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

I will ask groups to report on what they wrote

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?**

suc-cess, *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**

AN EXAMPLE:MICRO-SIZED ORNITHOPER WING DESIGN [E. Craparo/B. Ingram]

- **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 past (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**