MAE Department Update

Department of Mechanical and Aerospace Engineering

Presented to the Board of the Academy of Mechanical and Aerospace Engineering

April 19, 2013
Enrollment

• Spring 2013 Enrollment numbers:

On Campus:
  AE – 177(183) undergrad, 33(38) grad, 210 total (221 year ago)
  ME – 642(615) undergrad, 80(84) grad, 722 total (699 year ago)
  Manuf E - 14 total (18 year ago)

Distance:
  AE - 6 grad (7 year ago)
  ME - 26 grad (33 year ago)
  Manuf E - 16 total (16 year ago)
Status of Faculty Searches

For Spring 2013
Dr. Kyle DeMars – Guidance and control of aerospace vehicles
   PhD University of Texas at Austin
   NRC Postdoctoral Associate, Air Force Res. Lab, Kirtland AFB

For Fall 2013
Dr. Tansel Yucelen – Dynamical systems and control
   PhD Georgia Institute of Technology
   Research Engineer, Georgia Tech

Dr. Lian Duan – Computational fluid dynamics
   PhD Princeton University
   Research Scientist, National Institute of Aerospace, NASA

Dr. Heng Pan – Advanced manufacturing processes and modeling
   PhD University of California, Berkeley
   Senior R&D Process Engineer, Applied Materials Inc.

Dr. Cheng Wang – Experimental fluid dynamics, micro fluidics
   PhD University of Illinois, Champaign Urbana
The S&T Campus Strategic Planning Process

• In June 2012, the Campus initiated a year-long strategic planning process.

• This initiative is aligned with UM System President Timothy Wolfe’s request that each campus produce a strategic plan focusing on its strengths while addressing the challenges facing higher education including identifying new revenue streams.

• Final five-year plan due to UM System by June 3
MISSOURI UNIVERSITY OF SCIENCE AND TECHNOLOGY
STRATEGY STATEMENT:

Missouri S&T will provide by 2020 a top return on investment among public research universities to students, employers, research partners and donors through extraordinary access to renowned expertise, services and experiential learning opportunities.

Theme 1: Develop and inspire creative thinkers and leaders for life-long success.

Theme 2: Enhance reputation and raise visibility.

Theme 3: Achieve sustainable growth to ensure best return on investment.

Theme 4: Increase and facilitate meaningful access to and interaction with renowned faculty, staff and services.
If new and innovative strategic initiatives result from the process, will UM System help?

- The UM System President developed four criteria for funding strategic initiatives.

- The criteria are:
  i. Campus co-investment
  ii. Measureable and significant impact on strategy
  iii. Impact on student learning
  iv. Cross campus initiative and/or replicable and scalable
MAE Instructional Laboratories

• Not only repair instructional laboratory equipment ... but transform the laboratory experience.

• Concept: Design experiment stations that can be used by the students throughout their curriculum (multiple “touch points”) to foster connections to lectures and hands-on experiences ... each time encountering a new principle and reinforcing learned concepts.
Progress on Instructional Labs

Year 1: Fluid Dynamics Laboratory
Funded and to be completed this summer

Year 2: Dynamic Systems and Controls
Appears to be funded by AMAE Past Presidents, Board of Directors, Membership—Thank you!

Year 3: High Speed Flow and Gas Turbine Lab
Introduction of a new gas turbine laboratory and upgrade of the existing supersonic wind tunnel (pursuing corporate funding spearheaded by AMAE, Past Presidents)
Lab 1: Fluid Dynamics Instructional Laboratory

- Contributions from Jon (ME ‘73) and Barbara Jansky and Rob (ME ’74) and Kathy Williams have enabled the Department to initiate development of a new instructional lab: Fluid Dynamics Lab.

- Fluid Dynamics Lab focuses on the principles of internal fluid flow, pump performance, instrumentation and flow control.
Fluid Dynamics Instructional Laboratory - Status

- **Phase 1 complete** – being used in ME 231 (undergraduate fluid dynamics), ME 242 (student designed experiments in mechanical systems laboratory)

- **Positive Development** - Further support has been obtained from Fisher Control Valve Division of Emerson through the donation of $80,000 of new instrumentation and control valves. This has enabled the addition of Phase 3 (pump performance)

- **Setback** – Faculty member who was the architect of the fluid dynamics laboratory has left the university. This impacts course integration but new faculty are stepping up.
Fluid Dynamics Laboratory

Phase 1 – Mobile stations for class room instruction and demonstration

**Specific Aim:** Demonstration of fundamental fluid flow principles.

- Frictional losses in pipes and fittings
- Bernoulli’s principle
- Laminar / turbulent flow
- Fluid momentum
- Hydrostatics
- *Upgradable to remote operation*

Interchangeable experiment modules for demo of fluid flow principles
Fluid Dynamics Laboratory

Phase 2 – Fixed facility ...under construction
**Specific Aim:** Demonstration of **fundamental pump performance**.

