A First-Year Design-Based Activity for Mechanical Engineering Students

Oziel Rios and Dani Fadda
Mechanical Engineering Department
The Erik Jonsson School of Engineering and Computer Science
The University of Texas at Dallas

Extended Abstract

A team-based 3D design activity administered to first-year mechanical engineering students is discussed in this extended abstract. The activity introduced freshman students to various aspects of the engineering design process including participating in effective brainstorming sessions, the importance of iterations in design and documenting a design[1,2,3]. As part of this activity, the students learned to create 3D models of parts and assemblies.

The activity is part of two freshman courses offered during the freshman year, MECH1100 and MECH1208. These courses have evolved from lecture based to project based courses with supporting lectures. The two courses cover topics related to mechanical engineering: engineering design, engineering drawing, 3D modeling of parts and assemblies, design innovation, computer tools, project management, reverse engineering, engineering ethics, mechanical components, forces on structures, fluids, and thermal energy.

In the 3D design activity, students learned the important role which CAD software can play when working on design problems. Students worked in groups of two and created simple three dimensional parts and assembly models using SolidWorks by following tutorials from the SolidWorks help menu[4] and other tutorials written by the instructors. The tutorials covered the topics of sketching, extruding, revolving, patterns, and assembly constraints. The instructors and teaching assistants provided immediate feedback during the activity and also graded deliverables which were defined in the tutorials.

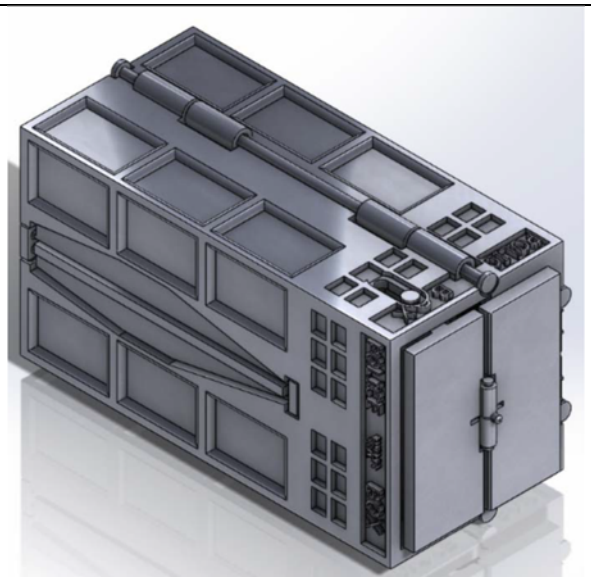
Once the students successfully completed their deliverables, they were given an open-ended design problem. Students were asked to create an assembly model of a toy car (Spring 2016) that is either original or inspired by existing designs but with their own design elements added. As an added incentive, the best designs were 3D printed and complete plastic assemblies were given to the students. The maximum overall dimensions of this assembly were 3”x3”x4” so the model would fit in the printers which were available for the course.

The students brainstormed, considered multiple iterations to make improvements on their design, and documented their design. Although many shapes could be created using the simple modeling tools covered in the provided tutorials and the students were only required to implement those, many of the student groups decided to implement other modeling tools like sweeps, lofts, blends, and surfacing by either investigating online resources on their own or by asking the instructors for help with these tools. This was an unexpected but highly encouraged outcome of the design activity. The final designs submitted by the students varied and two samples are shown in Fig. 1.

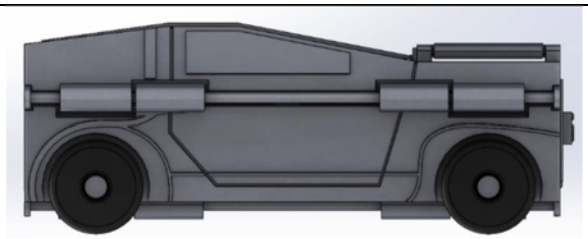
At the end of the activity, a survey consisting of questions implementing a 5-point Likert scale as well as free-response questions was conducted to obtain feedback from the students. The survey addressed the student's enjoyment of the project and its engineering value.

