Engineering Technology & Industrial Distribution Department

Departmental Facilities and Individual Faculty Research Laboratories:

**Additive Manufacturing Laboratory**
The Metal AM lab is equipped to generate 3D models, render machine build-code, manufacture metal AM parts, and recycle metal powder. The technology in use is Selective Laser Melting, where fine metal particles are melted and re-solidified together layer by layer. This process opens new opportunities for research and production of novel designs.

**Analog and RF Electronics Lab**
**Contact:** Dr. Jay Porter
The Analog and RF Electronics Lab conduct advance research in design and testing of analog, RF and instrumentation devices for product characterization.

**Control and Optimization Lab**
**Contact:** Dr. Wei Zhan
The Control and Optimization Lab is equipped for advanced research work in the areas of modeling and simulation for dynamic systems, optimization, fault detection, software and hardware development for real-time control systems, robust design, and quality control.

**Global Supply Chain Laboratory (GSCL)**
The GSCL is the Texas A&M Industrial Distribution Program laboratory utilized to educate our students, create cutting edge solutions for wholesale and industrial distribution channels, and provide answers to Distribution and Supply Chain Management (SCM) challenges. The lab conducts research projects to solve distribution industry problems. Projects areas include inventory classification (ABC stratification), forecasting, purchasing planning, distribution network optimization (asset management), logistics planning, distribution channel analysis, application of performance metrics, Enterprise Resource Management (ERP) process and functionality improvements, etc. The lab also assists distributors and manufacturers with technology implementation, process automation and training to better manage their assets and increase profitability. The Global Supply Chain Laboratory also offers education and training to industrial distributors and manufacturers. The educational programs are research based, innovative, proven, and cutting edge methods developed within Texas A&M's Industrial Distribution Program.

Manufacturing and Mechanical Engineering Technology Program Research Facilities
The Manufacturing & Mechanical Engineering Technology program has an active research program that spans from theoretical work, industrial applications, and education in areas that pertain to manufacturing processes and systems:

- Automation including robotics, system integration, and smart design of reconfigurable manufacturing systems
- Manufacturing systems including performance assessment and optimization, quality assurance, and capacity management.
- Applied mechanics including the modeling of novel materials processing technologies, and the modeling of forming polymer coated materials and thin-film coated polymers.
- Thermal sciences including the physical characterization of nano-particles for heat transfer applications, energy conservation, renewable energy, and fuel cells.
- Educational research including K-12 outreach models, web-based teaching and learning, and curriculum globalization.

**Manufacturing, Geo, and Biomimetic-Tribology Lab**
**Director:** Dr. Mathew Kuttolamadom
The overarching research focus of our group is on elucidating the fundamental nature of friction and wear in harsh synthetic tribosystems in order to manipulate their various evolving facets to our advantage by mapping the surface tribological and sub-surface structural responses, and on the forensic metrology of such surface/sub-surface damage. Application areas span a variety of material-system surfaces and interfaces that involve contact/shear in the manufacturing, automotive, aerospace and energy industries, as well as in bit-rock interaction studies for O&G exploration and production.

**Micro/Nano Manufacturing Laboratory**
**Director:** Dr. Wayne Nguyen P. Hung
Facilities include micromachining systems using traditional techniques (milling, drilling) and non-traditional techniques (electrochemical, electrical discharge, laser), white light interferometer, laser scanner, 3D measuring microscope, form and surface measuring systems.

**Mobile Integrated Solutions Laboratory**
**Director:** Dr. Joseph Morgan
Mobile Integrated Solutions Laboratory (MISL) is an applied research facility that is housed in the Electronic Systems Engineering Technology Program at Texas A&M University. The lab supports undergraduate experiential learning opportunities beyond the classroom and educational laboratory and is focused on design and development of space-based products and systems and in ground-based robotics for research, education and STEM outreach.

**Product Innovation Cellar**
In January 2013, the electronic systems engineering technology (ESET) program opened the Product Innovation Cellar (PIC) in the basement of Thompson Hall. The 3,400 square foot facility boasts an open area workspace that encourages conversations and interactions between teams and faculty; an electronic fabrication lab for production and testing; a mechanical fabrication lab equipped with a 3D printer, a computer numerical control (CNC) machine; a parts store; a design lab; and an industry collaboration meeting room complete with a SMART Board and video conference capabilities where students can interact with their industry partners.

