Mechanisms and Mechatronics in Minnesota

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University of Minnesota:

- 54,000+ students (9th largest in US); 4,800+ faculty
- 8th largest research expenditure of US public universities
- One of only five universities in the US with an engineering school, a medical school, a law school, a veterinary medical school, and an agricultural school all on one campus

Department of Mechanical Engineering:

- 47 faculty
- 540 undergraduate students
- 339 graduate students
- Ranked 32nd in the world in the 2024 Global Shanghai Rankings (just one position behind ETH), and 10th in the US

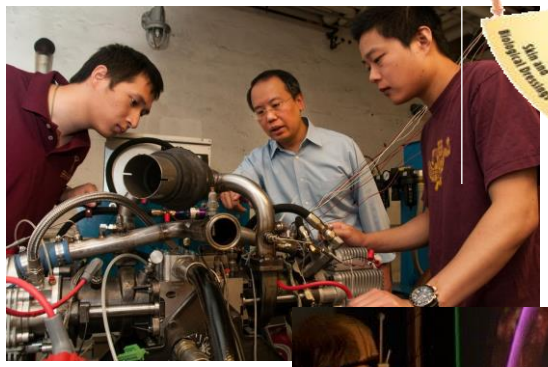
ME National Research Centers

Advanced Technologies for the Preservation of Biological Systems (ATP Bio)

Center for Compact and Efficient Fluid Power (CCEFP)

Bakken Medical Devices Center

Center for Transportation Studies



ME Unique Relationships and Resources

Medical devices

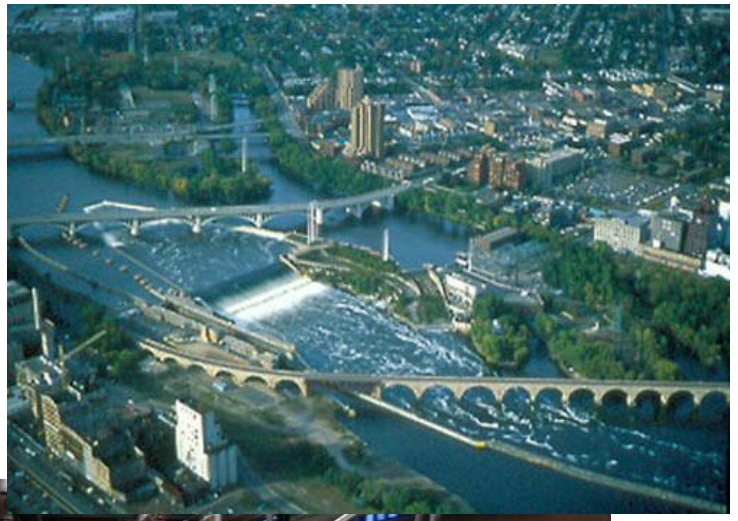
- Major medical device companies
- UMN hospital
- **Medical Devices Center**
- Mayo Clinic

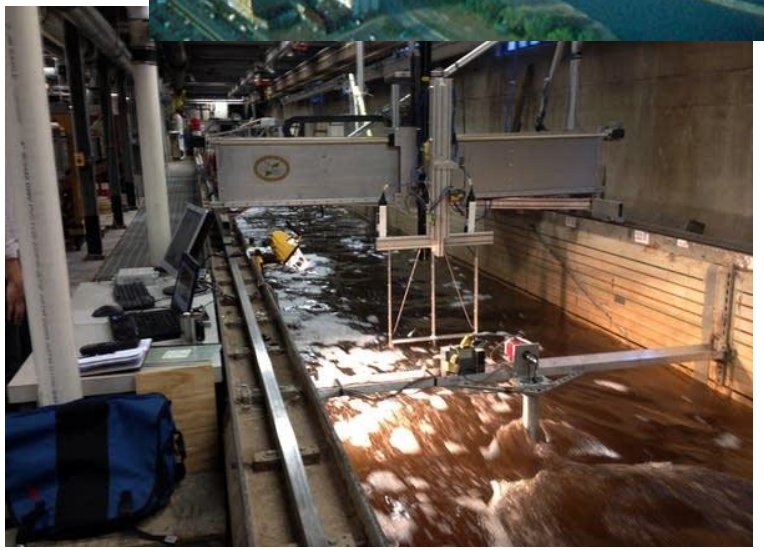
Saint Anthony Falls Laboratory

Murphy Engines Laboratory

Anderson Labs

Minnesota Supercomputing Institute





ME Foundations

Impact Areas

We drive innovation in five major impact areas:

ENERGY TRANSITION

ENVIRONMENT & SUSTAINABILITY

HUMAN HEALTH

NEXT-GEN MANUFACTURING

ROBOTICS & MOBILITY

Technical Areas

Our teaching and research is grounded in nine technical areas:

