# Perspectives on Teaching Hands-On Courses

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# Outline

1. Laboratory learning outcomes
   - Collaboration across depts
   - Research-based laboratory course
2. Engagement in engineering design
3. Role of mentors in structured laboratory and design courses

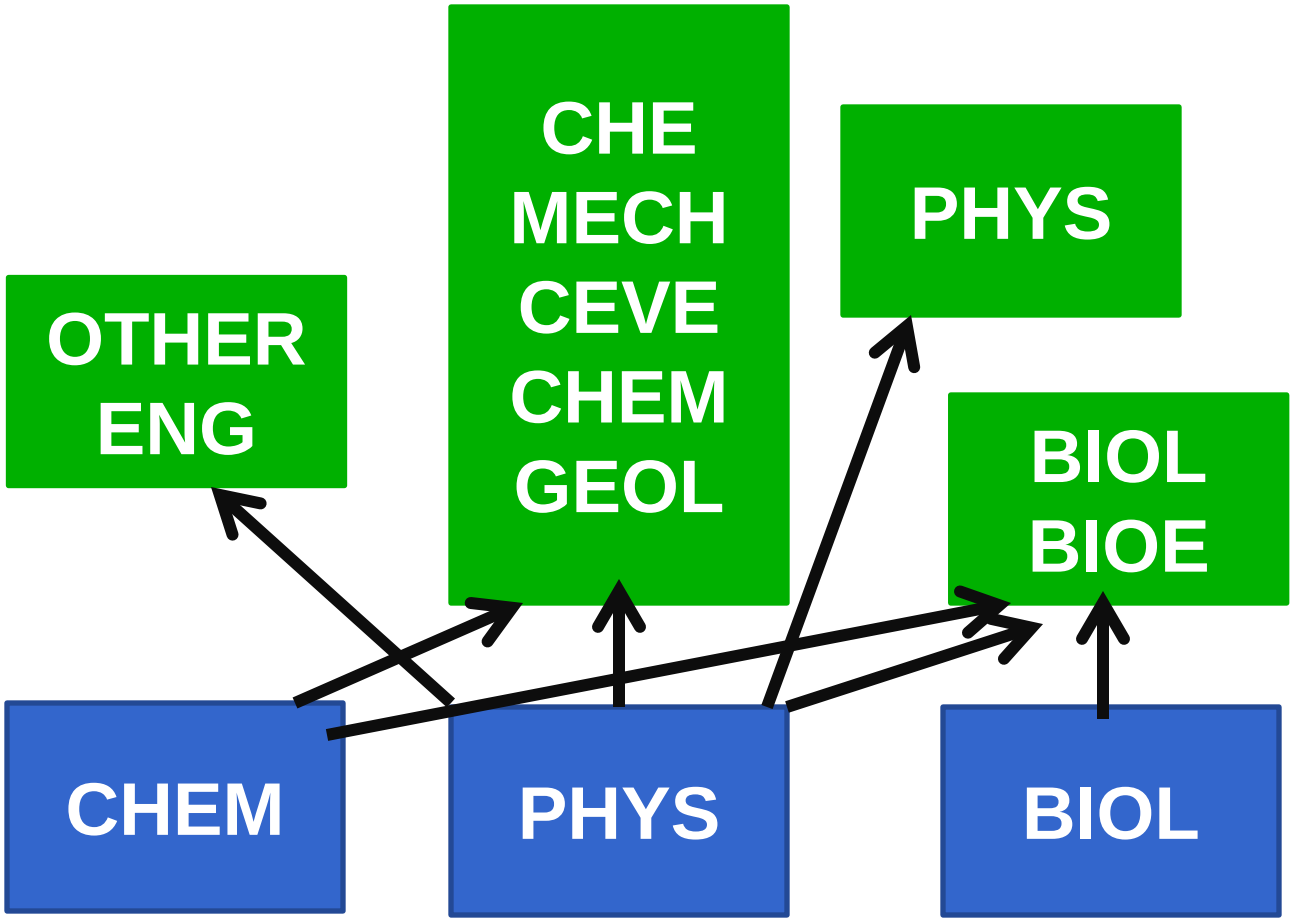
# Why Does this Matter?

