

ME 370 – Design Lab 2 - Prototyping

A. Objective

By the end of this lab, you should be able to:

- Understand the connection between requirements, design concepts, and prototypes
- Explain why different prototyping tools are used in different design scenarios
- Develop a prototype to explore and evaluate your Project 1 concept

B. Lab Format

- All assignments are team-based; the lab is in-person in the Innovation Studio
- Pre-lab:
 1. Completing and submitting your Team Contract.
 2. Watching the Google Glass TED Talk.
 3. Reading the attached section, "Introduction to Prototyping."
- In-lab: the in-lab activity will include discussion activities and physical prototyping.
- Post-lab: the post-lab will be a **team submission** containing all of the parts outlined in the post-lab section (Section H).

C. Lab Overview

Design Lab 2 will introduce you to the concept of prototyping - a technique for evaluating design concepts through cycles of feedback and iteration. The pre-lab manual content and video will build your knowledge about prototyping concepts and methods. During the lab, you and your group will:

- Place these methods onto a 2x2 matrix based on the purpose and level of fidelity of each method.
- Be given a design challenge **as part of Project 1** and tasked with answering a series of questions about it, leading up to the creation of an idea and sketch for a prototype that might be useful to the challenge.
- Create a low-fidelity physical prototype using the materials you have around you and discuss the similarities and differences between them.

E. Some Important Definitions

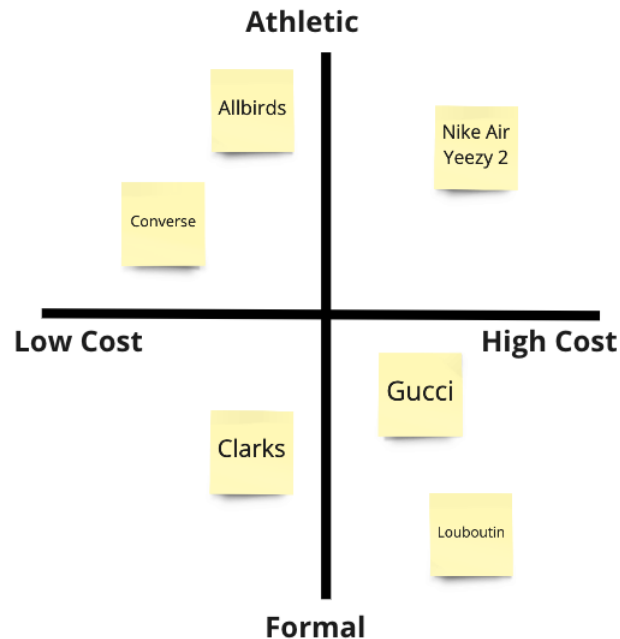
- **Prototype** - A simulation or sample version of a design concept, typically created for **discovery** and/or **communication** of an idea
 - **Discovery** - learning more about your design concept to incorporate findings into future iterations.

- **Communication** - demonstrating your design concept to others to help them understand it.
- **Experience Prototype** - A prototype used to answer question(s) about the experience a person might have using a design concept.
- **Function Prototype** - A prototype used to answer question(s) about the necessary technical functionality of a design concept.
- **Low-Fidelity Prototype** - A prototype developed rapidly and/or using improvised materials, often created earlier on in the design process.
- **High-Fidelity Prototype** - A prototype with considerable effort and care put into it, often created later on in the design process.
- **Design variables** - the parameters of the design which can be changed to meet the requirements.
- **Design constraints** - a restriction of the design which does not add capability but effects the implementation. Examples of these include the "-ilities" such as manufacturability, assembleability, reliability, availability, sustainability, etc.