BIOSYSTEMS & BIOENGINEERING

COMBUSTION & ENGINES

FLUID MECHANICS

FLUID POWER

MATERIALS & MECHANICS

PARTICLE TECHNOLOGY

PLASMAS

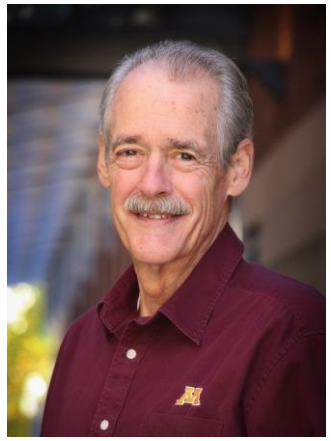
SENSING & CONTROLS

THERMODYNAMICS & HEAT TRANSFER

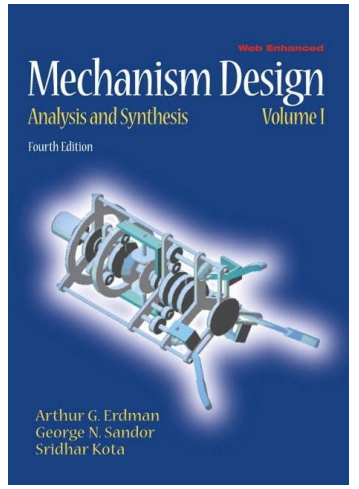
Mechanisms at the University of Minnesota

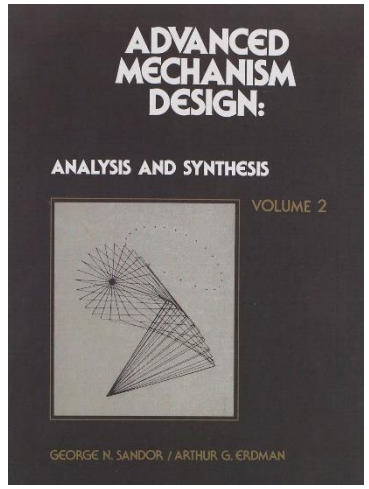
UM's rich history in mechanism design has been led by Prof. Art Erdman, who

- Wrote two of the most common mechanism design books for undergrad and grad students,
- Created the Earl E. Bakken Medical Devices Center at the University of Minnesota to engage industry and academia together to discover unmet clinical needs, and
- Designed LINCAGES, a mechanism software design package used worldwide.



Prof. Art Erdman





Additional UM ME faculty expand on Erdman's Mechanism Design to

- Create soft robotic fabrics (Abel)
- Design large-scale physics experiments (Chase)
- Manufacture at micro and nano scales (Cui)
- Convert, store, and generate energy efficiently (Van de Ven)

Prof. Abel

Prof. Chase

Prof. Cui

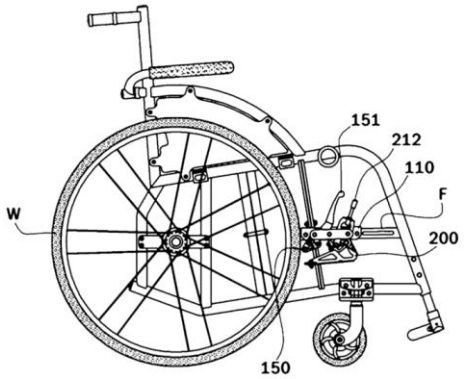
Prof. Van de Ven

Mechanisms Move Our World

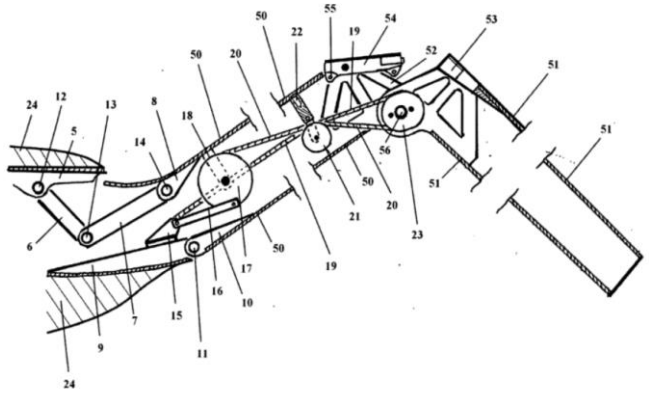
Mechanisms are mechanical devices that transfer **force** and **motion** from a **source** to an **output**. Mechatronics combines mechanical, electrical, computer, and robotics engineering to create **automated machines**.

