Guidelines for Final Project

Engineering Leadership Module

E10 Engineering Design & Analysis – Spring 2011

For this module, you will work in teams, adopting the role of a consulting engineering group hired by the Lawrence Hall of Science (LHS) to design a new "Ingenuity" exhibit, as described in these guidelines and the module syllabus. To fulfill your client's needs, you will be expected to complete several individual and group deliverables throughout the project timeline, as outlined below.

Lawrence Hall of Science (LHS) Client Statement:

The current **Ingenuity in Action** exhibit and the **Ingenuity Lab** engage visitors in the engineering design process, but the engineering component is not explicit to visitors. Oftentimes, visitors don't even fully complete the design process. We need a facilitation method and exhibit design that will help visitors gain awareness of the design process and the engineering that they engage in while interacting with the exhibits. Your task is to find some way to involve visitors more fully in the design process so that they come up with the best solution to the challenge or problem. In other words, we need you to engineer the best method for teaching the engineering design process.

LHS "Ingenuity" project

Your project will be to design and implement a facilitation strategy for making the engineering design process (Figure 1) explicit to LHS visitors.

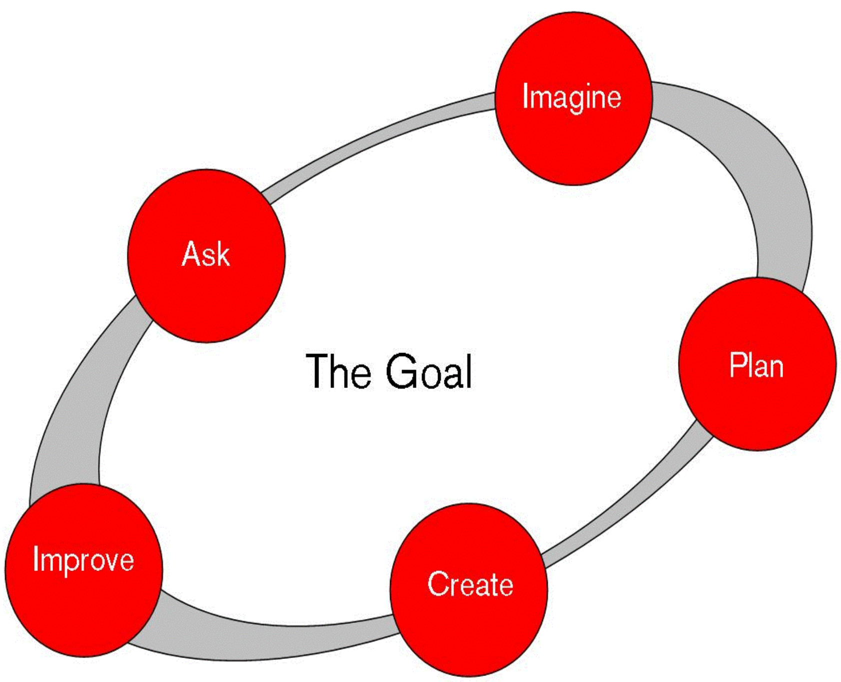


Figure 1: The Engineering is Elementary® 5-Step Engineering Design Process

You have two primary options for activities:

1. Adapt an existing activity in the **Ingenuity in Action** exhibit. The museum floor features three activity stations. Revise the facilitation process to add the *engineering design process* to the activity. Within this exhibit there are three activity stations:

(i) ***Fly High***: Create your own flying machine and test it in a wind tube. This is a highly open-ended design challenge.
(ii) ***Design and Drive***: Combine wheels and treads to optimize your vehicle for climbing on rough surfaces. This project is more constrained due to requirements of gear ratios and terrain, etc.
(iii) ***Span the Gap***: Experiment with the basic building of bridges (inspired by the Bay Bridge) to create your own. This design challenge is constrained by a number of factors including safety and efficacy.

This project is completed by implementing your facilitation strategy on the LHS floor with LHS visitors in the **Ingenuity in Action** exhibit.