G. In-Lab Activities

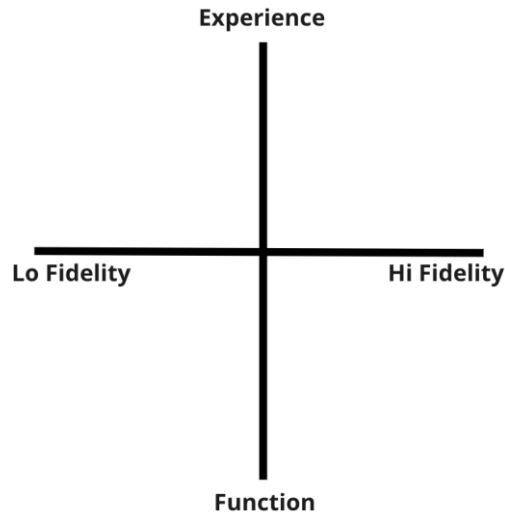
I. PROTOTYPE METHOD CATEGORIZATION

In this activity, you and your group will categorize the prototyping methods we introduced in the pre-lab using a couple criteria, but first we will introduce the concept of the *2x2 matrix*.



In a *2x2 matrix*, the two axes represent two mutually-inclusive traits, and we can place items on the matrix based on where they coincide with those traits. An example from the above 2x2 is Allbirds brand shoes; they are **lower cost** shoes and can be **worn during a workout**, so they've been placed in the **top left quadrant**. On the other hand, Louboutin shoes are **high cost** and are worn for more **formal events**, so they've been placed in the **lower right quadrant**. Keep in mind - in this kind of 2x2, we don't need to restrict ourselves to the quadrants! You can imagine each axis as an infinite set of points, and an item can go anywhere on each line, leading to a more nuanced representation.

This is the 2x2 we'll be using for this activity.



Definitions from the pre-lab are included here for your convenience:

- **Experience Prototype** - A prototype used to answer question(s) about the experience a person might have using a design concept.
- **Function Prototype** - A prototype used to answer question(s) about the necessary technical functionality of a design concept.
- **Low-Fidelity Prototype** - A prototype developed rapidly and/or using improvised materials, often created earlier on in the design process.
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Breakout 1: Prototype Method Categorization

Using the Lab 3 In-lab Template (found on Canvas), you'll find the above 2x2 as well as the list of prototyping methods from the pre-lab. Reference this list for the next activity.

1. For each prototyping method on the list, discuss as a group where on the **fidelity** spectrum it belongs (from low- to high-) and where on the **purpose** spectrum it belongs (from purely-for-experience to purely-for-function) relative to the other methods. Place the "post-its" onto the 2x2 based on what you decide. **IMPORTANT NOTE:** *This activity is subjective; don't worry about getting the "right" answer, and focus more on being able to justify your choices.*

Once you've placed every post-it, answer the following discussion questions with your group:

2. *Were any of the prototypes on the list surprising to you? Pick 2 or 3 and describe why.*

3. Which prototypes on the list prompted the most discussion from your group on where to place them? Pick 2 or 3 and describe how your group came to your decision.

II. PROTOTYPE CREATION PROMPT

Now that you developed familiarity with these methods, identify what method(s) are helpful for Discovery/Communication of your Project 1 design ideas.

Project 1 Scenario: Design a hand-cranked dispensing/timing mechanism that incorporates a linkage mechanism and potentially a gear mechanism. Your device [describe what your dispensing/timing mechanism does] and aims to be used by [insert your target user group].

Breakout 2: Prototype Creation Prompt

Using Project 1 info on Canvas, complete each of the following fields **with your group**:

On the template (Slide 5), list with your group what specific **constraints** and **variables** might be present in this challenge.

- **Design variables** - the parameters of the design which can be changed to meet the requirements.
- **Design constraints** - a restriction of the design which does not add capability but effects the implementation. Examples of these include the "-ilities" such as manufacturability, assembleability, reliability, availability, sustainability, etc.

1. Identify **at least 2 design constraints** present in the challenge
2. Identify **at least 2 design variables** present in the challenge

Next, think about what **unanswered questions** remain about the design that we can use prototyping to discover the solutions to.