During this course, students will

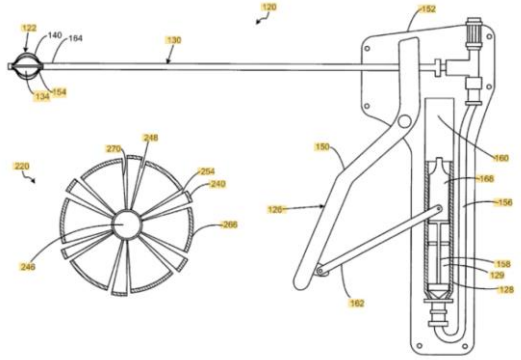
- Learn introductory kinematic analysis and synthesis theory in a design context,
- Apply graphical and analytical methods to analyze and design mechanisms to create arbitrary motion,
- Use software tools for detailed linkage synthesis,
- Control mechanical systems for autonomous operation, and
- Design and construct a working mechanism in small teams.



Wheelchair Brake Unit
WO2018212492A1



Folding wing and locking mechanism
US20100051742A1



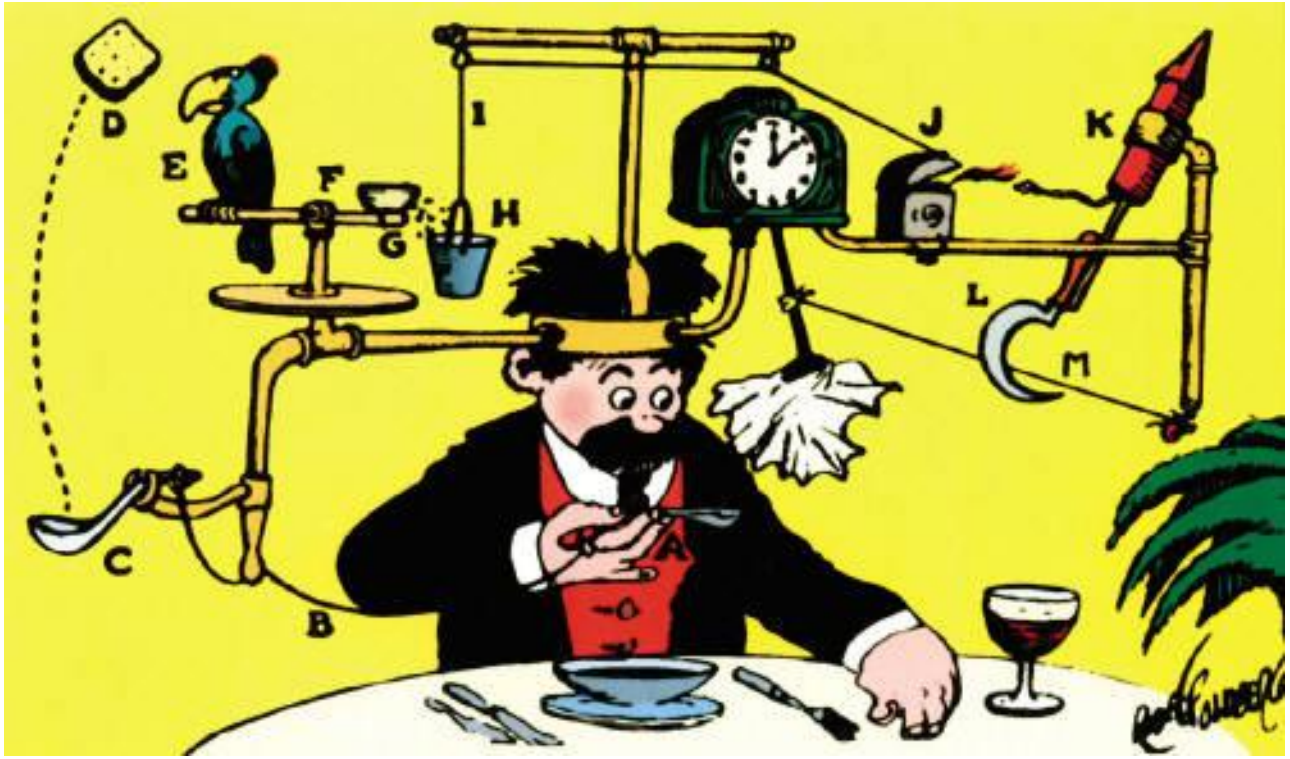
Medical device with dual expansion mechanism
US9089347B2

Project: Collaborative Rube Goldberg-like Machine

You will use the technical skills you learn to design and build a Rube Goldberg-like machine

Rube Goldberg machines are machines that rely on chain reactions to complete a simple task

The techniques you use to create these silly machines are the same as the techniques you would use for product design or repetitive manufacturing tooling