2. Develop a *new challenge* for the **Ingenuity Lab**.

The **Ingenuity Lab** contains legos, motors, gears, programmable microchips, basic circuitry materials, and other interesting materials. Develop a design challenge for visitors making use of the materials available in that lab space and illustrating the engineering design process. This project is completed by facilitating the challenge activity with LHS visitors in the **Ingenuity Lab.**

The new challenge is open-ended and is motivated by available materials and interests of E 10 teams.

Some "**Ingenuity**" project design parameters that apply to both options:
1) *Your process must allow for the drop-in nature of the museum experience.* Museum teaching can be very different from classrooms. There is not a designated start and stop time. Facilitators must be able to orient new groups as they walk up to the station.

2) *Your process needs to allow for visitors to develop their own creative solution to the challenge*. The overall goal of the experience is to allow the visitor to do his or her own creative thinking and tinkering. Your facilitation structure should preserve that feeling while still providing structure that illustrates the engineering design process.

3) *Your activity needs to be fun!* Museum visitors vote with their feet. An educational activity is only effective if the visitors are having enough fun that they stick around to finish it!

Research of LHS user needs (10 hours total)

Each of you will be expected to spend at least 2 hours/week (<u>for a total of 10 hours</u>) at LHS, 8 hours of which will be dedicated to educational/user research during the first four weeks and 2 hours which are for project implementation.

The 8 hours of user needs research should be split into 2 hours at each of the four existing exhibits (Fly High, Span the Gap, Design & Drive and the Ingenuity Lab). During this time, you will be expected to guide visitors through the design process and collect data/observations on their experience (see attached form titled "Educational Research"). Please include this completed form (and any additional data) in your design notebooks. You will also be asked to enter your collected data into a bSpace form each week by Monday at 5 pm. Your final 2 hours are for your team to implement your design and gather feedback. At a minimum, you are expected to capture the testing of your exhibit design through photographs; videos and other forms of visual display are highly encouraged.

Your hours will be recorded by signing in/out at the LHS front desk upon your arrival/exit on the museum's volunteer website, Volgistics. Please see the last page in the module syllabus, "Lawrence Hall of Science, Guidelines for outreach teaching and user needs research," for further guidelines outlined by your client, LHS.

Design Notebook

Each of you will be required to maintain a design notebook (see module syllabus for details regarding design notebook content). Design notebooks will be subject to random collection at any time and no back-logging is allowed. Notebooks will be due on the last day of lab (the day of final presentations).

Weekly Project Deliverables

For each weekly lab, you and your team will be asked to provide a project deliverable that will ultimately be included in the final report. Deliverables will consist of two assignments: individual pre-lab assignments and group post-lab assignments. All pre-lab deliverables should be recorded in your lab notebook. All post-lab deliverables are to be uploaded the day after your lab by 5 pm to your team folder on bSpace->Resources->ModuleA: Eng. Leadership->YourLabDay. The following table and descriptions outline the weekly deliverables:

(i) Mission Statement– Provide a mission statement for your group project. What is your design? How will your company fulfill your client's (LHS) needs with your design (i.e. your team's elevator pitch – how will this benefit LHS?)? In addition, address the following questions: Why is this project important to undergraduate students in engineering? What is the broad impact to society as well as K-12? Why is service learning important in engineering?

(ii) Elevator Pitch– Based on the initial mission statement, each team members will provide 3 -5 concepts for their project. Team members will then perform concept selection and choose which concept will be advanced for storyboarding. Team members will update initial statement to reflect the selection of the final concept and create a 30 second elevator pitch for their final concept.

(iii) Storyboard/Narrative/Flowchart– Explain how this experience "works" for a visiting family or school group. What would they experience as they went through the stations/activities that your team designed?

(iv) Project Wrap up– Provide a description of each design "station" – what happens at that station, what materials are needed, duration of activity, etc. You do not need to necessarily separate stations so that they match the "Engineering is Elementary" design loop – more than one step of the design process might happen at one station. Think of this as capturing the physical moves that you want visitors to make and what stuff will be there for them to use at each station. Provide (embedded into the final report) a technical illustration that explicitly captures this process.

