Mechanical Engineering and Engineering Science research areas
**Research areas**
- Dynamics and Controls
- Computational Mechanics and Materials
- Manufacturing and Metrology
- Thermal Sciences and Fluid Mechanics
- Energy Engineering
- Bioengineering
- Motorsports Engineering
- Nanoscale Science and Technology
- Optical Science

**Research centers**
- Center for Precision Metrology (CPM)
- Energy Production and Infrastructure Center (EPIC)
- North Carolina Motorsports and Automotive Research Center (NCMARC)
- Center for Biomedical Engineering and Science (CBES)
- Center for Freeform Optics (CeFO)
Research centers

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Faculty research clusters

- Manufacturing and metrology
- Computational mechanics and materials
- Motorsports
- Bioengineering
- Thermal-fluids
- Dynamics and controls
Manufacturing and metrology

Overview
- 11+ faculty with primary focus on manufacturing-related research
- Largest and strongest group in US academia
- Strategic focus for UNC Charlotte

Research areas
- Additive and subtractive manufacturing
- Machining dynamics
- Dimensional metrology
- Machine tool metrology
- Ultra-precision machining
- Optics manufacturing and metrology
- Precision machine and instrument design
Faculty

- **Matt Davies** – Optics manufacturing, Dynamics and vibration of machines, Nonlinear dynamics, Precision engineering, Plasticity, Design and control of high-speed/high-accuracy machines

- **Chris Evans** – CPM Director, Advanced metrology and precision manufacturing, Diamond turned optics, Surface form metrology, Self-calibration techniques

- **Konstantinos Falaggis** – Optical inspection, Optical system design

- **Gert Goch** – Dimensional metrology, Gear metrology, Wind energy

- **Edward Morse** – Computational metrology, Assembly modeling and analysis, Geometric tolerance and standards, Computer-aided manufacturing

- **Brigid Mullany** – Precision surfaces, Polishing, Surface roughness measurements

- **Steve Patterson** – Precision machine design

- **Tony Schmitz** - Machining dynamics, Manufacturing process modeling, Uncertainty evaluation, Displacement measuring interferometry

- **Scott Smith** – Dynamics of machine tools, Vibrations, Machine design

- **Stuart Smith** – Low force contact mechanics, Probe-based microscopy, X-ray interferometry, Proximity sensing, Design and manufacturing of precision instrumentation

- **Joshua Tarbutton** – Additive and subtractive manufacturing, Tool path planning

- **John Ziegert** – Manufacturing, Precision metrology, Machine tools
Manufacturing and metrology

Center for Precision Metrology
- Industrial affiliates program
- 25 faculty and staff from five academic departments
- 50+ MS and PhD students
- 30,000 sq. ft. of laboratory and office space
- Capital equipment in excess of $20M
Center for Precision Metrology
- 1500 sq. ft. facility contains more than $2M in state-of-the-art equipment
- Temperature is held at 20°C ± 0.1°C
- Humidity is < 40%
- Contaminants are filtered from the air to provide a class 100,000 cleanroom
- Capabilities competitive with national laboratories
Center for Precision Metrology
Manufacturing capabilities include: manual machine tools, CNC machine tools, diamond turning machines, EDM, grinding, polishing
Finite element modeling
- ABAQUS, LS Dyna, ANSYS or in-house code is used
- Finite element methods are used to model complicated phenomena such as crash, fracture, metal forming, and material processing

Multi-scale modeling
- Finite elements and atomistic modeling are linked to each other
- Mostly applied to nanomaterials and nanodevices
Large-scale parallel simulations performed using university high-performance clusters
- 60 computer nodes
- 480 computing cores
- 58 TBs storage

Nanomaterials synthesis and characterization
- chemical vapor deposition
- pulsed laser deposition

Mechanical testing of nanostructures
- In-situ testing using SEM
- Nanoindentation

Ultrafine grain nanocrystalline materials
- Severe plastic deformation
- Powder metallurgy
Research facilities

- Pulsed laser deposition
- Chemical vapor deposition
- Ultraviolet-visible spectroscopy
- Electron microscopes (SEM, TEM), atomic force microscopy, nanoindenters, x-ray diffractometer
- Split-Hopkinson pressure bar
Harish Cherukuri
Finite element modeling, Plasticity, Dynamic behavior of materials

Ron Smelser
Deformation processing, Failure of materials, Materials process and structure relations

Alireza Tabarrei
Finite element modeling, Atomistic simulation, Fracture and damage

Howie Fang
Finite element modeling, Structure optimization, Crash modeling
Computational mechanics and materials

Qiuming Wei
Nanocrystalline materials, Dynamic behavior of materials, Mechanical properties at micro/nano scale