**RFID/Sensor Lab**

**Contact:** Dr. Ben Zoghi

The Purpose of the RFID/Sensor Lab is to design systems and sensor networks integrating remote sensors (Environmental, Security and Tracking, Biomedical, Asset and People location, Process Control Automation and Structure) monitoring, RFID, GPS, and wireless technology. The RFID/Sensor Lab securely links the physical plant and its operational environment to the information technology and business environment allowing customers to dynamically aggregate, analyze and act upon data and adjust operations in response to changes in their business environment. The main purpose of the lab is to design systems that will utilize the integration of remote sensors, RFID, GPS and wireless technology for Environmental, Security and Tracking, Biomedical, Asset and People Location, Process Control Automation and Structural monitoring.

**Rockwell Automation Laboratory**

**Director:** Dr. Sheng-Jen ("Tony") Hsieh

The Rockwell Automation Laboratory was established by a generous gift from Rockwell Automation, Inc. ETID faculty members involved included Richard Alexander, Dan Jennings, John Mayer, Jr., Sheng-Jen ("Tony") Hsieh (Technical Director) and Barry Lawrence. The lab consists of a main laboratory and a system integration laboratory. Students learn basic (component-level) knowledge and skills in the main laboratory, then develop integrated (system-level) knowledge by working in the system integration laboratory.

The main laboratory contains 13 workstations, each equipped with ControlLogix programmable logic controller, PanelView Operator terminal, PowerFlex motor motion control unit and various analog/digital and input/output devices, such as push buttons and switches. The workstations are networked using EtherNet and ControlNet networks, allowing data to be shared throughout the network.

The system integration laboratory also houses a Festo modular and configurable production system (MPS) consisting of nine workstations. Each workstation has a different function, such as material handling, pressing, and testing. In the near future, a vision system will be incorporated into the MPS for inspection purposes. The MPS will also be equipped with smart sensors from Allen Bradley to form a DeviceNetwork to allow diagnosis of failures at the component level.

**Thomas and Joan Read Center for Distribution Research and Education**

This center applies both advanced research skills and a thorough understanding of distribution to every project. Our experts, who merge long standing industry experience with the latest
developments in academia, conduct both primary and secondary research for manufacturers, distributors, professional associations and publications.

Our expertise lies in the following major areas within the field of Industrial Distribution:

- Distributor Quality
- Sales / Marketing
- Executive Leadership
- Strategy / Relationships
- Profitability / Purchasing
- Supply Chain Management
- Transportation / Logistics
- ERP / CRM / IT / E-business

Virtual Instrumentation and Mixed Signal Test Lab

**Contact:** Dr. Rainer Fink

The Virtual Instrumentation and Mixed Signal Test Lab was established within the Department of Engineering Technology and Industrial Distribution to support the development of computer-based instrumentation solutions for real-world test and measurement problems. The lab is currently working on applications in a variety of areas including medical imaging, mixed-signal integrated circuit testing, and law enforcement.

Multi-User TAMU Facilities:

Supercomputing Facilities:

**TAMU High Performance Research Computing**

This resource for research and discovery has four available clusters for faculty research:

1. **Ada** is a 17,340-core IBM/Lenovo commodity cluster with nodes based mostly on Intel's 64-bit 10-core IvyBridge processors. In addition to the 852 compute nodes, there are 8 login nodes, each with 256 GB of memory and GPUs or Phi coprocessors per node.

2. **Crick** is a 368-core IBM Power7+ BigData cluster with nodes based on IBM's 64-bit 16-core Power7+ processors. Included in the 23 nodes are 1 BigSQL node with 256GB of memory per node and 14TB (raw) of storage and 22 data nodes with 14TB (raw) storage for GPFS-FPO and local caching. Crick is primarily used for big data analytics. In addition to these nodes are 2 login nodes with 128GB of memory per node.

3. **Curie** is a 768-core IBM Power7+ cluster with nodes based on IBM's 64-bit 16-core Power7+ processors. In addition to the 48 nodes are 2 login nodes with 256GB of memory per node. Curie's file system and batch scheduler are shared with Ada cluster.