	Lab Activity	Pre-Lab Deliverables	Post-Lab Deliverables	
		Individual Deliverables (Design Notebook)	Group Deliverable (bSpace, day after lab by 5 pm)	Individual Deliverable (Design Notebook; bSpace)
Week 1 Feb 7 to Feb 11	**Client Meeting 1** Orientation	-	-	-
Week 2 Feb 14 to Feb 18	**Client Meeting 2** Elevator Pitch	3-5 Design Concepts; Mission Statement	Final Team Mission Statement & Elevator Pitch	User Research Report 1 (Due Feb 14 by 5 pm)
Week 3 Feb 21 to Feb 25	**Client Meeting 3** Storyboard Review	Draft of Storyboard (to present to your client)	Final Team Storyboard	User Research Report 2 (Due Feb 21 by 5 pm)
Week 4 Feb 28 to Mar 4	Project Wrap-up	Outline of detailed description	Final Team Detailed Description	User Research Report 3 (Due Feb 28 by 5 pm)
Week 5 Mar 7 to Mar 11	**Final Client Meeting**	**Group Deliverable - Final Presentation & Report**	-	User Research Report 4 (Due Mar 7 by 5 pm)

Final Report (5 pages, 12 point font, Times New Roman font, single spaced, 1 inch margins)

Each team will be expected to submit a written report of no more than 5 pages, with figures embedded in the text (NO appendices are allowed). Reports should include your mission statement, storyboard/narrative/flowchart, and detailed description. Include at least one technical drawing of your exhibit as well as evidence of your user research. In addition, at least 5 scientific citations should be included (one of these can be the ABET criteria). References should be recorded using Harvard formatting.

Final Presentation (10 minutes, maximum)

Final presentations from each team will be given during the last lab of the module to several representatives from LHS. You will be asked to present your design in no more than 10 minutes. Treat your presentation as a marketing pitch to your client: Why should LHS choose your design? How does your design fulfill the "Engineering is Elementary" design loop? How does your design fulfill your user's needs (i.e. how did your user research influence your design)? Business casual dress is expected.

NOTE: Final reports and power point presentation slides are expected to be uploaded onto bSpace by 11:59 pm the night BEFORE your final lab. In addition, bring your individual design notebooks and 3 hard copies of your team report to your presentation. You will be expected to pay attention to the presentations of all the groups in your module and will submit evaluations of each presentation: What did you like about the proposed LHS exhibit? What areas of the proposed LHS exhibit can be improved? What aspect(s) of the presentation was effective? What aspect(s) of the presentation could be improved? Students will also be voting for their favorite presentation.

Each group should consider capturing their design project with video footage that can be incorporated into the final presentation. Also elements such as CAD design and eco-friendly solutions are encouraged. Most LHS visitors are in the 4-8 year-old range—consider this in your solution.

Reminder: Labs are held in the classrooms at LHS

Module A	E10 Lab room numbers at LHS for:		
Week	Tues.	Wed.	Thurs.
Feb 8-10	165	165	175
Feb 15-17	175	165	165
Feb 22-24	175	175	175
March 1-3	175	175	175
March 8-10	150	Auditorium	Aud.

Module B	E10 Lab room numbers at LHS for:		
Week	Tues.	Wed.	Thurs.
March 15-17	175	175	175
March 29-31	175	175	175
April 5-7	175	165	165
April 12-14	175	175	165
April 19-21	Aud.	Aud.	Aud.

