IF YOU WERE NOT HERE LAST WEEK...

PLEASE COME TO THE FRONT OF THE CLASS AND SEE PROF. COTTON.

"Any sufficiently advanced technology is indistinguishable from magic."
--Arthur C. Clarke, "Profiles of The Future", 1961 (Clarke's third law)
English physicist & science fiction author (1917 – 2008)

"The Bible shows the way to go to heaven, not the way the heavens go."
--Galileo Galilei

"By denying scientific principles, one may maintain any paradox."
--Galileo Galilei

The Scientific Method (continued)

Supplementary Material for CFB3333/PHY3333

Professors John Cotton and Stephen Sekula

January 23, 2012

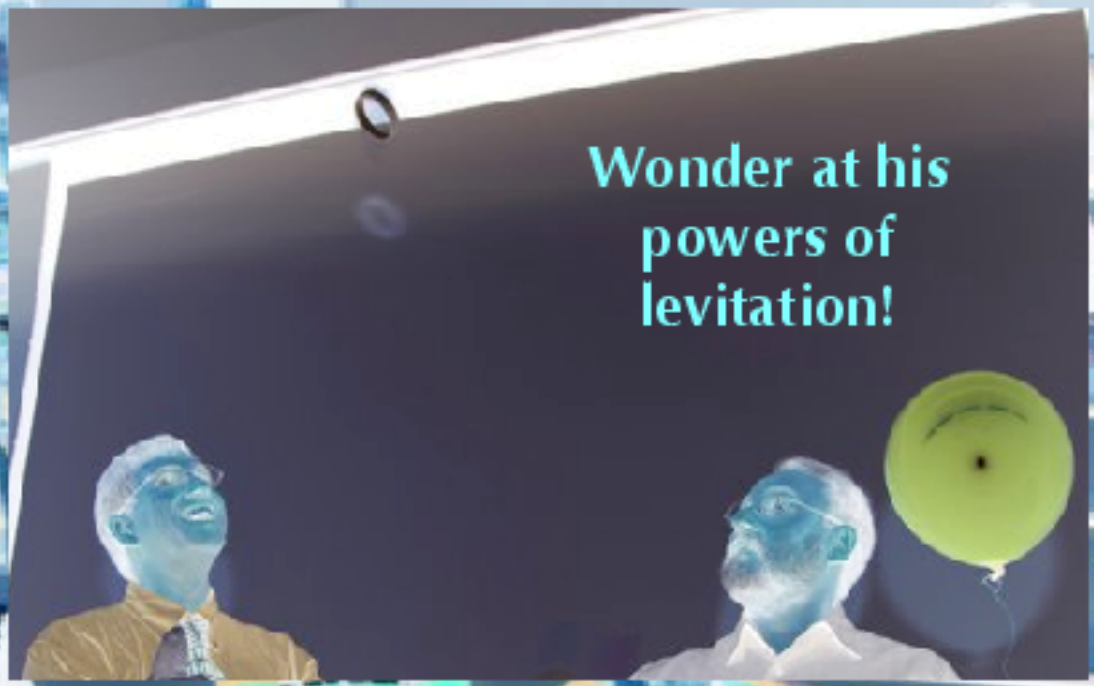
Based on the following information on the web:

http://www.physics.smu.edu/pseudo/SciMeth

But first . . . some MAGIC!

A round of applause for . . .

SCALISE, IL MAGNIFICO!



Gasp as he commands the elements of nature!

GLOSSARY OF CRITICAL DEFINITIONS

FACT

- The National Academy of Sciences definition of fact:
  - ***An observation that has been repeatedly confirmed and for all practical purposes is accepted as true.***

"In science, 'fact' can only mean 'confirmed to such a degree that it would be perverse to withhold provisional assent.' I suppose that apples might start to rise tomorrow, but the possibility does not merit equal time in physics classrooms."
--Stephen Jay Gould

EXAMPLE: At Standard Temperature and Pressure, lead is more dense than water.

THEORY

- The National Academy of Sciences definition of theory:
  - ***A well-substantiated explanation of some aspect of the natural world that can incorporate facts, laws, inferences, and tested hypotheses.***

Theories are not easily discarded; new discoveries are first assumed to fit into the existing theoretical framework. It is only when, after repeated experimental tests, the new phenomenon cannot be accommodated that scientists seriously question the theory and attempt to modify it.