(a) by Morganne Blaylock and Rohail Gill

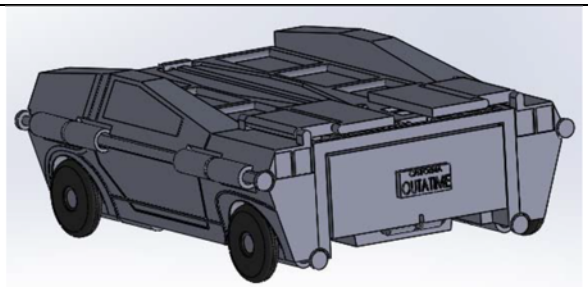
(b) by Morganne Blaylock and Rohail Gill



(c) by Harrison Dott and Ryan Tottori



(d) by Harrison Dott and Ryan Tottori



(e) by Harrison Dott and Ryan Tottori

Fig. 1, CAD Activity's Samples

The students were asked to respond to the following specific statements in the survey:

- **Design**: This activity helped me better understand aspects of the design process including brainstorming, iteration, and documentation using CAD software.
- **Parts**: After working on this activity, I understand how to create simple 3D shapes in SolidWorks using extrudes and revolves.

- **Assembly**: After working on this activity, I understand how to create simple assembly models in SolidWorks.

The student's answers to these questions are shown in Fig. 2. When combining the "Agree" and "Strongly Agree" categories, at least 87% of the students felt they had a good understanding of the design process, part creation, and assembly modeling.

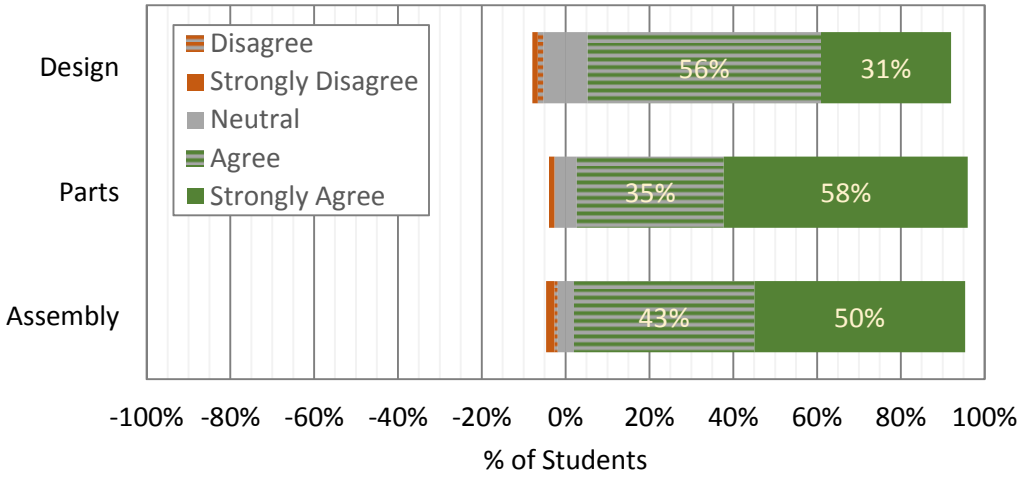


Fig. 2, CAD Activity's Impact on Learning

The students were also asked to provide their opinion on how improvements to this activity could be made. Several students commented on the toy car design theme. Some liked the theme while others would have preferred to work on other themes.

Students who would have preferred other themes stated: "maybe have different design topic other than a toy car," and "I think that limiting to just a toy car may limit others who might have an interest in other themes such as submarines, boats, or aircraft." Another student wrote: "Would be cool to allow modeling of spaceships or complex objects."

On the other hand, among the students who liked the toy car subject, one wrote "thought the 3-D modeling of a toy car was super cool, and interesting." Another wrote: "In my opinion, it's a great activity that really helps you explore what SolidWorks is about."

After the spring semester of 2016, this activity remains in the freshman course. However, instead of using a toy car (Spring 2016), a mechanical tool was used (Fall 2016) and other themes may be selected in the future. This activity was also modified (Fall 2016) to include an innovative and entrepreneurial aspect where the students were asked to create mechanical tools that could be sold commercially. Additionally, since 3D printing has become abundantly available on campus at a low cost for students (raw material costs only), the students were encouraged to perform the printing themselves (Fall 2016). A survey was conducted at the end of Fall 2016 and additional results will be included in subsequent publications.

Acknowledgements

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Oziel Rios, Ph.D.

Dr. Rios is a Senior Lecturer of Mechanical Engineering at the University of Texas at Dallas. His research interests include modeling, design and control of robotic systems, computer-aided design (CAD), kinematics and dynamics of machines and engineering education. He has taught courses in CAD at the graduate and undergraduate levels and introduction to the Mechanical Engineering profession.

Dani Fadda, Ph.D., P.E.

Dr. Fadda is Clinical Associate Professor of Mechanical Engineering at the University of Texas at Dallas. His background includes two decades of professional engineering practice in the energy industry where he has held numerous positions. Dr. Fadda has worked in product research and developed patented products for chemical, petrochemical, and nuclear applications. He is involved with professional organizations and was named the 2016 ASME North Texas Engineer of the Year.