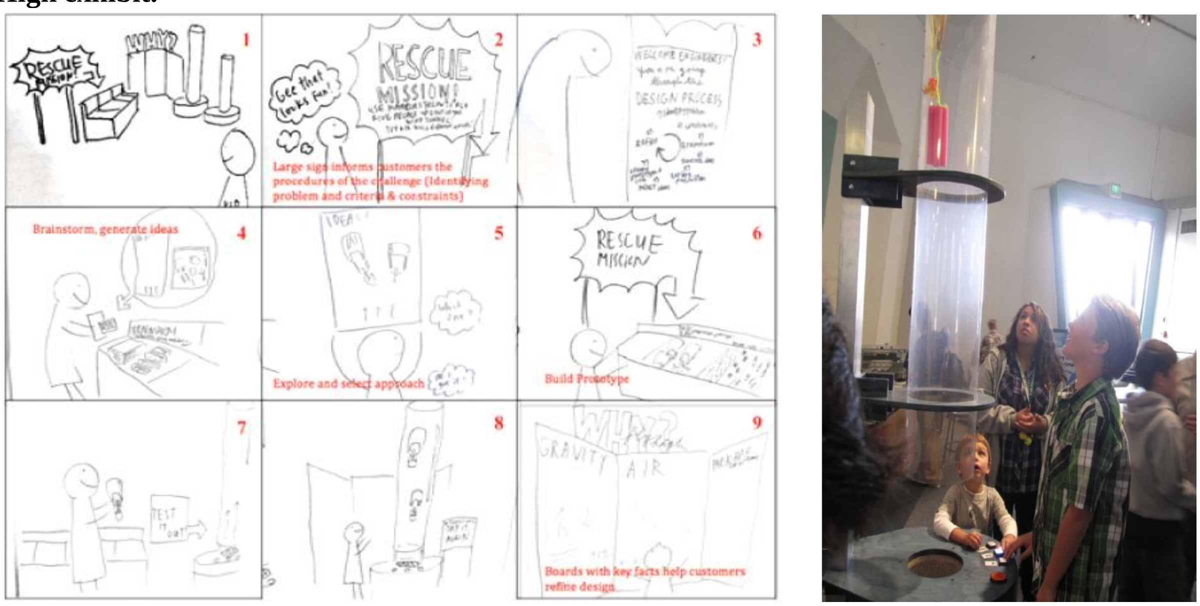
Examples of previous E10 student projects

Additionally, examples of implementation videos, final reports, and final presentations are posted on: bSpace -> ENGIN 10 Sp11 -> Resources -> Module A: Eng. Leadership -> E10 Project Examples

Fly High

For the wind tube design challenge, one of the first-year engineering student teams developed a storyboard narrative to draw visitors into the exhibit with the challenge of rescuing stranded soldiers. The constraints are imposed with the limited choices of materials (design kit) made available to the k-12 visitors. This group used 4 stations to capture the design process: (1) problem statement and welcome sign, (2) brainstorming, (3) materials selection and (4) prototyping.

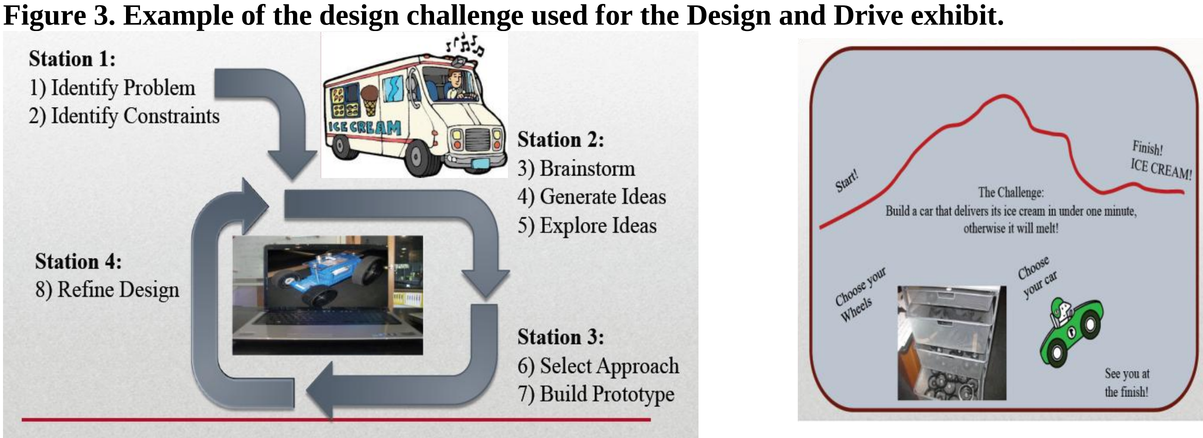
Figure 2. Storyboard narrative depicting the design challenge of rescuing soldiers using the Fly High exhibit.