"Professor Butts and the Self-Operating Napkin (1931). Soup spoon (A) is raised to mouth, pulling string (B) and thereby jerking ladle (C), which throws cracker (D) past toucan (E). Toucan jumps after cracker and perch (F) tilts, upsetting seeds (G) into pail (H). Extra weight in pail pulls cord (I), which opens and ignites lighter (J), setting off skyrocket (K), which causes sickle (L) to cut string (M), allowing pendulum with attached napkin to swing back and forth, thereby wiping chin." Wikipedia

Project Objective

Teams of 3-4 students will design and build a linkage mechanism

Team A's linkage must carry an object through several randomly generated points in space

Once Team A's linkage has carried the object through all the defined points, it must pass the object to Team B

Team B's linkage must carry the object through a different set of several randomly generated points in space before passing it to the next team

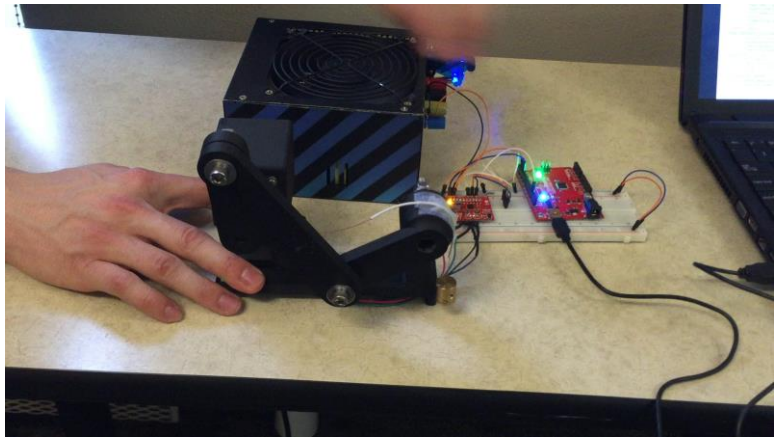
Project Details

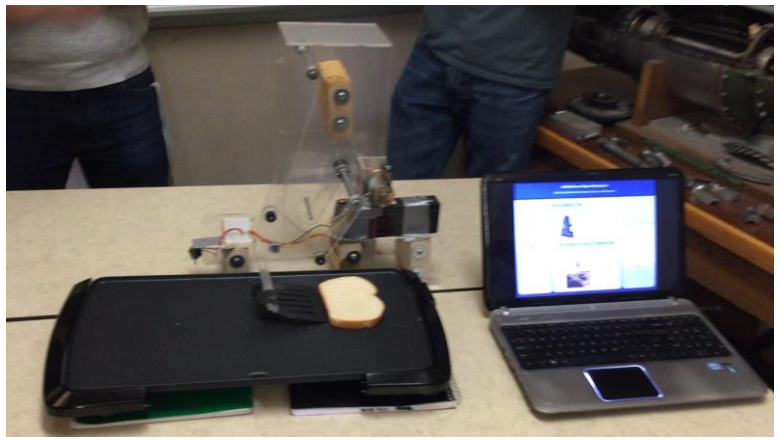
Create your linkage mechanism in the Anderson Design Lab and Polaris Machine Shop to using

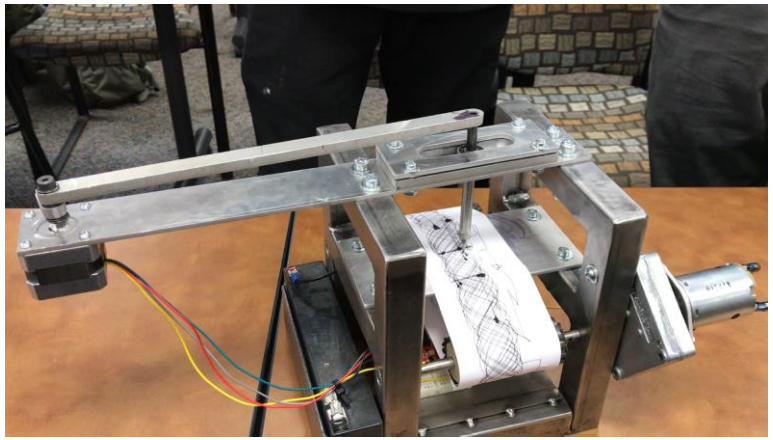
- FDM 3D printers
- Laser cutters
- Water jet cutters
- Mill, lathes, and drills

Assemble your unique mechanism using inventory of machine components and motors

Example Mechanisms:







Visit Contents

During your visit, you will

- Attend lectures
- Tour University of Minnesota research facilities
- Visit a local Minnesota company (17 Fortune 500 Companies)
- Build a collaborative Rube Goldberg-like machine
- Explore the Twin Cities (award-winning parks, bike trails, and culture)
- Take a short trip outside the Cities