosion/Radiation/Pressure/etc.
CAVE³
Current and Past Research Sponsors

- **CAVE Center Memberships**
  - Full, Associate, Affiliate
- **Funded Projects**
  [Contract Research]
- **Approximate Funding Level** is $2-3M Annually
NEPCM
DOE, Multi-University Project

Nano-Structure Enhanced Phase Change Materials for Enhanced Thermal Energy Storage

PCM (liquid)

1 ~ 10 mm Micron range

Nanoparticles

195x163

Nano-size structures

FREE-FORM Colloids

FORM-STABLE

PCM/Metal Composites

DOE, 2009-2012, $2.4M
5 Alabama Universities, 25 Faculty + Students
Jay Khodadadi, PI
GPS and Vehicle Dynamics

David Bevly, PI
$10M Research over 10 Years
Currently 20 Students (8 PhD, 8 MS, 4 BS)

Example Research Topics
- Unmanned Autonomous Vehicles
- Vehicle modeling
- Determination of rollover propensity
- Vehicle sensor fusion/integration
- GPS/INS navigation
- IMU & laser scanner fusion
- Sensor characterization and modeling
- Development of a software GPS receiver
- High speed control of ground vehicles
Analytical Microscopy Cost Center

- Largest Instrumentation Center on Campus
- State-of-the-Art Characterization Instrumentation
  - 29 Instruments
- 3 Recent, Large NSF-MRI awards
- Serve 139 users Across 5 colleges
- Serve Local Industry and Universities
- Self Supporting, Fee-Based Center
- Training and Operators Available
- Director, Bart Prorok
SUMMARY

- **ME Department**
  - Mechanical Engineering and Materials Engineering Academic Programs
  - Strong Experienced Faculty
  - Large Research Program
  - Leaders at AU in Enrollment and Research Funding for Several Years
  - Challenges: Very Few Young Faculty and Diminishing Resources