MEAM 211

http://www.seas.upenn.edu/~meam211

Introduction

Professor Vijay Kumar

http://www.seas.upenn.edu/~kumar

What is Dynamics? The Big Picture

Three parts

- Geometry
  - Shapes, curves
- Kinematics
  - Motion
  - Curves, shapes + time
- Kinetics
  - Motion and causes of motion (forces)

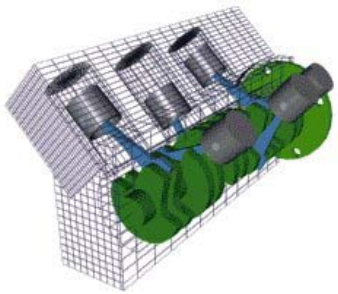
Types of Problems

- Describe motion
- Given motion, what forces caused motion?
- Given forces, predict motion

What is Dynamics? And why should we study it?

Motivating Examples

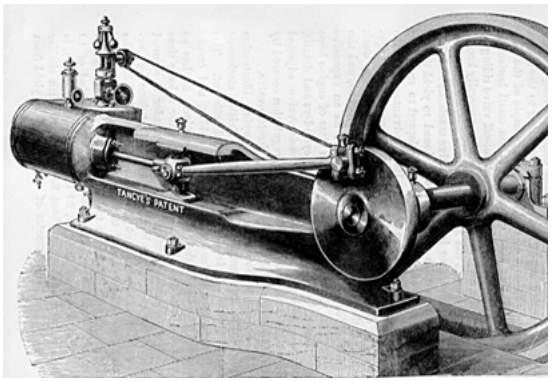
- Cruise missile
- Internal combustion engine
- Mechanisms



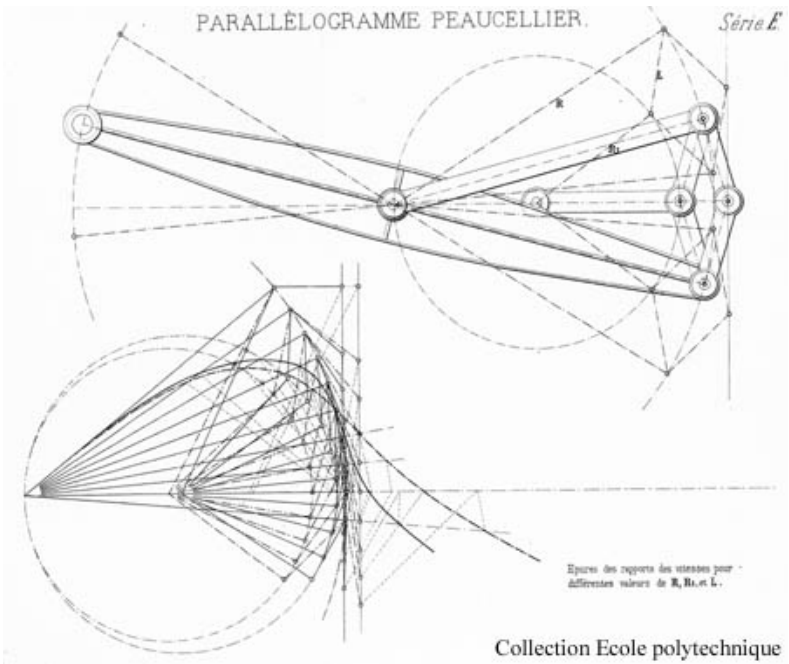
http://auto.howstuffworks.com/engine5.htm

