Northwestern University

- Established 1851 for Northwest Territory (OH, IN, IL, MI, WI, MN)
- Location: Evanston and Chicago
- Private university
- 16,200 students
  - 8,400 undergraduate
  - 7,800 graduate
  (plus ~ 3,000 part-time)
Northwestern University

Eight departments:

- Biomedical Engineering
- Chemical and Biological Engineering
- Civil and Environmental Engineering
- Electrical Engineering and Computer Science
- Engineering Sciences and Applied Mathematics
- Industrial Engineering and Management Science
- Materials Science and Engineering
- Mechanical Engineering

Robert R. McCormick School of Engineering and Applied Science
ME Graduate Program Rankings

- #11, US News and World Report
- #3 in US, #4 in world based on Shanghai Rankings (impact of scholarly output)
- Top 5 in most recent National Research Council rankings
2010 NRC Rankings

Northwestern Engineering

The dot represents the best reported rank for an individual program (i.e., the program was ranked this high or higher 90% of the time).

Each line represents the range of reported ranking results for an individual program.

ME @ NU
Mechanical Engineering at NU

Research Thrust Areas for ME @ NU

Design
Biosystems & Health
Nano/Micro-science
Energy
Multiscale Simulation

Core Groups
Systems
Manufacturing
Mechanics
Systems Research in Mechanical Engineering

Research Topics

• human-robot systems
• human-centered design
• haptic displays
• bio-inspired sensing, actuation
• robot manipulation, automation
• prosthetics, rehabilitation
• complex networked systems
• system and device design
• multibody dynamic simulation and optimal control
• swarm robotics

Commercialization: many licensed patents; spin-offs: MAKO Surgical (bought by Stryker), Cobotics (now part of StanleyWorks), HDT Robotics, Tanvas

Systems Research

- Human-robot systems: prosthetics, assist devices, rehabilitation
- Spatial/surface haptic interfaces
- Self-organization and swarm robotics
- Bio-inspired sensing and actuation

Northwestern Engineering

McCormick
Manufacturing in Mechanical Engineering

Research Topics

- computer integrated processing
- design optimization
- machine tool control
- micro-, nano-manufacturing
- metamaterials, nanophotonics
- tribology, interfacial mechanisms
- industrial systems optimization
- energy conscious manuf.
- life cycle assessment

Funding: NSF, ONR, DOE, AFOSR, NRL, NIST, industry

Commercialization: over 25 patents; close relationships with many industries, eg, Ford, Boeing, Alcoa, GE, GM, IBM, Otis, Goodyear

Manufacturing Research

Incremental forming
Surface texturing
Tooling inserts
Virtual texturing
Woven fabric composites

Friction Coefficient Reduction (%)

Sliding Speed (m/min)

Temperature Rise (°C)

Distribution pattern
Solid Mechanics Research in Mechanical Engineering

Research Topics
- **nano**engineered composites
- **biological** system mechanics
- smart materials
- Nondestructive testing
- **multiscale** material analysis
- **energy** efficient structures
- **computational** modeling
- structural health management
- processing and characterization

Funding: NSF, ONR, DOE, AFOSR, NRL, ARO, industry

Commercialization: over 25 patents; close relationships with many industries, eg, Ford, Boeing, GE, GM, Medtronic, Lockheed, Goodyear

Leadership: National Materials Advisory Board, ASME Mechanics Board

Editorships with ASME JAM, Adv Engr Matls, J Composite Matls, Composites A, Computational Mechanics, …
Solid Mechanics Research

- nanocomposites
- photonic crystal sensors
- self-assembled photo-voltaics
- biomaterials
- smart actuator materials

Design, Bio, Nano, Energy, Simulation
Fluid Mechanics Research in Mechanical Engineering

Research Topics
- nano- and microfluidics
- biological system mechanics
- granular flows
- turbulence
- multiscale modeling
- fluids in energy
- computational modeling
- membranes and charged surfaces
- protein folding

Funding: NSF, NIH, DOE, NASA, DARPA, industry

Commercialization: patents, relationship with many industries, eg, GE, Dow, international corporations

