DEVELOPMENT OF HYPOTHESIS, OBJECTIVE AND SUCCESS CRITERIA (HOS)

16.621
DEFINITION OF A HYPOTHESIS

• Hypothesis
  A tentative explanation that accounts for facts and can be tested by further investigation; a theory
  Something taken to be true for the purpose of argument or investigation; an assumption

• Experiment
  A test under controlled conditions that is made to demonstrate a known truth, examine the validity of a hypothesis, or determine the efficacy of something previously untried.

*American Heritage Dictionary, 3rd Edition*
CONNECTION BETWEEN HYPOTHESIS AND EXPERIMENT

• Hypothesis is a critical part of experiment design
  Translation: I have an idea and I want to see if it is valid
  Consequence: My experiment is designed so it can achieve this

• “No experiment should be undertaken without a clear preconception of the form its results might take”
  Advice to a Young Scientist [Sir Peter Medawar]

• The experiment is being carried out to assess the hypothesis, not to prove it
  – Examine engineering evidence critically
  – One school of thought is that the most critical scrutiny should be when experiment and hypothesis agree

• “The strength of your conviction about an idea has no bearing at all on whether it is true or not - and vice versa” [Medawar]
AN ACTIVE LEARNING EXERCISE

For your project, with your partner, write down (or commit to memory) a short description of “your project” and what you think the Hypothesis is (Hypotheses are)

I will ask groups to report on what they wrote

You will get more chances to hone the H (and OS)

An experimental observation is that a good HOS is a requisite (even a blueprint) for success in this subject
OBJECTIVES

Ob-jec-tive, n.

Something that one's efforts or actions are intended to attain or accomplish; purpose; goal; target

[from Webster's New Universal Unabridged Dictionary, 1996, Barnes and Noble, Publishers]
CONNECTION BETWEEN HYPOTHESIS AND OBJECTIVE

• The hypothesis and the objective must be consistent

• The objective flows from the hypothesis statement

• The objective in 16.621 will be a high level statement about the nature and the goal of the experiment to be carried out.
AN ACTIVE LEARNING EXERCISE

For your project, with your partner, write down (or commit to memory) a short description of your project and what you think the Hypothesis and Objectives are

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You will get more chances to hone the HOS

An experimental observation is that a good HOS is a requisite (even a blueprint) for success in this subject
SUCCESS CRITERIA(I)

• How do we measure success?

success, n.
Favorable or desired outcome; The attainment of wealth, favor, or eminence  [Webster’s New Collegiate Dictionary]

• There are at least two measures of success we should consider

• Discuss first the successful journey through 16.62X

• What do we use as success criteria for 16.62X?
SUCCESS CRITERIA(II)

• The success criteria in 16.62X is clear assessment of your hypothesis

• Success is NOT whether the hypothesis is true
  – You are not trying to “prove” a theory

• This needs to be reflected in your write-up
• **Hypothesis** - A flapping wing can have substantial advantages over conventional (propeller) propulsion systems for micro UAVs (Uninhabited Air Vehicles)

• **Objective** - Create a micro-sized ornithoper wing and compare its performance to a propeller system

• **Success goal** - Demonstration that the performance (thrust and propulsive efficiency) were [or were not] X and Y per cent better than for propeller driven micro-UAVs
WRITING SUCCESS CRITERIA

• **Do:**
  - Use action verbs that indicate a drive towards completion / resolution of some problem
  - Examples: assess, define, demonstrate, determine

• **Don't:**
  - Use verbs that show no closure
  - Examples: understand, study, investigate...
A NOTE ON ANALOGIES WITH THE REAL WORLD PRODUCT DEVELOPMENT PROCESS

- In product development there are typically several explicit reviews
- These serve as gates through which the design and development process must pass (PDR, CDR, Passport Review, etc.)
- The process is sometimes referred to as a *staged gate process*
  - At each succeeding gate the stakes are larger, the amount of money spent is greater, and the closeness to fielding the product increases
- Based on our previous experience with the HOS as a predictor of success, we have a staged gate in our process
- The HOS needs to convey to the 16.621 staff that your project will be successful -- If not, *this must be fixed before you can proceed further*
ANOTHER VIEW OF SUCCESS OVER AND ABOVE 16.62X

• You have an idea you think is exciting

• You are working hard to see if it is true (favor, eminence, wealth will result)

• The yes outcome is much more desirable than the no outcome

• This is most often the case in research or project work--you are working to make the project an engineering success, rather than to assess a hypothesis

• This is a different success criteria than that needed for 16.62X and we need to think in different terms
A WAY TO MEASURE SUCCESS (OAA16.62X)

• Ask yourself (or others) the question:
  – What would be such a good result that we would have a party?

• I first heard this asked by Prof. Richard Murray of Caltech

• It has since become known as the *the Caltech party criterion*

• Using this as a thought exercise can be a good way to get people to think about success criteria and to communicate them

• It may be an *adjunct* to your Success Criteria for 16.62X, *but it does not replace them*

• The two types of success criteria need to be kept separate
OTHER ASPECTS

• Once the HOS is set we need to define in depth the path to get there

• Need to think through the whole process on an end-to-end basis

• Need to identify the hard parts

• Need to identify the key milestones (mid term exams)

• This will include (at some level) questions such as:
  - What will we do?
  - Why will we do it?
  - Where will we do it?
  - Who will help us?
  - How will we do it?
  - How well do we have to do it?
  - When will we do it?
SOME FINAL COMMENTS

• I have not discussed “Background and Motivation”

• YOU, however, need to do so in Version I

• Several of the questions in the “Research Catechism” go directly to this point

• More generally, the “Research Catechism” is helpful as a filter to apply to any research plan
G. H. HEILMEIER’S “CATECHISM” FOR EVALUATING A RESEARCH PROJECT

• What are you trying to do? (Articulate your objectives using absolutely no jargon)
• How is it done today and what are the limits of current practice?
• What is new in your approach and why do you think it will be successful?
• Who cares? If it is successful, what difference will it make?
• What are the risks and the payoffs?
• How much will it cost? How long will it take?
• What are the midterm and “final” exams to check for its success?
THE NEXT INSTALLMENT FOR HOS

• Your assignment is to formulate a draft version of your HOS
  – Each part is one or two carefully chosen sentences

• On Tuesday, 24 February we will discuss these in class

• Send your HOS to us electronically Monday
• Bring your draft HOS on a transparency on Tuesday