Science and Society

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- Donna Arsenault: the enforcer
- Questions are welcome anytime. The instructor will limit discussion only for time constraints and to stay on topic
- Extra credit for catching the instructor in a mistake!

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- My TOALC page
  http://froglevel.org/toalc
- Wikipedia
  http://en.wikipedia.org

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- Introduction: What is Science?
- Renewable Energy
- Nuclear Power
- Wind Power
- Power Transmission
- Genetic Manipulation
- Mind and Consciousness
- Particle Physics, Particle Accelerators, and the Large Hadron Collider (LHC)
- Evolution

Science and Society
What is Science?

The meaning of science, how it is done, and what it achieves is widely misunderstood in spite of its dominant role in our daily lives.

- What is science and what is “the scientific method”?
- How did we come to understand why objects such as billiard balls move the way they do?
- How did we come to understand the evolution of living organisms?

What are the differences distinguishing science, engineering, and technology?

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What is Science?

What is science?

What is “the scientific method”?

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What is Science?

What is "the scientific method"?

What is Science notes by Bruce Railsback, Professor, Department of Geology, University of Georgia

- Observations
- Observations → facts
  - We see the sun go overhead each day
  - We see the sun go overhead differently by the seasons

- Explanations
- Explanations → theories
  - The sun revolves around the earth
  - The earth and other planets revolve around the sun

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What is Science?

What is "the scientific method"?

- Observations
- Observations → facts
- Explanations
- Explanations → theories
- ~~Opinions~~
- ~~Desires~~
- ~~Other explanatory systems: philosophy, religion~~

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What is Science?

- Does not depend on the moral, intellectual, or other *goodness* of the scientist.
- Does not depend on the status of the scientist.
- Does not depend on the authority of the scientist
- After the work is done, it is totally independent of who did it.
- Sometimes, it takes a long time to decide what is science and what is not.
  - Celestial mechanics
  - Evolution
- Human nature does not always produce good science; but it eventually prevents quackery.

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What is Science?

How did we come to understand why objects such as billiard balls move the way they do?

- For a few thousands of years, humans had no explanation for the movement of objects that could explain simple observations we make today. They hadn't even made most of the observations.
- Through the 15th century, anyone who thought about it believed the theory of Ptolemy that the sun, moon and stars were mounted on crystal spheres rotating around the earth.
- In the 16th century Copernicus began to get the facts (and some preliminary explanations).

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What is Science?

How did we come to understand why objects such as billiard balls move the way they do?

- About seventy years later, the Church began to see Copernicus' work as antiBiblical
- A few decades later, Galileo stirred up the controversy and got himself labeled a heretic.
- By the turn of the 17th century into the 18th, Isaac Newton made a few more observations, figured it all out and announced his laws(explanation) of motion and laws(theory) of gravity.

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What is Science?

How did we come to understand the evolution of living organisms?

- Charles Darwin (and others) observed how species varied depending on their surroundings
- Charles Lyell (and others) observed the characteristics of the earth's rock formations.
- Based on biological observations and the geologic evidence that the earth was very old, Darwin figured out how we came to have so many different but related species and published *On the Origin of Species*.

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What is Science?

How did we come to understand the evolution of living organisms?

- And so, just as was the case for the theories of motion and gravitation, two centuries later we still have to argue about Evolution.

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What is Science?

- Are theories just speculation?
- Some people take that view with respect to evolution.
- The theory of evolution is an explanation derived from facts just as is the theory of gravity.
  - The earth is very old
  - Different species lived in the past
  - The complexity and variability of species increases with time
  - Species adapt to different environments today: the peppered moth
  - Biology has found the molecular components and mechanisms by which evolution can work
  - Many, many others

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Self Correction

- Erasmus Darwin (Charles' grandfather) understood evolution and believed that offspring inherited acquired characteristics
- Jean-Baptiste Lamarck a bit later wrote about evolution and adapted E. Darwin's idea about acquired characteristics
    - A giraffe stretches its neck to get leaves, and its offspring have longer necks
    - A blacksmith develops strong muscles, and his sons have big muscles
- Charles Darwin initially believed in acquired characteristics

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Self Correction

The idea seems embedded in conventional wisdom

Exodus 20:5 "I the LORD thy God am a jealous God, visiting the iniquity of the fathers upon the children unto the third and fourth generation"

Numbers 14:18 "visiting the iniquity of the fathers upon the children unto the third and fourth generation"

Deuteronomy 5:9 "visiting the iniquity of the fathers upon the children unto the third and fourth generation"

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Self Correction

Charles Darwin believed in acquired characteristics until has experimental work convinced him otherwise

Lamarckian inheritance had no experimental basis until very recently

It has been observed that *epigenetic* factors are influenced by behavior in adolescence and do affect offspring for a few generations

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Correction by others

- Prosper-Rene Blondlot claimed to have discovered N rays in 1903
- N rays were emitted by nearly everything except green wood
- They were detected (by over 120 researchers) by detecting a very weak glow of a phosphorescent screen in a dark room
- Some researchers could not observe them
- RW Wood of Johns Hopkins visited Blondlot and provided a definitive proof

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What is Science?

- Observations → facts
- Explanations → theories

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What is the difference between science and technology?

- Science concerns itself with discovering and verifying facts and producing explanations—e.g., how do electrons move through matter.
- Technology (technical knowing) applies those facts and explanations to create possibilities—e.g., how to make a transistor.
- Engineering is the art of applying science and technology to make things—e.g., 2N3906 transistors, 50” LCD televisions, CISCO internet routers, etc.
- Many heated debates, arguments, and opinions notwithstanding they are different, but one is not *inferior* to the other.
- We will discuss all three.