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MAKER: 3-D Printing and Designing with Robot Chassis

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MAKER: 3D Printing and Designing with Robot Chassis (Work in Progress)

Abstract:

This paper discusses a 3D printing project that students will complete involving an electronics kit and an existing robotic chassis kit. Students will be given a chassis built on the laser cutter, an electronics kit and instructions to design a 3D printed shell that will meet design criteria. Students will use one of the CAD software available at the school (Creo, SolidWorks, NX, Autodesk products) or another software approved by the instructor.
In the Spring 2016 the shell design criteria will dictate form elements, size constraints, material limits and require that students use the Makerbot 3D printers available at the school. Arduino boards will be used to drive the motors and students will be given design requirements for the chassis. Projects will be evaluated on adherence to design constraints, creativity, and speed of their vehicles.

Project Goals and Motivation:

Baker College Flint has shifted its admissions and outreach processes over the past few years to focus more on middle school and high school students. Bringing younger students into the college creates a need for more hands on activities. Instead of showing students the laser cutter and 3D printers on a tour and demonstration we want to give them a hands on experience to design, do rough analysis and print out a shell for a remote control vehicle.

Most students, especially students who come to us interested in STEM topics and STEM careers, have heard of 3D printing. Exposing students to the technology and working with them to complete a project using the technology will hopefully give a better and longer lasting impression of the technology, STEM fields, and the college.

Method:

The author teaches design and introduction courses for all of the engineering majors, the CAD program, Advanced Manufacturing, Photonics and some Computer Science courses. The chassis project will focus on the Capstone Design Project course in the Spring 2016 term for associate degree students, the high school students who attend the college in the summer for early college credit, and the Introduction to Engineering and Design students in Fall 2016 term.

In all of the design experiences some CAD training is required. Students are given the assignment to design a shell for a car that uses a standard chassis cut from acrylic on our laser cutter. A set of motors, gears and tires will also be provided along with wires and batteries.

The CAD design itself is the majority of the work that the student will do for the project. A four hole pattern is dictated for the students to use. This is where the shell will attach to

the rest of the project. There is a 5" cubic build window that the students need to design within, and the inside of the shell must be hollow to fit around the design components on the chassis and the tires. A theme is also given to the students to incorporate into their designs - the theme might be fire, robots, drones or dinosaurs. There are no other design requirements beyond telling the students that they are to design something interesting that they would like to see built out of plastic and attached to their chassis.

In the past during similar projects students have used SolidWorks, Autodesk products, Creo, or Tinkercad software to design their chassis. The goal of the project is to inject creativity and excitement into the design while using existing CAD knowledge, not dictate the software that a student should use. The college also has NX software currently installed if a student would prefer to use it.

Students will complete the design, export an STL file for the Makerbot software, and analyze the build that will be done on the Makerbot Replicator 2 machines. Students need to find data for how much plastic will be used in the construction of their shells, and the amount of time required to build the shells.

The rubric given for the student to use as they complete their design:

Characteristic	Excellent 5	Good 4	Fair 3	Poor 2	None 0
Design Requirements Does the design meet the requirements for hole pattern and internal shelling?					
Creativity Does the design look different than a standard RC car? Does the design follow the theme of the competition?					
Speed Does the design allow the tires to move freely, not reducing the speed or alignment of the vehicle?					

Excellent scores are given to projects that meet all criteria for a design goal.
Good scores are given to projects that meet one criteria and can show that an attempt was made to meet the second criteria.
Fair scores are given to projects that can show they attempted to meet both criteria for a goal.
Poor scores are given to projects that can show they attempted to meet one criteria for a goal.
None scores are given to projects that did not attempt to meet criteria for a goal.

RC vehicles are tested on an eight foot long track. Students are each allowed to decide if they want their vehicle to run on a flat track or a climb a five degree incline. This

realistically has no bearing on the final grade that the student receives on the project but middle school and high school students are very interested by the idea of climbing a ramp.

Students create a design report for the experience that shows their design for the vehicle, the amount of plastic that was used for the vehicle shell, the dollar value of the plastic based on the price of a 0.5 kilogram spool of PLA, the time that was spent building their shell, their initial goals when undertaking the project, and recommendations for students who are building the next year's project.

Author Notes:

The project in this form will be run for the first time in the Spring 2016 term, beginning April 4, 2016.
Pictures of the project along with results of the first student runs of the project will be included with the poster during the conference.
The assignment as given to the students is attached to this paper. CAD, Mechanical Technology, and Advanced Manufacturing students are all running through the project this term.
Reviewer comments from the Draft regarding adding Art to make this a STEAM project (and enhance the design part of this project) will be adapted for the Summer high school students, but are not included in this run of Associate Degree student projects.

Design Project – Spring 2016 Car Project

You will design a car body to be 3D printed and tested.
Design will be developed based on design criteria, you will estimate a cost for the vehicle and then evaluate the vehicle based on your program of study.
You will make a short presentation for this project.

Car Design Assignment:
Design a car chassis that fits in a 4 x 2.5 x 2 inch envelope. There must be two ¼" clearance holes in the bottom of your chassis, 2 inches apart. The overall theme for this design is 'Toy Cars'.
Ideally the clearance holes will be in the middle of the part for easy assembly to the vehicle.
You can use any design software. Baker College has Creo 3.0, NX 9.0, Autodesk and SolidWorks software on our campus. You can also use a different software if you're comfortable using it.
Our Makerbot machines require an STL file, so after you finish your design please convert the file to STL.
TURN IN: Three pictures of your design (ideally put these in one document), STL file.
DUE: 2nd Week, April 13, 2016

Car Cost Assignment:
Develop a cost for Baker College to 3D print the chassis that you design in the Design Assignment.
Room S132 should have MakerWare software that will tell you how much filament will be used to print the part.
Your total cost should include (1) filament cost, (2) machine cost, (3) electricity costs.
Baker College uses a Makerbot Replicator 2, and Makerbot PLA filament.
You cannot answer this wrong as long as you justify your ideas for cost with numbers and references.
TURN IN: Spreadsheet showing cost to print your part based on the (3) elements listed above.

Discipline Specific Assignment:

AMT Students:

Take your vehicle shape and estimate the time and cost required to build the part in our shop, using whichever machine you feel is best suited to the part.
Answer the following questions:
How would you machine the part? Think about the operations required to create the shape. List the operations, machines required, and any special tools required.
What material would you use? How much does the material cost?
How much time is required to build the part?
How much would building the part cost? (Hourly machining rate * Hours required to build)
You are making assumptions. Outline your assumptions and be prepared to justify them.

CAD Students:

Build an assembly with axles, wheels, and whatever other components you want to add to the assembly. A minimum of five components (wheels and axles count as one component each) must be in your assembly.
Show pictures of the assembly, the assembly tree, the separate new parts you've created, and a drawing of the assembly.
Use whatever CAD program you feel comfortable using.

MTE Students:

Find the centroid of your part, in the x and y directions.
Show the centroid on a drawing or diagram. Clearly label your zero point and dimensions from zero.
Answer the following questions:
Does the centroid make sense in the x direction?
Does the centroid make sense in the y direction?
Verify your centroid using a CAD program.
Give the percent error of your calculated result vs simulated result.