4. **LoneStar5** is the latest cluster hosted by the Texas Advanced computing Center. Jointly funded by the University of Texas System, Texas A&M University and Texas Tech University, it provides additional resources to TAMU researchers. LoneStar5 has: 252 Cray XC40 compute nodes, each with two 12-core Intel® Xeon® processing cores for a total of 30,048 compute cores; 2 large memory compute nodes, each with 1TB memory;
8 large memory compute nodes, each with 512GB memory; 16 Nodes with NVIDIA K-40 GPUs; 5 Petabyte DataDirect Networks storage system; and Cray-developed Aries interconnect.

The HPRC group provides its users with access to several specially configured "HPRC Lab" Linux workstations at two separate locations on the TAMU campus, and can assist with: debugging, code optimization and parallelization, batch processing, and collaborative advanced program support.

Other Multi-User Facilities:

**AGGIEFAB**
AggieFab Nanofabrication Cleanroom: The AggieFab at Texas A&M is a 5000 sq. ft. class 100 and 1000 cleanroom open to the campus community as a core facility. The facility is currently located in the Jack E. Brown building, but will be soon moved to the newly built GERB. The facility houses state of the art micro and nano fabrication equipments (mask aligner, spinner, metal evaporator, RIE, PECVD, oxidation/diffusion furnaces, wire bonder, dicing saw, polisher) and various analysis equipments (microscope, profilometers, ellipsometer, probe station). The facility has multiple chemical hoods and laminar hoods and is equipped with in-house de-ionized water, vacuum, and nitrogen. Research equipments include an electron beam lithography system (Tescan Mira 3 EBL), two mask aligners (MJB-3, MA-6, Karl Suss Microtech), two spin coaters, five electron beam evaporators (four Lesker PVD75 series, Temescale Ebeam evaporator), a plasma enhanced chemical vapor deposition (PECVD, Unaxis 790) system, a low-pressure chemical vapor deposition (LPCVD, MTI RTP) system, four dry etching systems (STS Multiplex ICP etch system with Bosch Process, Oxford Plasmalab 100 ICP RIE, Oxford Plasmalab 80 metal etch, Oxford Plasmalab 80 dielectric etch), two polishers, two profilometers (Bruker DektakXT), a thin film analysis tool (Ocean Optics NanoCalc DUV), a dicing saw, a wire bonder (Kulicke & Soffa 4500), an O2 plasma asher, four oxidation/diffusion furnaces, multiple hot plates, ovens, and chemical hoods.

**Engineering Innovation Center**
The Engineering Innovation Center (EIC) is an open space where engineering students have access to state-of-the-art prototyping tools, equipment, material and support staff. Through partnerships with industry and non-profit sponsors, the EIC is an environment where concepts become solutions to real world problems and student teams come together to build new prototypes, acquire new skills and develop new relationships. The Engineering Innovation Center is supported with Differential Tuition funds and it is open to engineering undergraduate students.

**Design Studio (12)**
- 7000 sq.ft.
- 53 project work benches and tables with power and wired Ethernet
- Access hours: 8 a.m. - 12 a.m. M-F, 2 p.m. - 12 a.m. Sat-Sun
- 42 project storage units
- Access to parts store - MSC computerized parts vendor
- 3 Weller Solder stations with Anti-Static mats
• Weights and measuring station
• Bernina 215 heavy duty sewing machine
• 2 wooden work benches with vises for assembly and sanding
• 112 drawer miscellaneous parts cabinets

**Fabrication Center (12)**

Manual Machine Shop
• 6600 SF facility with supervised access
• HASS TL2 CNC lathe
• Drill press/band saws
• ShopBot Auto Router
• Woodworking equipment
• Sanding and grinding/Bead Blaster
• Arc, Gas, MIG welding

Rapid Prototyping
• Stratasys OBJET 24
• Stratasys EDEN 260V

Electronic Circuit Board Shop
• LPKF ProtoMat S103
• LPKF ProtoMat S63
• LPKF mini contact cladding system

Dirty Lab
• HEPA filtered room for grinding, sanding, and painting

**HAAS Technical Education Center**

The primary function of HTEC-TAMU center is to provide hands-on manufacturing education. Students use various machine tools at the Center and have access to metrology equipment and supporting equipment from other Labs and Centers. **Available at HTEC-TAMU:**