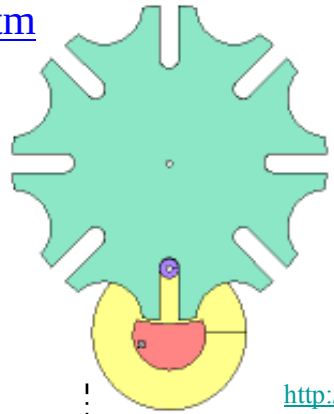
Mechanisms

http://www.brockeng.com/mechanism/index.htm

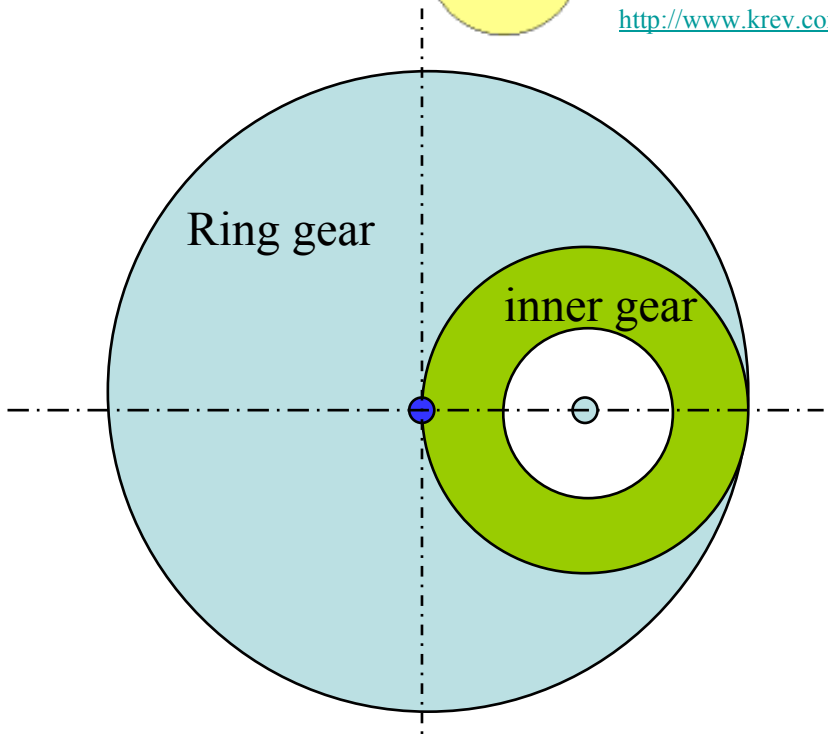


http://www.history.rochester.edu/steam/thurston/1878/



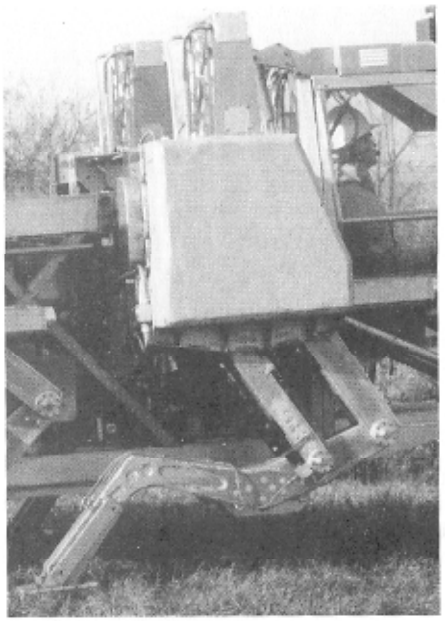


http://www.krev.com/



http://www.ornithopter.de/english/crank.htm

Mechanisms: The Pantograph Mechanism



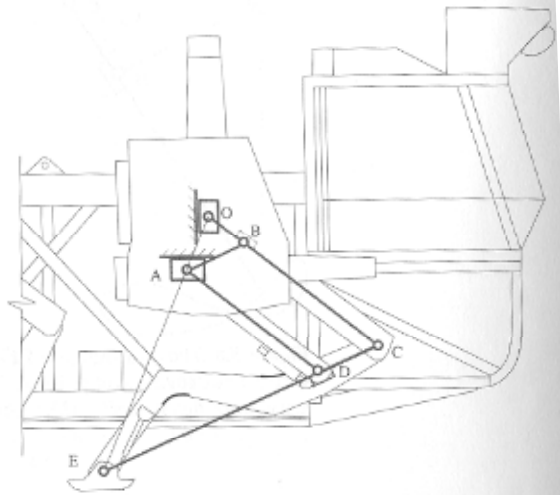
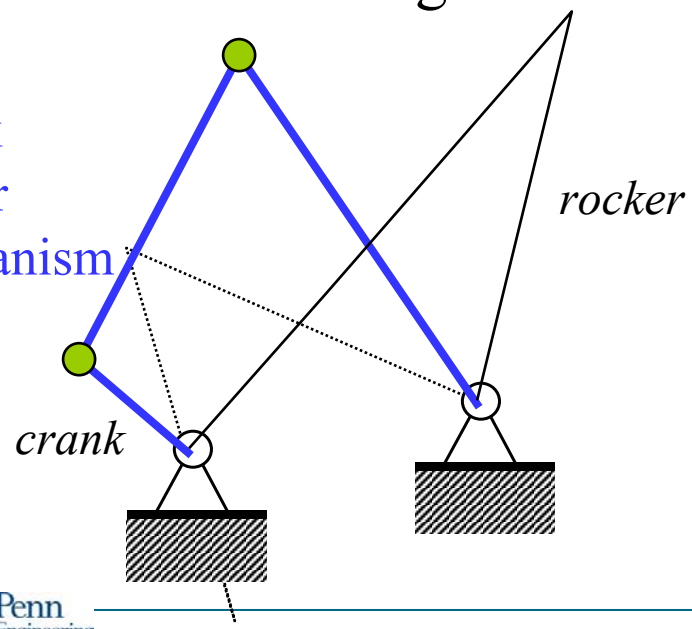


Figure 5.9 The leg mechanism of the Adaptive Suspension Vehicle. Point *O* moves on a slide that is vertical relative to the leg mounting structure to produce a corresponding vertical motion of the ankle point *E*. Point *A* moves on a slide that is horizontal relative to the vehicle body to drive point *E* along a horizontal path.

Mechanisms: Oscillating Water Sprinkler

Four-bar linkage – crank rocker

Crank rocker mechanism



Planetary Gear

500:1 reduction

Head-controlled Feeding Device for Quadriplegics

- Head motion controls a passive (mechanical) feeder

Dynamics: Historical Perspective

- Chapter I
  - Newtonian mechanics
    - Kepler - planetary motion
    - Galileo - importance of acceleration
    - Newton - *Principia Mathematica* (1687)

100 years later …

Historical Perspective (Continued)

- Chapter II
  - Lagrangian mechanics
    - Bernoulli - principle of virtual work, statics
    - Euler - dynamics of rotating rigid bodies
    - D'Alembert - extension of virtual work to dynamics
    - Lagrange - *Mechanique Analytique* (1788)

Analytical mechanics

- Analytical because it is based on a few fundamental principles
- Lagrange describes it as an approach which does not require drawing any diagrams (e.g. free body diagrams)

Focus in MEAM 211

- Newtonian mechanics
- No relativistic effects (no quantum mechanics)
  - Reasonable velocities
  - Reasonable length scales
- Practical problems
- Analysis and Design
- Projects linked to MEAM 247

Lectures and Recitation

Lectures

- New material
- Problem solving

Recitation

1. Forum for solving problems
2. Computer-Aided-Engineering labs

Teaching Assistants

Spring Berman

Nathan Michael

Jimmy Sastra

meam211@seas.upenn.edu

Instructor

Dr. Vijay Kumar

kumar@me.upenn.edu

Graders

Olga Epshteyn

Megan Arensen