- Pump performance
  - Pump sizing
  - Generation of pump curves
  - Series-Parallel demonstration
  - Pump type characteristics
Objective: Strengthen the understanding of mechanical and aerospace system modeling and control by providing a hands-on dynamic system and control laboratory experience for student.

Key faculty: Drs. Bristow, Landers and Balakrishnan

Reinforcement of principles progressively over various courses
ME211 → ME242 → ME279 → ME 280 → ME/AE381 → ME/AE479

Total number of students affected ~ 1000 students every academic year
- ME211 – Modeling and Analysis of Dynamic Systems: ~ 250 students
- ME242 – Mechanical Engineering Systems Laboratory ~ 250 students
- ME279 – Automatic Control of Dynamic Systems ~ 250 students
- ME280 – Controls Laboratory ~ 250 students
- ME307* – Vibrations ~ 20 students
- ME378* – Automatic Control of Dynamic Systems ~ 20 students
- ME/AE381* – Mechanical and Aerospace Control Systems
- ME/AE479* – Analysis and Synthesis of ME and AE Systems: ~ 15 students
Dynamic Systems and Control Facility – Other Experiments

Two Cart, Inverted Pendulum:
- Reconfigurable for multiple experiments
- Illustrate vibrations concepts
- High order nonlinear system

2D Helicopter:
- Investigate aerospace stability and controls concepts
- Multiple input, multiple output system

Magnetic Levitation:
- Perfect for a classroom demonstration
- Illustrates concepts of electromagnetic systems
- Low order nonlinear system

Two Tank System:
- Investigate fluid controls concepts
- Reconfigure from simple to complex
- Multiple inputs and multiple outputs

Heat Flow System:
- Investigate heat transfer controls concepts
- Perfect for classroom demonstration
- Low order system
Lab 3 : High Speed Flow / Gas Turbine Facility

Objective: Provide a facility that will enable students to:

Part 1) Observe and conduct experiments in high speed (supersonic) flows

Part 2) Experience hands-on operation of a gas turbine

• Powerful experimental hardware complement to current instruction in many areas of aerospace and mechanical engineering, including fluid dynamics, thermodynamics, combustion, propulsion, instrumentation, etc.

• Establish capability to remotely run and demonstrate gas turbine operation from the classroom, with data displayed in real-time for instructional purposes.

• Key faculty: Drs. Riggins, Finaish, Isaac, and Rovey

• Courses Impacted: AE 235, AE 335, AE 271, ME 219, ME 221, ME/AE 327, etc.

• Laboratory courses impacted: AE 282, AE 283, ME 240, ME242
Part 1: Upgrade of existing high speed wind tunnel

- This unique facility has been used to teach courses on compressible fluid dynamics and instrumentation in high speed flow for many years.

- The controls are out dated, inconsistent and incompatible with modern data acquisition and control.
Part 2: Turbine Technologies complete gas-turbine (turbojet) power system specifically designed and manufactured for engineering education

- This rig has been obtained and used at over 100 universities across the country
- One difference – Our approach is to not only have it available in a lab setting but operational remotely from the classroom
### Approximate Costs of High Speed Flow / Gas Turbine Laboratory

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<tr>
<th>Cost Description</th>
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<tr>
<td>Upgrade of high speed tunnel controls and data acquisition</td>
<td>$20,000</td>
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<tr>
<td>Gas turbine SR-30 MiniLab Turbojet Laboratory</td>
<td>$50,000</td>
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<td>Solid model files for engine, including for compressor, diffuser, turbine, guide vane</td>
<td>$1,500</td>
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<tr>
<td>Integration of gas turbine apparatus into existing laboratory facility (air, exhaust, fuel/oil storage cabinet, safety, etc.)</td>
<td>$5,000</td>
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<tr>
<td>Implementation of remote run capability</td>
<td>$20,000</td>
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**Total** $96,500