• 2 Haas VOP-B VF1 CNC mills with 5.1µm position accuracy and 2.5µm repeatability. *Details of VF-1 mill.*
• 1 Haas VOP-A SL20 CNC lathe with 5.1µm position accuracy and 2.5µm repeatability. *Details of SL20 lathe.*
• 2 Bridgeport V2XT CNC mills.
• 1 Bridgeport ROMI CNC lathe.
• Feature CAM, AutoCad, SolidWorks, Pro-E and integrated CIM softwares.
• 1 IPG 200-watt YLR-SM Ytterbium fiber laser micromachining/microwelding system, integrated with a Haas VF1 CNC mill.
• 1 Keyence CCD laser displacement system with 0.2 µm repeatability.
• Iscar cutting tools, and
• Multimedia lecture room with 50 integrated DELL workstations.

**Accessible from other Labs and Centers:**

• Olympus STM6 3D measuring microscope with DP70 12.5 Mp camera and 0.1 µm resolution.
• Brown & Sharpe MicroVal coordinate measuring machine.
• Mitutoyo Surfet SJ-201P surface profilometer.
• ASC laser height measurement system.
• Nikon zoom stereo optical microscope.
• Velmex precision 6-axis computer controlled stages.
• Image Pro software.
• SEM, AFM, and TEM at Microscopy & Imaging Center.
• Metallographic facility at Material Laboratory.

Pending:
• Haas Office Mill micromachining system.
• Haas rotary table for 5-axis micromachining.
• Krisler mili-Newton dynamometer.

**Interdisciplinary Manufacturing Facility**
A multidisciplinary team of PIs representing 4 colleges at Texas A&M University (TAMU), namely, Engineering, Architecture, Veterinary Medicine, and Science, as well as the TAMU - Health Science Center, have established a shared Interdisciplinary Manufacturing Facility (IMF) in the Emerging Technology Building. The IMF has a hybrid manufacturing setup (3D printer), a 3D-Bioplotter®, and associated components, including ~$5M of equipment and instruments pooled from participating departments and installed as part of a 5000 sq. ft. space with multi-year technician support from TEES, and maintenance and service contract support from the participating departments. The IMF has the capability to create and characterize components and specimen made with materials, ranging from soft tissues to ultrahigh strength materials of widest possible scales, for broad-based applications.

**Materials Characterization Facility**
The Materials Characterization Facility (MCF) at Texas A&M University is a multi-user facility located in the Frederick E. Giesecke Engineering Research Building (GERB) housing the fabrication and characterization instrumentation essential for the development, understanding, and study of new materials and devices. Specific instrumentation available include:

Electron Microscopy:
• Field Emission-Scanning Electron Microscope (FE-SEM)(JEOL JSM-7500F),
• Lyra Focused Ion Beam-Scanning Electron Microscope (FIB-SEM) with an EDS Microanalysis System,
• Fera Focused Ion Beam-Scanning Electron Microscope (FIB-SEM) with EBSD and Integrated Time-of-Flight Mass Spectrometer (ToF-SIMS), and
• Electron microprobe with Wavelength Dispersive Spectroscopy (WDS)

Thermal and Electrical Analysis
• Thermal mechanical analysis (TMA)
• Dynamic mechanical analysis (DMA)
• Differential scanning calorimetry (DSC)
• Dielectric spectroscopy
• Hot Disc thermal conductivity analysis

Surface Analysis
• X-ray Photoelectron Spectroscopy (XPS)/Ultraviolet Photoelectron Spectroscopy (UPS)
• MultiMode Atomic Force Microscope (AFM)
• Nanoindenter
• Dip pen nanolithography
• Imaging ellipsometer
• Cameca ion microprobe
• Icon Atomic Force Microscope (AFM)

Fabrication
• Electron beam deposition chamber

Spectroscopy and Microscopy
• Spectrofluorometer
• UV-Vis-NIR spectrophotometer
• Raman confocal microscope
• Fourier Transform Infrared (FTIR) spectrometer
• Fluorescent confocal microscope

**Microscopy & Imaging Center (MIC)**
The mission of the Microscopy & Imaging Center (MIC) is to provide current and emerging technologies for teaching and research involving microscopy and imaging in Life and Physical Sciences on the Texas A&M campus and beyond, training and support services for microscopy, sample preparation, in situ elemental/molecular analyses, as well as digital image analysis and processing. This facility promotes cutting edge research in basic and applied sciences through research and development activities, as well as quality training and education through individual training, short courses and formal courses that can be taken for credit.

