First-year Experience for Engineering Lab Course: The Mini-Rose Parade Float Project Update – Year 6

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Abstract
This paper discusses how our university integrates the Cal State's "learn by doing" philosophy into the curriculum by combining both a lecture and lab to prepare students for careers in engineering through hands on activities. Each Winter Quarter, each EGR 100 Lab section is given the task of designing and building a miniature Rose Float. Under given specifications the class brainstorms along the actual Rose Parade theme. Each section is required to follow specifications for the design of their floats and the animations. Some of the specifications included size, speed, number of animations, and decorations. There is a detailed specification sheet and a rubric used by the judges to score the mini rose floats in the competition. Each class uses 3D modeling tools to develop the design, and to develop and improve 3D spatial visualization skills, which is key to their success as engineering students. The "Learn by Doing" project experience takes a project from concept to completion, very similar to what he or she would do in the field as an engineer. At the end of the four-week project a competition is held and the floats are judged during a parade of the completed mini-rose parade floats.[1]

Introduction
EGR100Lab is a one-unit class that meets once a week for 2 hours and 50 minutes. It is typically taken after or concurrently with the lecture component of the class, which is 3 units. Participants in this course will learn how to develop projects or a lab congruent to a lecture to better prepare students for careers in engineering as well as participate in student leadership, communication, problem solving, and teamwork skills.[1] Each year since 2009, Cal Poly has hosted the mini-rose parade float competition with all the sections of EGR 100 Lab during the Winter Quarter. Class size is from 20 to 25 students, with 90% of those students freshmen engineering students. The engineering disciplines include Aerospace, Chemical, Civil, Mechanical, Electrical, Computer, Industrial, Manufacturing, and Engineering Technology.

Procedure
The specifications and rubric for the mini-float are developed each year by a group of professors who teach the lab during the Winter Quarter. Each year the group of 5 to 7 professors review and modify the previous year's specifications. This year there were six professors teaching 10 sections of EGR100 Lab. The float speed was changed from 4 feet per minute to 5 feet per minute. The theme for the 2015 Rose Parade was announced on January 15th and this theme is the one used for the mini-rose parade float. Shown on the following pages are the specifications and rubric for the 2014 mini-float competition. The competition date is set for a Thursday, during university hours, so that all students are able to attend. Students are given 4 weeks to complete the project.

Specifications

Mini-rose parade float project – EGR100L Winter2014

The EGR 100L students shall undertake a class project to design and build a functional model of a parade float similar to those constructed for the annual Rose Parade in Pasadena, CA, on New Year's Day. This effort shall be implemented by teams of students responsible for one or several aspects of the float, with continued overall class meetings to coordinate the efforts relative to the finished product. Materials shall be both at the discretion of the group and as specified by the instructor. The theme for the float designs shall be "Inspiring Stories." The mini-rose float parade route is 30 feet long. There is a speed bump at 10 feet and a bridge at 20 feet.

Mini-rose float specifications

1. The overall envelope of the float shall be 24 inches maximum in length, 12 inches maximum in width, and be capable of traveling under a bridge that has a 12 inch clearance. These dimensions are checked before the parade and can change once the float is in motion.
2. A motor, powered by batteries, with an on/off switch, shall power the float. Students are responsible for making sure the batteries are charged prior to the parade competition.
3. The float shall travel at a rate of five feet per minute, plus or minus, so that the 30-foot parade route is completed in 6 minutes. Lower points will be earned for floats that travel too fast or too slow, or that need to be pushed.
4. The model should travel in a straight line, without steering. Lower points will be earned for floats that need to be touched by a team member to keep them in line.
5. The model must pass over a ½ inch high speed bump without assistance. Lower points will be earned for floats that need assistance to pass over the bump.
6. Commercially available building kits are not allowed. The float will be built from scratch, including decorations. Mini-figures such as ready-made dolls and models are not allowed. Lower points will be earned for floats that do not follow these rules.
7. Any items in question can be submitted to the team of EGR100L instructors for approval.
8. Remote control is not allowed.
9. The float shall contain a minimum of three (3) separate animated displays. The float with all animations shall fit within the above envelope.
10. The separate animation displays shall be powered by motors and 1.5-volt batteries. Each animation will have an on/off switch.
11. At least part of the float must be decorated with items found in nature.
12. The instructor shall approve the float covering and decorating materials.
13. The maximum amount that a team may spend is $60 total per float. There will be no reimbursement.