Design and Drive

One of the engineering teams developed a playful concept of designing an ice cream truck that could navigate the terrain of their village and deliver the ice cream to all the children in less than 1 minute. This group utilized the vehicles supplied by LHS and added age limitations for the push-car prototypes (5 and under) and the geared cars (6 and above). The students offered design constraints of different gear ratios and wheel sizes to adjust for speed and tractability for the challenge course. To teach the design process, the team developed a video that divided the 8-step design process into four stations (Figure 3). The students themselves were the actors and they narrated the audience through the design process in their filmed documentary. The students addressed the different learning styles using different demonstrations and the exhibit was set up with four stations that encapsulated the design process. To provide a competitive sprit the students develop a leader board that captured the names and drive times of the visitors.

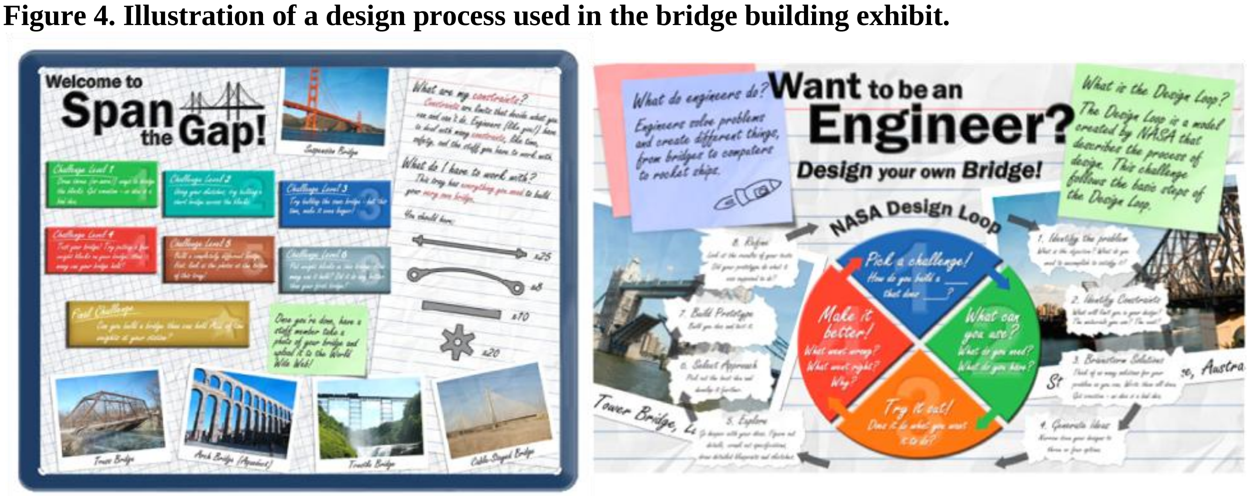
Figure 3. Example of the design challenge used for the Design and Drive exhibit.



Span the Gap

One of the engineering teams developed professional quality graphics to bring the visitor into their exhibit challenge of bridge building. To address age differences the team developed a series of challenges (Figure 4(a)) centered upon bridge span and weight bearing capabilities. The first year students utilize well-known bridge designs and translate the 8-step design loop into an elementary loop with four components that they use to navigate the visitors through their bridge design exhibit (Figure 4(b)).

Figure 4. Illustration of a design process used in the bridge building exhibit.



Ingenuity Lab
Sink or Sail

One group developed a project in the ingenuity lab and utilized the concept of “sink or sail” as a creative challenge for the k-12 visitors. They used four stations to capture the design process: (1) problem identification and constraints (materials), (2) brainstorming, (3) explore, select and build, and (4) refine design.

Figure 5. Four stations utilized in the “sink or sail” challenge.