Instruments available at the MIC include:

- **Light Microscopy**
  - Zeiss Axiophot
  - Olympus FV1000 confocal microscope
  - Multiphoton non-linear optical microscope
  - Deconvolution
  - Nikon Stereo Photo Microscope

- **Scanning Electron Microscopy**
  - FEI Quanta 600 FE-SEM
  - Tescan Vega3 SEM
  - Zyvex S100 Nanomanipulator

- **Transmission Electron Microscopy**
  - FEI Tecnai G2 F20 FE Cryo-TEM
  - FEI Tecnai G2 F20 ST FE-TEM - Materials
  - JEOL 1200 EX TEM
  - JEOL JEM-2010 TEM
  - Analog & Digital Image Analysis
  - Ancillary Equipment

- **Correlative Light and Electron Cryo-Microscopy**

FEI cryo-fluorescence stage on the Olympus microscope
Facilities from other TAMU Departments used by Engineering Technology and Industrial Distribution Faculty

**Advanced Metrology Lab**
**Director:** Dr. Yu Ding, Industrial and Systems Engineering Department
This laboratory houses metrology equipment and a wireless sensor network. Research activities at this lab are supported by the National Science Foundation, Department of Homeland Security, the State of Texas, and the Industry.

**Experimental Solid Mechanics Lab**
**Director:** Dr. Matt Pharr, Department of Mechanical Engineering
The experimental solid mechanics laboratory at Texas A&M University, led by Dr. Matt Pharr, investigates a wide range of problems in solid mechanics. Many of the systems we investigate exhibit a strong coupling between mechanics and other fields, such as electronics and chemistry. Despite the name of the lab, we also emphasize a complementary theoretical understanding of these systems. Current areas of interest include mechanics of materials for energy storage and conversion, deformation and fracture of soft materials, mechanics of flexible/wearable electronics, coupled electro-chemo-mechanics, and mass transport in materials.

**Klebanoff-Saric Unsteady/Quiet Wind Tunnel**
The Klebanoff-Saric Wind Tunnel (KSWT) is a low-disturbance, closed-loop wind tunnel designed for boundary layer stability and transition experiments.
**Tunnel Capabilities and Flow Quality** - All tunnel systems (motor, data acquisition, and traverse) are controlled through an in-house C++ program. With an empty test section, the speed in the test section can reach 30 m/s and can be controlled to within ± 0.1 m/s. The tunnel can be set to a constant motor speed, constant velocity, or constant Reynolds number depending on the test. The defining feature of the KSWT is the low-disturbance test environment. The freestream turbulence intensity is less than 0.02% across the full range of operating conditions in the tunnel.
**Instrumentation** - The KSWT is well equipped to make many different types of pressure, velocity, and temperature measurements as well as different flow visualization techniques. The instrumentation at the KSWT includes, but is not limited to, the following list:

- Shear Stress Visualization
  - Infrared Thermography
  - Napthalene Sublimation
- 10 channels of AA Systems CTA hotwire/hotfilm anemometry
- In-house CVA hotwire/hotfilm anemometry system
- Three-dimensional traverse with μm sized step resolution in the wall-normal direction
- Multiple MKS-Baratron static and differential pressure transducers
- Mitutoyo SJ-400 surface roughness tester
- KEMO VBF-44 Adjustable Amplifier/Filter (x3)

**National Aerothermochemistry Lab**
The Texas A&M University National Aerothermochemistry Laboratory (NAL) is a graduate research facility founded by Professor R. Bowersox to perform leading research and to house unique facilities in support of National interests in high-speed gas dynamics, unsteady flows, and flows with thermal and chemical non-equilibrium effects. Primary sponsorship is provided by the US Air Force, Army and NASA. The laboratory is a true multidisciplinary research resource, with significant faculty involvement from both Aerospace Engineering and Chemistry. The laboratory is currently considered a National Resource by the US Air Force Office of Scientific Research. Faculty supervisor: Rodney Bowersox

To accomplish the NAL mission, we combine modern theoretical modeling with state-of-the-art facilities, instrument and computational methods. Brief overview of the major laboratory resources are given below:

Blow-down Hypersonic Tunnels:
- **Mach 6 Quiet Tunnel (M6QT)** is a seminal low-disturbance facility that transitioned from NASA Langley to TAMU for fundamental studies of boundary layer stability and transition. The quiet Reynolds number range is 3.0 - 11.0 million per meter. The nozzle exit diameter is 0.18 m; the run time is 40 sec, and the duty cycle is 2.5 hours.
- **Actively Controlled Expansion (ACE) Hypersonic Tunnel** is a unique large-scale continuously variable Mach number (5-8) facility developed at TAMU to study turbulent and transitional flows using modern laser diagnostics. The Reynolds number range is 0.5 - 7.0 million per meter. The nozzle exit is 0.23 m x 0.36 m; the run time is 40 sec, and the duty cycle is 2.5 hours.
- **Supersonic (M = 2.2, 3.0 and 5.0) High-Reynolds (SHR) Tunnel** is a smaller scale high Reynolds number facility (Re/m = 40 - 60 million) developed at TAMU for fundamental turbulent boundary layer research and/or scramjet fuel injector studies. The nozzle exit is 7.6 cm x 7.6 cm; the run time is 30 min, and the duty cycle is 2.5 hours.

Pulsed Hypersonic Test Cells:
- **Repetitively Pulsed Hypersonic Test Cell** is small scale O(cm) facility developed to mature our laser diagnostic systems. The facility produces a continuous train of 10 msec pulses of high-speed flow (M = 3.0 - 6.2), which is synchronized to our Q-switched lasers. The duty cycle is 1 sec.
- **Pulsed Hypersonic Adjustable Contoured Expansion Nozzle Aerothermochemistry Testing Environment (PHACENATE “fascinate”) facility** is O(10 cm) variable Mach (3-7) facility to study non-equilibrium flows. The facility produces a continuous train of 10 msec pulses of high-speed flow (M = 4.5 - 6.0), which is synchronized to our Q-switched lasers. The duty cycle is 15 sec.

High-Enthalpy Impulse Tunnels:
- A large-scale **Hypervelocity Expansion Tunnel (HXT)** that provides total enthalpies up to 14 MJ/kg is under development. The facility will have 0.6 m nozzle exit. The planned nozzle exit Mach numbers are 9.0 and 15.0. The run time is O(ms), and the planned duty cycle is 3 hrs.
- A moderate scale and moderate enthalpy (3 MJ/kg) **Shock Tunnel** is available. This facility is fitted with a planar Mach 5.0 nozzle, with a 0.13 m x 0.13 m exit. The run time is up to 7 ms, with a duty cycle of 1 hr.

Specialty Tunnels:
- **A McKenna Flat Flame Burner** is used for high temperature diagnostic development. This burner has stainless steel outer housing, with a bronze water cooled porous sintered matrix.
- **A Low-speed RF-Plasma (RFP)** low pressure, recirculation channel flow wind tunnel, which was developed to study the effects of thermal non-equilibrium on turbulent and transitional flows. The facility is fitted with a 2.5 kW, 13.56 MHz RF power generator, which provides an opportunity to produce flows with significant amounts of vibrationally excited nitrogen.
- **Unsteady aerodynamic Dynamic Stall Facility (DSF)**, which consists of test section liners for the TAMU Oran Nicks Low-Speed Wind Tunnel to achieve higher Mach numbers and hydraulic apparatus to pitch wings at frequencies up to 10 Hz. The facility is used to study dynamic stall at realistic flight Mach (0.1 – 0.4) and chord Reynolds numbers (1.0 – 4.0 million).

**Instrumentation:**
Utilization and development of modern instrumentation are important aspect of our research. We utilize these instruments quantify flow structure and unexplored mechanisms ranging from nonequilibrium molecular effects to fundamental hydrodynamics. The instrumentation includes: Particle Image Velocimetry (PIV), Molecular Tagging Velocimetry (MTV), Planar Laser-Induced Fluorescence (PLIF), Coherent Anti-Stokes Raman Spectroscopy (CARS), Raman and Emission Spectroscopy, Multiple-overheat hot-wire anemometry (HWA), Pressure sensitive paint (PSP), Temperature sensitive paints (TSP), Conventional schlieren, Focusing schlieren w/ deflectometry, High-speed photography, Infrared thermography, and Kulite and PCB Pressure Transducers. We have also pioneered a new Vibrationally-excited NO Monitoring (VENOM) technique for combined MTV and 2-line PLIF thermometry to enable direct measurement of the turbulent heat flux. A new dual plane system (VENOM2) is under development to provide 3-D velocimetry and a more complete quantification of the thermodynamic state.

