



# Rationale Behind Biological Inspiration in Robot Design

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# Objectives

- Explain motivation for bio-inspiration in robot design
  - What ideas can nature offer engineers?
  - Can bio-inspired designs outperform traditional technology?
  - How is the source for bio-inspiration chosen?

# Summary from Last Class

- Nature offers engineers new design concepts
  - Engineers take ideas from the engineered world
  - The natural world offers a large source for new ideas
- Nature uses unique forms of locomotion not seen in robotics



- Bio-inspired designs may outperform traditional robots
  - Traditional mobile robots are limited by natural terrain
  - Nature's creatures are well adapted to and thrive in the natural world
  - Nature's creatures are capable of unique tasks



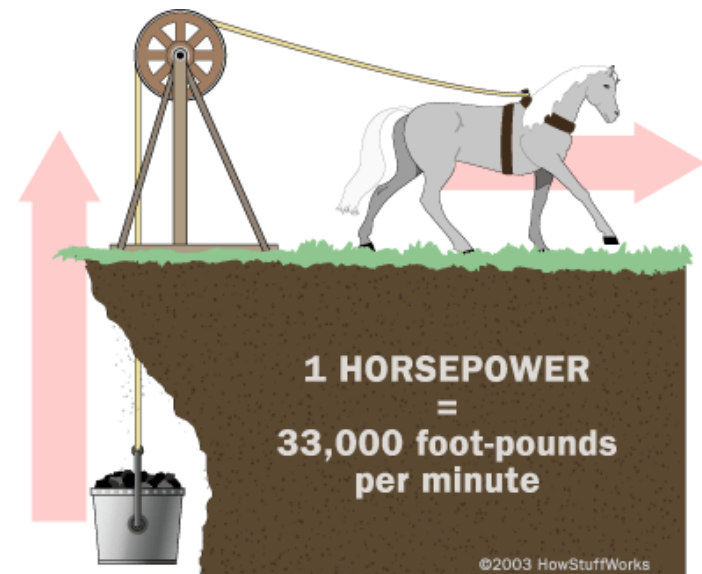
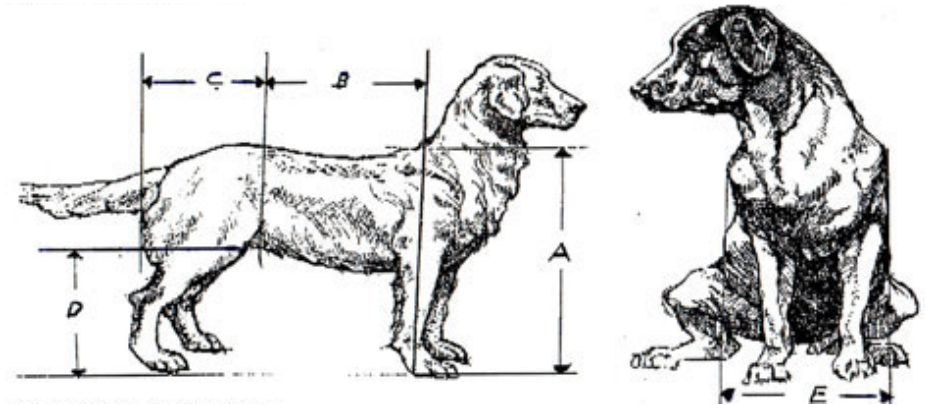
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# How to Select Source for Inspiration

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# Some Animal Characteristics

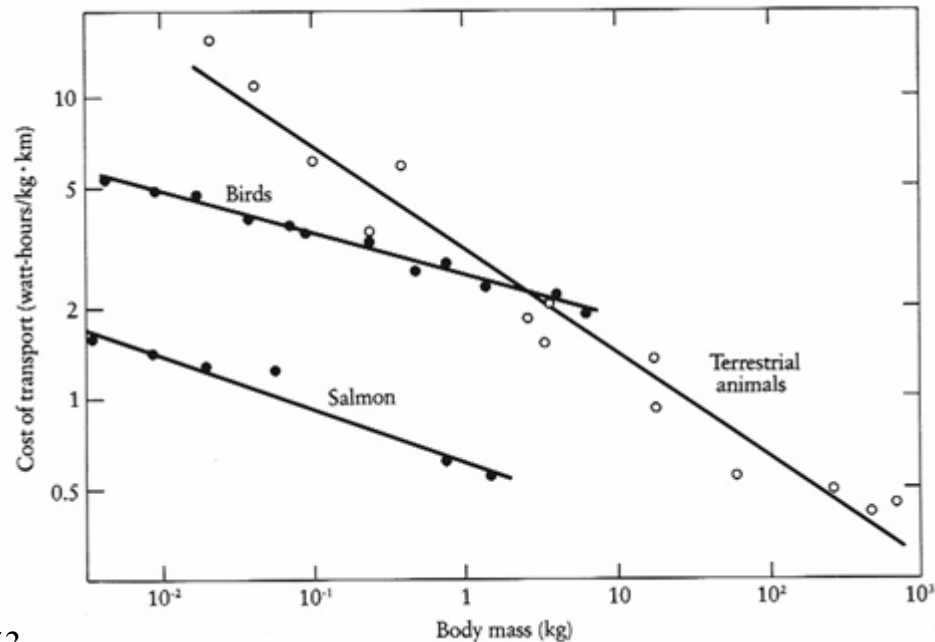
- Body dimensions
  - Body height
  - Clearance height
  - Body length
  - Body width
- Weight
- Degrees of freedom
- Power
- Range