TIP: You can also think about these as questions without objective answers, or questions you can't just look up the answers to. Try to make it more than "does the idea work?" Think more critically about specific questions you can ask. If you do want to know how something works, be more specific with your question (e.g. "Does this specific linkage design produce the desired motion?").

3. Identify **at least 3 questions** about the design for your selected destination that your team would like to answer using prototypes.

- Unanswered Question 1
- Unanswered Question 2
- Unanswered Question 3

To prepare for Q4, describe an idea for a potential prototype or partial prototype for each question in Q3. At this point, **it may be useful to share a part of an idea you generated for the prelab**. Feel free to be creative - you don't have to limit yourself to only what you think you could build! In a perfect world, how would you answer each of these questions?

4. **For each question**, generate **one idea** for one potential prototype per question in Q3.

Describe:

- a. What prototyping method would you use?
 - b. What information should each prototype provide?
 - c. Why is this prototype suitable for answering it's respective question?
5. As a team select **two** of your prototype ideas and make a **NEW sketch** for each of them. You are encouraged to use the Maker Space whiteboards (though it is not necessary)! You can also sketch on paper.

Note: two new team-based sketches are required per group, but additional sketches are welcome!

REMEMBER: You do NOT have to be a good artist to make good sketches - a good sketch is anything that helps **communicate** your idea better than words can. If that means stick figures and text bubbles, so be it!

Be sure to take a good quality picture/scan of your sketches and add it to your submission!

Finally, reflect on the idea that you drew.

6. Answer the following **reflection questions** (for each sketch):

- a. *Is there any other useful information you can get from this prototype?*
- b. *What other prototype(s) would you have to create to fill gaps in your knowledge?*
- c. *Would you change which method you picked? Why or why or not?*

III. PHYSICAL PROTOTYPE BUILDING AND ANALYSIS

The final activity in this lab will be the construction of super-low-fidelity physical prototypes by you and your group mates using the materials in the Innovation Studio.

As discussed in the pre-lab, the ability to come up with creative ways to prototype a design concept through low-fidelity means can help immensely in the design process. **Being able to answer important questions about the necessary functionality or user experience of a design concept with minimal effort can save your team lots of pain down the road.** Consider the Google Glass example from the video - the team's scrappy early prototypes took almost nothing to create and yet were extremely helpful in identifying some key design constraints.

Breakout 3: Physical Prototype Building and Analysis

To start, as a team select which of your three prototype ideas above is most suitable to a low-fidelity prototype (it doesn't have to be the one that you sketched!).

1. As a team, build **two** prototypes. Remember the **question** you're aiming to answer with this prototype; it could be as simple as trying to figure out what form or shape the design concept should take, or it can be as specific as honing in on a specific element of the design and simulating the experience or function of it.

Be sure to take high quality photos of your prototypes and add them to your submission!

Finally, answer the following **discussion questions**:

2. *What were you able to Discover/Communicate with these prototypes?*
3. *If you had more time and resources, what would be the next prototype to build?*

H. Post-Lab

Your post-lab is a TEAM submission (due the night before the next lab).

Ensure that your submission includes:

- Part I (3 points)
 - *Your group's 2x2 with all post-its*
 - *Your responses to the 2 discussion questions in Part I*
- Part II (10 points)
 - *Your identified design constraints, variables, and unanswered questions*
 - *Descriptions of at least 3 prototype ideas, one for each question*
 - *Sketch(es) of at least 2 prototype ideas per team*
 - *Your responses to the 3 reflection questions in Part II.6*
- Part III (7 points)
 - *Pictures of each of your team's two low-fidelity physical prototypes*
 - *Your responses to the 2 discussion questions in Part III.2 and III.3*

Make sure to export your filled in template as a PDF and submit it to Gradescope!

Additional Notes:

- **As a team, you should start to work on CAD or detailed engineering drawings as you work towards more complete prototypes (D4 & D5)**
- **The course instructors expect that you will continue to work on your prototypes for D4, and will have a more complete or functional prototype to present.**