**Computations:**
We utilize large scale computations to examine the intricate details of the flow structure, design experiments and test physical models. Our group has access to multi-million cpu-hour allocations via resource allocations at NSF-supported TeraGrid resources such as Ranger at TACC (UT Austin) and Kraken at NICS (U. Tenn./ORNL) as well as other DoE and DoD supported machines, which are among the most powerful supercomputers currently available to academic researchers in the world. In addition, we perform simulations on an in-house maintained 32-node cluster, larger department clusters, and TAMU supercomputers. A suite of in-house and commercial simulation and visualization software are used to characterize flow structure, verify mathematical model performance, and aid in experimental design.

**Oran W. Nicks Low Speed Wind Tunnel**
The Oran W. Nicks Low Speed Wind Tunnel is a self-contained research facility located near Texas A&M. It is a closed-circuit, single-return type tunnel, with a rectangular test section 10 feet wide and seven feet high and housed in a two-story building. The administrative building, tunnel and test section, external balance and drive motor all have independent foundations to reduce the transmission of vibrations among them. A wide variety of tests are conducted at the wind tunnel for industry, governmental agencies, educational institutions, and private individuals. Tests at the tunnel have dealt with, but are not limited to aircraft, space vehicles, ground vehicles, buildings and offshore structures. The wind tunnel can provide many different
types of information during a test. It is used for both basic and applied airflow research and development and also provides instructional aid for students of various departments.

**Power System Automation Lab**

**Director:** Dr. B. Don Russell, Electrical and Computer Engineering Department

The Power System Automation Laboratory conducts research in all aspects of automation, control and protection of electric power systems. The laboratory specializes in real-time, high-fidelity data capture and analysis on operating systems to detect faults and abnormal operating conditions. Current research includes data analysis to detect incipient failure conditions for line and apparatus, enabling true conditioned based maintenance before catastrophic failure. The laboratory is known internationally for its work in high-impedance fault detection which resulted in commercial relay systems that are widely used today in the electric utility industry.

**Smart Grid Center**

**Contact:** Dr. Mladen Kezunovic

The Smart Grid Center is an interdisciplinary university environment organized to modernize how electricity is delivered from suppliers to consumers and to enable new electricity products, services, and markets.

The TEES Smart Grid Center galvanizes a number of smart grid-related activities that are underway in the A&M System and brings them under a coordinated umbrella to form partnerships essential for smart grid research, education and training. These partnerships are funded through various projects in excess of more than $10 million over the next five years. The Center aims to expand on its broad range of capabilities and expertise in six key smart grid areas: Electricity Transmission/Distribution and Production/Consumption; Clean Energy Enabling Technologies; Electrified Transportation System; The Built Environment; Computer Information Services; and Energy-related Markets. They all come together to create an integrated infrastructure able to handle the growing power demands of residential, corporate, and public needs ranging from smart homes and plug-in electric vehicles to distribution intelligence and operation centers.

**Turbomachinery Lab**

**Director:** Dr. Dara Childs

The Turbomachinery Laboratory conducts basic and applied research into important problems of reliability and performance of turbomachinery — rotating machinery that extracts or adds energy to fluids. That’s everything from classic Dutch windmills to the space shuttle’s main engine turbopumps and compressors that move natural gas through the distribution system.

**Wind Tunnel Complex**

The Wind Tunnel Complex at Texas A&M University is home to five world-class wind tunnels and one icing tunnel, offering a range of speeds and unsteady/steady flows. Both the Klebanoff-Saric Unsteady Wind Tunnel and the NASA-Langley Mach 6 Quiet Tunnel are run by Flight Research Laboratory personnel. The TAMU National Aerothermochemistry Laboratory houses
the High-Reynolds-Number Blow-Down Tunnel (Mach 3-6), the NASA-Langley (Mach 6) Quiet Tunnel, and the MURI Tunnel (Mach 7). The Oran W. Nicks Low-Speed Wind Tunnel is a large-scale, subsonic wind tunnel located at Easterwood Airport (CLL) in College Station.