Terry Xu
Nanomaterials synthesis and characterization, Mechanical testing of nanostructures

Haitao Zhang
Material synthesis, Materials characterization, Device fabrication
Research areas

- Vehicle dynamics and stability control
- Racecar modeling/simulation
- Driver modeling/simulation
- Aerodynamics
- Experimental and computational fluid mechanics
- Crash modeling/simulation
- Tire mechanics
- Automotive instrumentation
- Engine and propulsion

Faculty

- **Mesbah Uddin** – Road vehicle aerodynamics, Experimental and computational fluid dynamics
- **Peter Tkacik** – Tire dynamics, Instrumentation and measurements, Flow imaging and velocimetry, Image correlation, Vibratory polishing
- **Howie Fang** – Vehicle dynamics, Racecar modeling/simulation, Stability control, Driver modeling/simulation, Tire modeling/vehicle interaction
Motorsports

- Alan Kulwicki Motorsports Laboratory (6,800 sq. ft.)
- Motorsports Research Building (16,500 sq. ft.)

- Engine dynamometer
- Emission analyzer
- Wind tunnel
- High-speed camera
- FARO arm with laser scanner
- Wet and dry flow bench
- Suspension testing instruments
- Machining and fabrication area
Bioengineering

**Research areas**
- Orthopedic biomechanics
- Cryopreservation and anhydrous cell preservation
- Biocompatibility of new materials
- Tissue engineering
- Cryosurgery
- Microfluidic chips
**Bioengineering**

**Nigel Zheng**, Orthopedic Biomechanics Lab
- Human motion analysis
- Sports injury prevention
- Computational biomechanics
- Medical devices: Motion trackers and Exoskeleton devices

**Ahmed El-Ghannam**, Biomaterials and Orthopedics Tissue Engineering Laboratory
- Tissue engineering scaffold for cell/drug delivery
- Resorbable graft for tissue regeneration
- Injectable bone cement

**Gloria Elliot**, BioStability Lab
- Cryopreservation and anhydrous cell preservation
- Biocompatibility of new materials
Bioengineering

**Charles Lee**, Bioheat and Mass Transfer Lab
- Low temperature therapy to revive, preserve, and destroy cells, tissues and organs
- Hypothermic machine perfusion
- Cryopreservation
- Cryosurgery

**Hansang Cho**
- Microfluidic chips
- Brain-on-chips
- Healthcare/environment monitoring platform
- Optofluidic mechanics
Thermal-fluids

Research areas
- Computational fluid dynamics (CFD)
  - large-scale computing
  - turbulence modeling
- Experimental fluids
- Bioheat transfer and biopreservation
- Race car aerodynamics
- Bio-fluid dynamics
- Combustion
- Stochastic flow and thermal processes
- Applied math and modeling
- Heat transfer
Research facilities

- Water tunnel
- Flow imaging: PIV, high-speed video
- Rocket nozzle test facility
- High-performance computing labs and clusters
- Bioheat and Mass Transfer Lab
- BioStability Lab
- Granular flow test facility
- ISERRT blast-structure interaction test facilities (Infrastructure Security and Emergency Responder Research and Training)
- Renewable Power Laboratory
- Materials Flammability Laboratory
Faculty

- **Russ Keanini** – Physical and mathematical modeling of natural and technological processes
- **Scott Kelly** – Bio-fluid dynamics, vortex dynamics, geometric mechanics, dynamical systems
- **Praveen Ramaprahbu** – Turbulence, shock-turbulence interactions, CFD, high-performance computing
- **Nenad Serunac** – Energy systems, combustion, heat transfer, energy efficiency
- **Gloria Elliott** – Anhydrous biotissue preservation, molecular-to-organ scale experimental and theoretical studies
- **Charles Lee** – Low temperature therapies for revivification, preservation, and destruction of cells, tissues and organs
- **Peter Tkacik** – Experimental fluid mechanics, race car aerodynamics, high-speed compressible flow
- **Mesbah Uddin** – CFD, turbulence modeling
Dynamics and controls

Research areas
- System dynamics
- Control systems
- Machining dynamics

Scott Kelly
- Biologically-inspired robotics
- Analytical mechanics
- Nonlinear dynamics
- Control of biological systems

Chris Vermillion
- Flight dynamics and control of tethered wind energy systems
- Hierarchical control theory and applications
- Vehicle control systems
- Human-in-the-loop control

Matt Davies
- Dynamics and vibration of machines
- Nonlinear dynamics
- Control of high-speed, high-accuracy machines

Tony Schmitz
- Machining dynamics
- Structural dynamics modeling
- Modal analysis
- High-speed imaging