# Some Measures of Locomotion Performance

- Velocity (Body lengths/second)
  - Peak
  - Continuous
- Acceleration/Deceleration
  - Peak
  - Continuous
- Cost of Transport
  - Total metabolic expenditure divided by body weight and velocity
- Maneuverability
- Ability to navigate terrain





# Maneuverability

- Definition: Ability to make a controlled series of changes in movement or direction toward an objective
- Objectives
  - Follow a target
  - Negotiate obstacles
  - Navigate through confined spaces
- Characterized by
  - Agility
  - Quickness
  - Readiness to move
  - Ease of movement
  - Complexity of movement
- How can maneuverability be measured and compared?





# Measuring Maneuverability

- Reaction time (s)
- Turning rate (degrees/s)
- Turning radius (m)
  - Minimum turn radius ( $r_{\text{path}}$ ) per body length
  - Minimum space radius ( $r_{\text{space}}$ ) per body length
    - $r_e$  = Effective radius of turning animal
    - $r_{\text{space}} = r_{\text{path}} + r_e$





# Land-based Mobile Robots

<b>Function</b>	<b>Constraint</b>
Propel forward	Speed
	Acceleration
Traverse terrain	Slope of terrain
	Hardness (texture) of terrain
Overcome obstacles	Obstacle height
Avoid obstacles	Obstacle spacing
Carry object	Weight of object

What is the right source of inspiration?

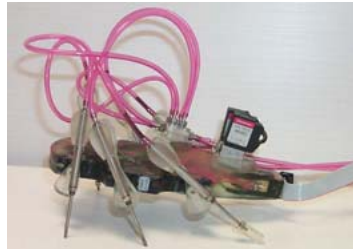


# Land-based Mobile Robots

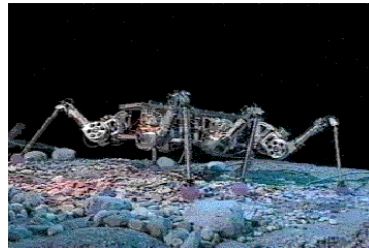
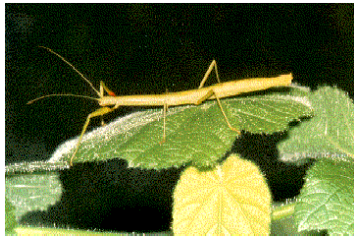
<b>Function</b>	<b>Constraint</b>	<b>Units</b>	<b>Candidates for inspiration</b>
Propel forward	Speed	m/s	Cheetah
	Acceleration	m/s <sup>2</sup>	Cheetah
Traverse terrain	Slope of terrain	degrees	Mountain goat, Gecko
	Hardness (texture) of terrain	kPa	Scorpion, Snake (Soft terrain)
Overcome obstacles	Obstacle height	m	Cockroach, Frog
Avoid obstacles	Obstacle spacing	m	Snake
Carry object	Weight of object	kg	Elephant, Ant

# Some Concepts from Nature

- Cockroach



- Stick Insect



- Spider



- Scorpion



- Crab



- Lobster

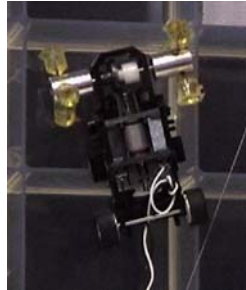


# Some Concepts from Nature

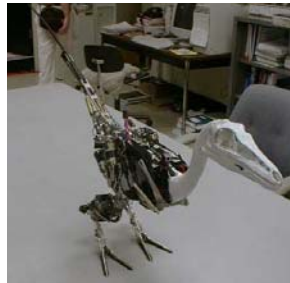
- Snake



- Gecko



- Dinosaur



- Dog



- Gorilla



- Human





# Project Teams

- So far six teams involving 16 students
  - Rose Faghih, Matt Huffman, and Christian SchneiderDavid
  - McCary, Siddharth Roy, and Andrew Skobac
  - Dave Frampton, Ben Jenkins, and Brett Kuklewicz
  - Allen Jones, Guru Ramu, and Laura Woodworth
  - Michael Shin and Gabe Cahn
  - Jessica Rajkowski and Stephen Swern
- As of today morning 20 students are registered for the course
- If you are not in a team please send me an email ASAP (Today!!)