EXAMPLE: Einstein's Special Theory of Relativity, which assumes that the speed of light is the same for all observers and all observers observe the same events, even if they disagree on why they occurred; it predicts that time slows down for observers in motion, space contracts according to observers in motion, the speed of light is the fastest that anything can travel, and that mass is another form of energy. These predictions have all been confirmed, repeatedly, by every test applied so far.

CONSTRUCT

A construct is "a non-testable statement to account for a set of observations. The living organisms on Earth may be accounted for by the statement 'God made them' or the statement 'They evolved.' The first statement is a construct, the second a theory. Most biologists would even call evolution a fact."

--Michael Shermer, Why People Believe Weird Things, pg. 20

OCCAM'S RAZOR

Occam's razor is a logical principle attributed to the mediaeval philosopher William of Occam (or Ockham) [1285-1349]. ***The principle states that one should not make more assumptions than the minimum needed.*** This principle is often called the principle of parsimony. It underlies all scientific modeling and theory building. It admonishes us to choose from a set of otherwise equivalent models of a given phenomenon the simplest one.

In any given model, Occam's razor helps us to "shave off" those concepts, variables or constructs that are not really needed to explain the phenomenon. By doing that, developing the model will become much easier, and there is less chance of introducing inconsistencies, ambiguities and redundancies.

OCCAM'S RAZOR - EXAMPLE

The structure of the Solar System is a good example of the application of Occam's Razor. The geocentric ("Earth-centered") system requires planets circling about empty points, with epicycles added to account for the non-uniform motions. Copernicus' heliocentric ("Sun-centered") model solved the problems without need for epicycles and the associated assumptions.

"Adding epicycles" is now modern jargon for complicating an explanation beyond the point of confidence; it may be time to stop trying to make the old explanation work and start looking for a new hypothesis. Occam's Razor is a "heuristic", which means that it does not have a theoretical base. It is something that is usually good to do. Important to be aware that heuristics can fail; theoretically derived rules normally don't.

HAS OCCAM'S RAZOR EVER FAILED?

Sure! Almost every time.

The Universe is complicated and the simplest explanation is probably not correct.

Then why use Occam's Razor? Because one should only add new assumptions when forced to do so by the evidence, not on a whim.

Occam's Razor keeps Science on track by not allowing it to wander too far afield.

ASSUMPTIONS

- An ASSUMPTION is something taken to be true without proof.
  - Assumptions are necessary because nobody knows everything.
  - An assumption is not necessarily a guess - sometimes an assumption is made based on some knowledge of the situation. You might call it an educated guess.
- This is in contrast to what is known as a WAG (wild-ass guess) in which the guesser really knows nothing and is making random propositions.

SKEPTIC

- A skeptic asks for evidence before accepting a claim.
  - Anecdotes and "everyone knows it" aren't enough.
  - Skeptics are open-minded enough to look at evidence and decide whether to accept the claim, but not so open-minded that their brains fall out.
- Take careful note of the phrase "Extraordinary claims require extraordinary evidence." It's from Carl Sagan.
  - Whenever someone makes a really far-out claim, DON'T just take it at face value. Ask for some real evidence in support of the claim.

DENIER

- A "Denier" is often confused with a "Skeptic"
  - THEY ARE NOT THE SAME THING
- A DENIER is . . .
  - . . . someone for whom there is never enough evidence.
  - There are many, many, many kinds of deniers
    - Holocaust Deniers
    - AIDS/HIV Deniers
    - Global Climate Change Deniers
    - Evolution Deniers
    - 9/11 Deniers
    - Presidential Birth Certificate Deniers

CYNIC

- A cynic questions everybody's motives, figuring all actions are self-interested and/or self-serving.
  - A real cynic is annoying.
  - There are, however, some times when a cynical approach is useful - even helpful. We mean simply that there are some times that a cynical approach will get you the answers you need.

CYNIC – AN EXAMPLE

- The old saying "If it seems too good to be true, it probably is" is still valid.
  - Take, for example, Facebook. It's offered as a “free service” to connect with friends and family. In exchange for your personal information and access to your private life (photos, lists of friends, media habits, etc.) you get to connect endlessly for free.
  - Wait, is it really for free? What's the trade-off? How is Facebook, a for-profit company, benefiting from offering a free service?
    - Personal information means targeted advertising, and ways of developing strategies for selling off your personal information to third-parties so they can better target you and your interests.
    - You are trading personal information for access, and Facebook is making money from your personal information