1. Cross-disciplinary lab learning outcomes may inform research learning outcomes.
2. Engineering design develops similar skills as research.
3. Many touch-points with experts are necessary for students to succeed.

# Hypotheses…

- STEM laboratory courses had common learning outcomes.
- Sequenced lab courses should build student capacity.
- Coordination across depts improve student skills and preparedness for research and upper-level labs.

# Sequencing of Lab Courses




2nd-4th year labs

1st -2nd year labs

# Common Teaching Objectives

20 objectives in 5 major categories:

A. Basic laboratory skills
B. Communication and record keeping
C. Maturity and responsibility
D. Context
E. Integration and application of knowledge

# C. Maturity and Responsibility

1. Ability to effectively prepare in advance for lab work
2. Ability to learn from mistakes
3. Ability to take initiative and work independently
4. Ability to work effectively as a part of a team

# Emphasis Varies

| Obj. | PHYS 101 | CHEM 121 | BIOS 211 | BIOS 311 | BIOE 441 |
|---|---|---|---|---|---|
| C1 prepare | 2 | 3 | 3 | 3 | 2 |
| C2 mistakes | 2 | 1 | 2 | 3 | 3 |
| C3 initiative | 1 | 0 | 1 | 2 | 2 |
| C4 team | 2 | 3 | 3 | 3 | 3 |

