Workshop - Using Low Fidelity Prototyping Materials to Achieve Inexpensive, Rapid Development of Prototypes

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Prototypes, or physical models, are an effective method to communicate mechanisms or complicated ideas. Developing materials which support regular prototype and model building can be costly and challenging to teach to students, thus limiting the use of the method. This workshop will introduce the idea of low fidelity prototyping as a method to communicate concepts and rapidly realize ideas for engineering based instruction. In this workshop, participants will learn how they can build functioning models with widely available common materials. The workshop will provide hands-on active learning examples for attendees and handouts with activities and shopping lists. It will also include a discussion of best practices for prototyping. This topic will be of interest for engineering educators who seek to have their students build prototypes and models quickly and without a large budget.

Many engineering classes can be aided by the use of physical prototypes as a method to overcome the limitations of diagrams, pictures, and vocabulary to communicate difficult ideas. Models can be effective to depict concepts at a molecular or atomic level, or to display difficult concepts in basic physics courses. Early prototypes in design courses can assist teams to gain consensus on an idea separated from functional demands; later prototypes may help teams prove functionality while lacking aesthetic appeal. Final prototypes are used to fulfill a client's objectives and constraints.

Despite the many advantages of using prototyping in practice, there are challenges that must be overcome to create successful prototypes. Students must have a clear understanding of how to start, what materials are available, and how to work with those materials. Even when students are adept at using building tools, they still have to contend with the time constraints of actual construction. Faculty must be able to counsel students in the iterative building of successive prototypes, which requires expert knowledge. At an institutional level, space or facilities must exist to support this type of building as well as a materials budget. In many cases, best practices are built over years and are program- and institution-specific.

A solution to these challenges lies in the use of low fidelity prototyping materials and practices. Low fidelity prototyping is the use of readily available and inexpensive materials as building supplies for a range of initial prototypes. One hallmark of creating low fidelity prototypes is to build things rapidly and without concern for aesthetics. This allows mistakes to be made and realized quickly and inexpensively. Using materials most people are already familiar with levels the playing field of model building skills and limits the opportunity for fear of failure to affect prototype quality. There are a number of benefits of this practice: improving student model making proficiency, solving disagreements in a team, and managing the solution generation process. From a curricular standpoint, low fidelity prototyping lowers many of the common barriers to prototyping: time, budgetary constraints, technical know-how, and tools. Prototyping activities can take as little as five minutes and require as few materials as newspapers and tape. They can be used as a warm-up for class as well as be used to teach concepts. When employed in a design course, they can decrease the time between iterative prototypes and increase the overall number of prototypes.

There are a wide variety of materials that can be used as low fidelity supplies. Many materials that are available in abundance locally can be useful: aluminum foil, chopsticks, tape, Styrofoam (or paper) cups, various kitchen consumables, cardboard, office supplies, etc. Table 1 lists some example materials.

TABLE 1.
USEFUL LOW FIDELITY PROTOTYPING MATERIALS.

Pipe cleaners	Styrofoam balls	Foam Sheets
PostIt notes	Popsicle sticks	Construction Paper
Foam blocks	Safety Pins	Sharpies
Rubber bands	Index Cards	String
Clothespins	Colored Straws	Burlap Twine
Beads	Thin Dowels	Florist Wire
Scissors	Playdoh	Masking Tape
Brushes	Paperclips	Aluminum Foil
K'nex	Elmer's glue	Rubber Balls
Felt Sheets		

This workshop was recently delivered to faculty at Jimma University in Jimma, Ethiopia. The workshop was crafted around materials that were sourced from their local market and activities were shaped to accommodate the specific group of materials commonly available in that part of the world.

The workshop schedule will include a brief introduction, hands-on exercises followed by discussion about the techniques, activities, and discussion of materials. First, the organizers will present brief thoughts on the

reasons to prototype, some associated challenges, and simple solutions employing low fidelity prototyping. The majority of the workshop will be spent in groups and at stations working with some of these low fidelity materials through hands-on activities. At the conclusion of the workshop, the organizers will facilitate a discussion with attendees about lessons learned and propose opportunities to introduce these activities into classes or how to use them for existing prototyping exercises. We will also discuss how to select problems and activities for students based on available local materials and budget constraints. Attendees will be able to look at and interact with examples of prototypes built by students.

The audience for this workshop will be focused toward faculty who teach components of engineering design education in their first-year program. All FYEE participants are, however, welcome to learn about the materials and witness some hands-on activities. Individuals who attend this workshop will participate in active-learning prototyping exercises in groups and alone, or will watch while others participate.

The workshop facilitators will provide all of the building materials for the workshop. This includes the low fidelity prototyping materials, and bins/bags to hold them. Additionally, printed materials including a sampling of hands-on activities, a list of recommended best practices, and shopping list of materials, will be provided for attendees.

Samples of prototyping activities and examples of previous low fidelity prototypes can be emailed as supporting evidence, if necessary. A video time lapse of the workshop held in Ethiopia for Jimma University can be found here: https://goo.gl/SU6bmL. On the right side of the room are the low fidelity prototyping supplies and on the left/middle are the faculty working through the hands-on activities in groups and in solo. This workshop was originally structured for Jimma University's Department of Bioengineering to use, and covered a wide range of materials. The FYEE workshop will have a subset of these materials, with activities and materials spaced out around the room at tables/stations.

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