Daniel Guajardo **Engineering Design and Development**

Harlingen HS **Grades 11-12**

Harlingen CISD **15 days**

Enhancing Teacher Knowledge and Skills in Manufacturing

The objective of this lesson is to have students design components to meet specified needs within reasonable constraints. The knowledge acquired at the RET program in TAMU will be implemented in the Engineering Design and Development (EDD) course, specifically technical drawings, metrology, Computer Aided Drafting (CAD), and Computer Aided Manufacturing (CAM). The EDD curriculum requires students work on a problem throughout the year while creating a working prototype. The new skills learned here will supplement the current curriculum and be incorporated with the following TEKS:

§130.412. (5C) select appropriate mathematical models to develop solutions to engineering design problems;

§130.412. (5D) integrate advanced mathematics and science skills as necessary to develop solutions to engineering design problems;

§130.412. (5E) judge the reasonableness of mathematical models and solutions;

§130.412. (5K) use conversions between measurement systems to solve real-world problems.

Students are to go through the engineering process to design, model, and 3D print a prototype based on measurable design requirements and develop an unbiased testing plan with qualitative and quantitative measures.

The approximate duration for the lesson is 15 days. The initial week will be spent learning the ins and outs of the software Autodesk Fusion 360. It is a very comprehensive CAD/CAM program and we will build upon the skills learned at this stage. The lesson will start with myself demonstrating how to use the software from my computer and walking around the classroom helping students. I will project my work onto a screen for students to see and emulate from their computer stations. This part of the lesson would be a group effort, having students collaborate with each other. We would first learn how to draw basic shapes like triangles and cubes, followed by other commands such as modifying dimensions, rotating the view of the object, and dimensioning. There are so many features to this program, that is why it is important to lay a sound foundation. The next five days of the lesson will be spent manufacturing a design using a 3D printer. This is where students will get hands on experience with the design process. We will explore more software functions such as changing views from Model to Cam, to Simulation, to Render, etc. For this assignment, students will work individually. Students will have to design a 3D part of their choice with dimensional constraints. This will be a great opportunity to explore their creativity and at the same time taking ownership and pride in their work. Once their design is complete I will teach them how to export files into PDF and STL form. Fusion 360 can convert designs into technical drawings by turning it into a PDF file. Although students covered technical drawings in their Introduction to Engineering Design class (IED) class, I will review this topic to refresh them on orthographic, top, front, and side views. Applying this function, I will ask them to produce a technical drawing of their design. I will also

emphasize dimensioning, so they can verify their designs later in the lesson. Converting our design into an STL file is a requirement to 3D print. At this point we will 3D print the designs. I know there are websites where one can download STL files, so I would monitor my classes very closely to ensure students complete the assignment on their own. Once the designs are 3D printed, the second part of the lesson will conclude. The final stage of the lesson will have students verifying their designs using measuring instruments. They will be able to hold in their hands something of their own creation. This is to emphasize the importance of metrology, the science of measurement. For this phase, students will work in pairs assigned by the me. I will teach the class how to use dial calipers and micrometers by bringing everyday items such as Legos or plastic bottles and measuring them. Each group will have to verify the dimensions of the 3D oriented parts and confirm these findings with their partner. This is the reason why I will emphasize dimensions in the technical drawings. After completing this lesson students should be able to create their working prototypes required in the EDD course.

To implement this lesson, several things are needed. First, a an Fused Deposition Modeling (FDM) 3D printer would need to be installed in my classroom and the Fusion 360 installed in all computers in my lab. Also, it would be beneficial if students have access to a version of the program at home. Students need to work on their designs on a regular basis and these resources are essential. I will also need 20 standard dial calipers and 20 micrometers to complete the metrology part of the lesson. I would like the RET team come talk to my students about opportunities in manufacturing engineering and their experience in 3D printing. I will also need consumable supplies such as 3D plastic material and periodical calibration and maintenance from my administration. Regarding support from industry, I would like for one of my students, and I already have several in mind, to participate in Autodesk's Student Elite Program. In this program, a student is trained and paid to learn the software and then train fellow students. If a student does participate in the program, they could assist me implementing this lesson.

To close out the lesson we will have a group discussion to gather feedback. I will also be administrating an open-ended pre- and post-test to gage how much they learned. For this reason, I will administer the same test before and after the lesson. I expect much more elaborate answers after completing the lesson. The questions are as follows:

1. What is manufacturing engineering?
2. What is 3D printing?
3. What experience do you have with CAD/CAM software?
4. What are some of the factors you should consider when 3D printing?
5. What can be 3D printed?
6. What cannot be 3D printed?
7. How does a 3D printer work?
8. What are the benefits of 3D printing?
9. What materials can be used to 3D print?
10. What makes 3D printing unique to other manufacturing techniques?

I truly believe students will enjoy and benefit greatly by completing this lesson. They will acquire new, valuable skills and have a better understanding of the engineering profession and essentially be better prepared when going to college and eventually entering the workforce.

The EDD curriculum requires students go through the engineering process to create a prototype as a solution to a problem. In the past, these have been constructed out of different

materials such as metallic cups, filters, nets, water jugs, and PVC pipes donated by local businesses. With the skills acquired here at the RET program, and if provided the proper resources, my students will be able to construct these prototypes in class and diminish, or even eliminate, the need for assistance from third parties. These skills include technical drawing, metrology and CAD/CAM design. As part of the engineering process, modifications and adjustments must be made. If something does not look or work the way intended, modifications are critical, however small these might be, to ensure a functioning product.

The RET program was a great experience and would recommend it to anyone. I have worked with some extraordinary individuals here whom I have learned so much from and admire deeply. I explored many different topics, from designing drill bits to porosity and profilometry. Although we don't realize it, every is manufactured and there is much thought that goes into each design process. I will be implementing much of what I've learned, but there is an activity that stands out. A couple of times we were asked to research a topic, create a PowerPoint presentation and presenting it before the topic was covered. Once all group members had presented, the professor went on to give his lecture. This exercise gives one a better understanding of the material, a head start if you will, and serves as a reflection. This is a great exercise in a small group environment. I will be sharing my newly acquired skills with my students, but also would with administration and colleagues if given the opportunity.