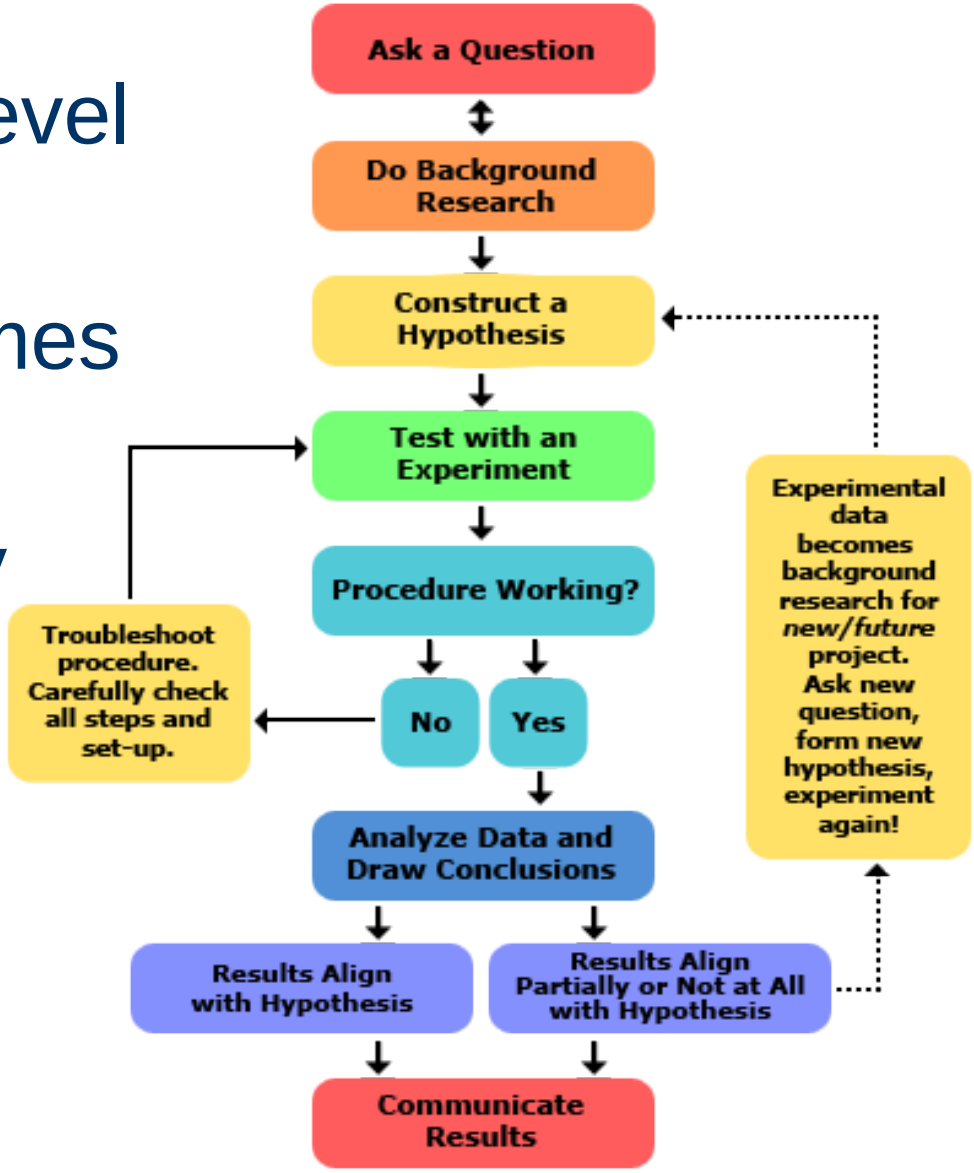
0 = no emphasis  3 = strong emphasis

# How Helpful?

- Evaluate lab courses within & across depts
  - Do skills build?
  - Is there an appropriate balance?
  - Is development shared?
  - Ideas for improvement/redesign?
- Think carefully about development of skills in research setting
  - Not the technical details
  - Instead, translatable skills

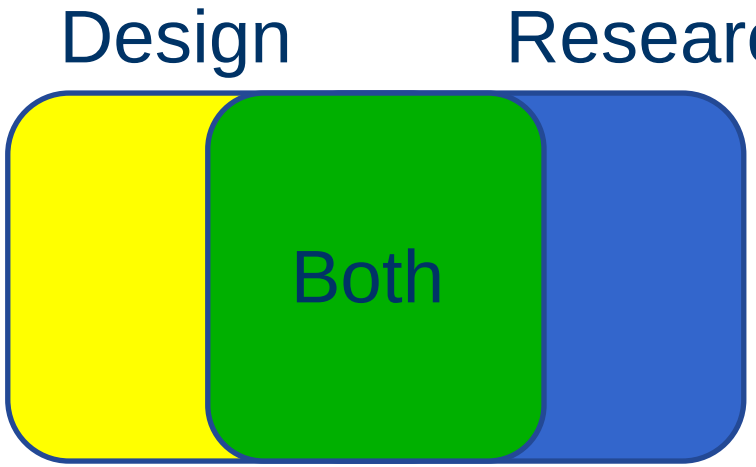
# Launch 1st Yr Research Course

- Goal: teach high-level skills for research
- 11 learning outcomes
- Research projects from STEM faculty labs
- 1st year students
- HHMI-funded



# Engineering Design

- Engineering design tackles open-ended, authentic challenges to create new or improved products and processes.