EGR 100L – Winter 2014
Rose Float Project Assessment Rubric
"Inspiring Stories"

Date: 6 March 2014
Evaluator:
Team:

	Excellent (5)	**Good (3)**	**Needs Improvement (0)**	**5**	**3**	**0**
Size (length, width, height)	Correct dimensions and fits under bridge	Too big or too tall	Too big and too tall			
Speed	5 feet/min (completes course in 6 minutes)	Too slow or too fast	Does not move, needs to be pushed			
Negotiates bump	Goes over smoothly	Goes over with difficulty	Requires help			
Lateral dispersion	Goes straight	Deviates from straight line	Strays outside boundaries			
Animation 1	Performs an interesting motion, creative ideas	Works	Doesn't work			
Animation 2	Performs an interesting motion, creative ideas	Works	Doesn't work			
Animation 3	Performs an interesting motion, creative ideas	Works	Doesn't work			
Completes route	Finishes	Drops out after bridge	Drops out after bump			
Overall creativity	Very clever	Interesting	Plain			
Overall look	Beautiful	Looks good	Plain			
Overall functionality	Works well	Needs help	Does not work			
Starts without push within 1 minute	Starts within 1 minute	Needs help	Does not start			
Budget	Cost summary provided and meets $60 budget	Cost summary provided and exceeds $60 budget	No cost summary provided			
Total Score						

Comments:

Figure 2. Mini-rose parade float project assessment rubric

During the 5th week of the quarter the students are given the specification and rubric for the mini-float project and the engineering design process starts. Taking a project from concept to finished project in a limited timeframe in a first year engineering course, provides students with a great opportunity to develop their skills:

- Brainstorming to generate concept ideas
- Concept selection
- Open-ended problem solving (i.e., how to fit three animations within the specified float size)
- Generating concept visualization through the use of 3D tools like SolidWorks, Blender, Inventor or SketchUp
- Time and Project Management – setting key completion dates and times
- Managing a budget

The class is one big team working towards the same goal; within the larger team are several smaller teams along with an overall project team leader and a finance person:

- Animation 1 Team
- Animation 2 Team
- Animation 3 Team
- Design Team
- Drive Train Team

Results and Discussion

The students involved in this project develop life-long learning skills by exploring new areas of thinking outside the box, and finding solutions not as individuals but as a cohesive team of future engineers.[1] They discover their own skills as well as those of their classmates. Their teammates bring prior knowledge into the process in the form of new ideas and creativity to enhance the overall project. They learn and utilize the full design process as described in Landis' third edition of *Studying Engineering, A Road Map to a Rewarding Career* to optimize their design.[2] Sorby and Baartmans have developed specific courses to help improve 3D spatial visualization in first-year engineering students; their results have shown higher retention rates for engineering students who have participated in their course, particularly females who consistently score lower on the pre-test evaluation than their male classmates.[3] Blender, an open source software, has been used in India and SketchUp has been used in Spain to help improve spatial visualization for first-year engineering students. Both studies found that instruction using Blender or SketchUp for enhancing 3-D spatial skills is beneficial and engaging for the students, particularly female engineering students.[4,5] And finally students develop teamwork and interpersonal skills that will service them as they progress through their engineering studies and on to their future careers.

EGR100L Winter 2014 – End Survey

Students completed a survey at the end of the quarter. This year's results showed an average of 7% increase in agreement to the statements in the survey versus the same survey given last year. The results of this survey clearly indicate that the students benefitted from this project; hence this project has become a repeat event each winter quarter at Cal Poly Pomona. Students were also asked to respond to the following prompt:

Name one thing you learned in this course that was most useful for you (if anything).[6] Some common themes:

- The importance of teamwork
- Leadership
- Time, budget, and project management
- Wiring and soldering motors, batteries, and a switch
- Communication and cooperation across teams
- Motors and gears

The design team used SketchUp to create a concept drawing, like that shown in Figure 2, then the other teams developed each of their animations and drive train to meet the specifications stated in the beginning of this report and sized the animations according to the concept drawing provided by the design team.

Figure 2. Concept.

Figure 3. Finished product

The design team worked closely with each of the animation and drive train teams to finalize the placement of each animation (motor, battery pack, and switch) and the drive train (wheels, axles, frame, motor, battery pack, and switch), which was placed underneath the float. The team leader's role was to keep each team on task, and to assist with communication between each team. The team leader also worked closely with the finance person to get the needed materials purchased, and the communication to each team to assure the mini-float was within the specified budget of $60.00. The team finance person created a spreadsheet and kept track of all the expenses for the mini-rose parade float, this cost summary was provided, and was included as part of the rubric, see Figure 1, for the competition. The drive train was designed to meet the speed criteria and travel straight, but also designed with a low profile, yet still able to travel over the bump. Calculations were used to estimate speed in feet per minute, based on known rpm and wheel diameter. Each float was carefully decorated, with each motor for the animations hidden and a switch available to activate each of the animations and the drive train. Refer to Figure 3 to view the finished product.

One of the main complaints about this project was that it was primarily a mechanical engineering focus with the use of motors and gears on the drive train and animations. The 3D modeling aspect added another dimension to this project to help students visualize in all three dimensions how to get from concept to finished product while still staying within specification. The wiring and soldering skills are valuable tools for any engineering major. The selection of appropriate materials and the overall structure of the float could easily fall under civil, chemical, and aerospace engineering. Another main complaint was that the students did not have enough time, however in the end they confessed that their productivity level in the first 2 weeks of the project was very low, even though team assignments were made and a concept agreed on.

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