Leadership: American Physical Society, ASME Fluids Board
Many major editorships
Figure 2: Left panel is a conceptual sketch of a DNA crossing a solid-state nanopore driven by an applied Voltage. The right panel shows the translocation velocity \( v \) as a function of the dimensionless gap width \( (R_0 - a)/a \), where \( R_0 \sim 5 \) nm is then a pore radius and \( a \sim 1 \) nm is the radius of the double stranded DNA. The symbols represent experimental data due to Storm et al. Phys. Rev. E (2005), 71, 051903. The solid and dashed lines are predictions from a hydrodynamic model \[5,6\] with and without the reduction of DNA effective charge due to the Manning condensation effect. There are no fitting parameters here other than the uncertainty over the exact value of the Manning factor \( q_B \) which is probably between one and the classical value of \( q_B = 4.2 \).

Thermo-fluid heat transfer probs. Bio-inspired robotics and neuromechanics protein folding lotus effect
Mechanical Engineering at NU

Research Thrust Areas for ME @ NU

- Design
- Biosystems & Health
- Nano/Microscience
- Energy
- Multiscale Simulation

Core Groups
- Mechanics
- Manufacturing
- Systems
Outstanding Central Facilities:

- Mechanical Engineering Machine Shop
- Rapid Prototyping Laboratory
- Mechatronics Laboratory
- NUANCE: NU Atomic and Nanoscale Characterization Experimental User Facility
- Mechanical Properties & Fatigue Facility
- Optical Microscopy and Metallography Facility
- Chemical Analysis Facilities
- Center for Nanofabrication and Molecular Self-Assembly
- Center for Nanoscale Materials (CNM) @ Argonne
- plus specialized equipment in research group labs…
Collaborations 2010-12

http://collaboration.mccormick.northwestern.edu (active map of collaborations by year)
Key Institutes @ NU

Segal Design Institute

The Garage
WHERE IDEAS GET BUILT

NICO

INTERNATIONAL INSTITUTE FOR NANOTECHNOLOGY

ISEN
INITIATIVE FOR SUSTAINABILITY AND ENERGY AT NORTHWESTERN

IBNAM
Institute for BioNanotechnology in Medicine

ANSE
Solar Energy Research Center

THE FARLEY CENTER FOR ENTREPRENEURSHIP AND INNOVATION

and many others...
Mechanical Engineering at NU

MS Programs:
- 12 units of courses/project
- One year program (can be 9 mo)
- 1-3 unit research project
- Thematic areas
  - Energy-Sustainability
  - Nano
  - Robotics
  - Simulation-driven Engineering (SdX)
  - Mini-MBA certificate
  - Design-your-own
- Opportunities for internship (industry, gov’t lab)

ME@NU provides an exciting, interdisciplinary and thriving environment for achieving excellence in research and education
Mechanical Engineering at NU

PhD Program:

- Student-advisor matching in the first year
- 15 courses post-BS degree
- No comprehensive exam with >3.5 GPA
- MS thesis with defense (optional en route to PhD)
- Candidacy exam: written thesis proposal and oral exam
- Opportunities for internship (industry, gov’t lab…)
- PhD degree in 5 years post-BS
  - Median number of years registered as a graduate student: 6.8 years for all engineering Ph.D’s across US

ME@NU provides an exciting, interdisciplinary and thriving environment for achieving excellence in research and education
Federal Requirements

- [http://www.citiprogram.org](http://www.citiprogram.org)
- Must do online NOW, or no pay! You will be contacted to email your certificate of completion
- PhDs do ME 513 – spring 2016

Research Ethics

- Honesty
- Referencing
- Authorship

Personal Ethics

- Mentoring
- Discrimination
- Fairness

*Introduction to the Responsible Conduct of Research, NH Steneck*
Chicago Area – Population 7 Million
Parks

Lincoln Park

Millennium Park

Navy Pier

Lakefront Path

Grant Park
Museums

- Shedd Aquarium
- Adler Planetarium
- Art Institute of Chicago
- Field Museum of Natural History
- Museum of Science and Industry
Theater
Music

Blues, Jazz, Music Festivals, Opera…
Close Collaborators

Northwestern University

Rehabilitation Institute of Chicago

Argonne National Lab
Department of Mechanical Engineering