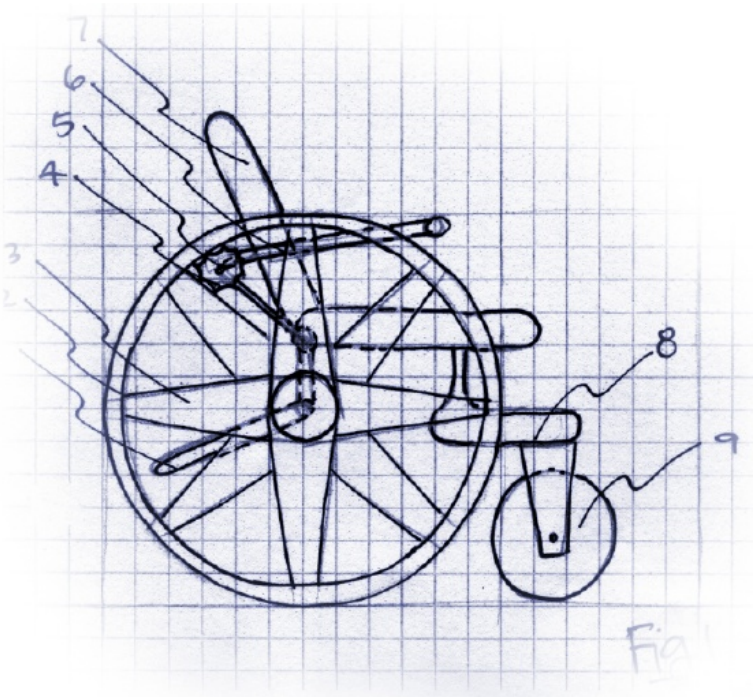

- Apply knowledge
- Directed

- Creating new knowledge
- Less directed

- Open-ended
- Important problems
- Client in mind
- Collaborative

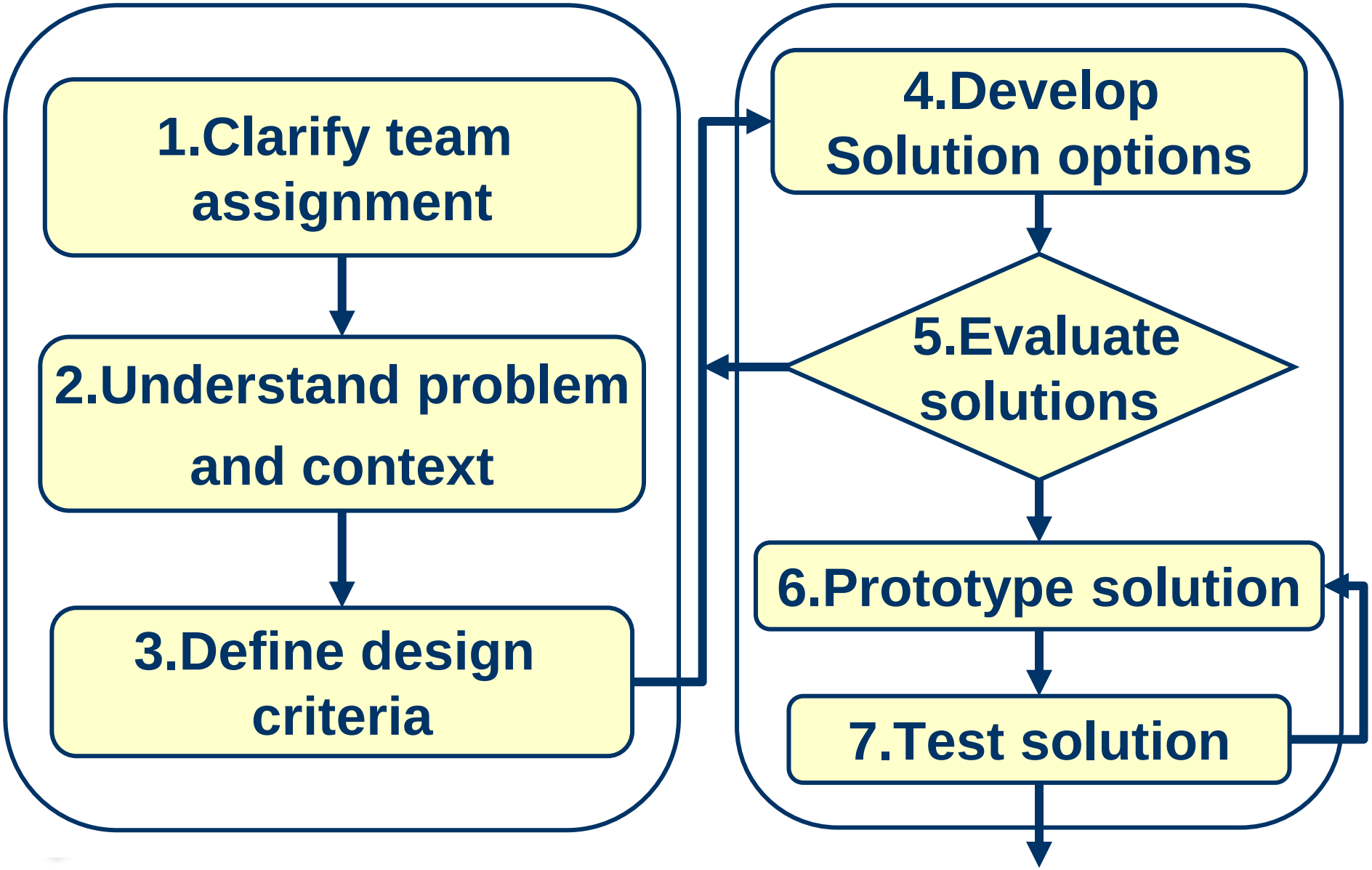
# Engagement in Design

- First-year engineering design course
- All ENG majors
- Multidisciplinary teams
- Client-based projects
- Explicit teaching and practice of process knowledge




project sketches by Allison Garza

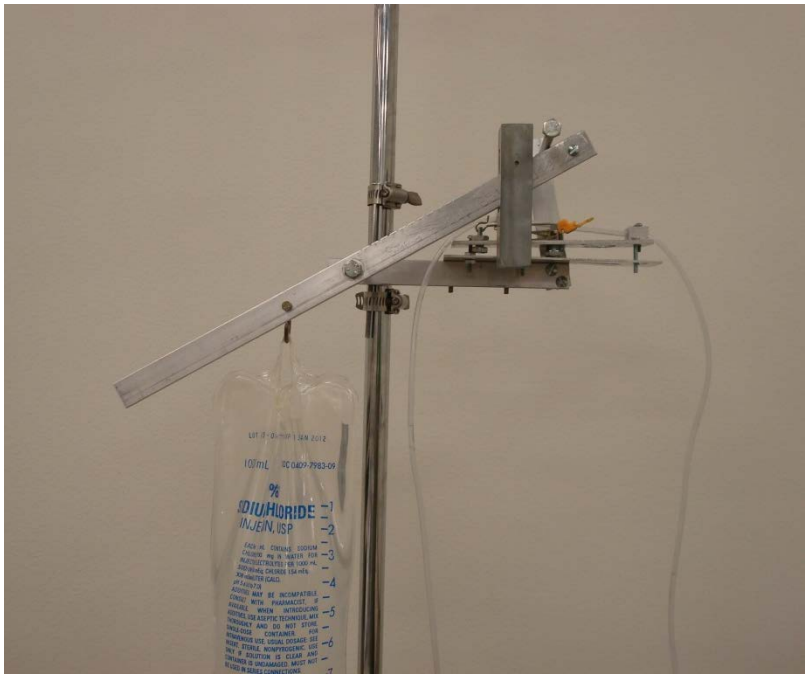
# Engineering Design Process



# 1st Yr Projects at Rice University

**Giraffe hay feeder**
Client: Houston Zoo

**New hose design to water campus trees**
Client: Rice Facilities Engineering & Planning



**System to limit IV volume from a 1 liter bag**
Client: Beyond Traditional Borders

# Clients Participate in Rice Engineering Design

75+ Different Clients

- Texas Children's Hospital
- Shriners Hospital
- Shell Oil Company
- Houston Zoo
- Dynamic Orthotics and Prosthetics
- Rice Facilities Engineering & Planning
- Beyond Traditional Borders
- Wilson Elementary School
- OrthoIntrinsics


HOUSTON ZOO
NATURALLY WILD

Creating Leaders Meeting Global Needs
BEYOND TRADITIONAL BORDERS
RICE UNIVERSITY

RICE
Facilities Engineering and Planning

Texas Children's Hospital®

# Why Does Design Matter?

- Core skill for ALL engineers (e.g., ABET)
  - Everyone does capstone design…
- Increases engagement and retention
- Research: Women, URM

- Using a course model, many/all of ENG students can tackle design challenges.
- Common facility (e.g., Maker Space)

# Cloud of Mentors

- Near-peer mentors
- Faculty mentors

What works in course setting?

- Structure, esp young students
  - Rubrics for grading
  - Regular meetings
- Reward system