Introduction to Engineering Design Phase

Course Syllabus

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1. INTRODUCTION TO ENGINEERING DESIGN PHASE

1.1. INTRODUCTION

The intent of this syllabus is to provide a practical guide that educators can follow for sixth grade that is a quarter-long course introducing students to the Engineering Design Process (EDP) using 3D CAD software. This course provides exposure to the process engineers use when solving a problem or answering a question. Students will follow a design phase inclusive of planning, testing and executing a 3D design with peer feedback. The culminating project involves students designing a place holder for an agenda using Tinkercad™. This Project Based Learning (PBL) project will provide students with the opportunity to work through the design phase using 3D CAD software.

Differentiation will be addressed through pre-assessment and student need while working through the 3D CAD program tool. Voice and choice will give students the option to choose the design for the culminating project. While working through this course, higher-level students will design their own project using more complicated designs, shapes and thickness of the product. This is scaffolded so students begin with provided designs and directions, progress to modifying those designs, and then create new designs that fit the criteria and constraints of the given problem/challenge.

Formative assessment monitors student learning using student samples of designs, reflections, sketches, observations, weekly check-ins, peer critique, and notebook entries. Summative assessments include quizzes and the culminating project. Quizzes cover terms and physical use of the 3D software to show mastery.

Engineering notebooks provide a location for students to record information obtained during the course. The notebooks will provide a structure to record struggles, strengths, questions, sketches, ideas and general thoughts. Notebook entries will be assessed on a weekly or biweekly basis for completeness and accuracy of information.

In order to allow students to progress at their own pace the classroom will need to have a visible project board. This tool provides a central location for the students to ask questions, get answers, and obtain assignments and rubrics. This way the students can become more independent learners by checking the board, then a peer, and lastly the teacher. A collaborative culture is necessary for students to work and this process of using a class project board encourages collaboration. The board will also provide students with assignments to work at their own pace once they become acclimated to the 3D CAD programming tool.

Students will have the opportunity to continue class discussions or ask peers questions using an on-line discussion board. This can be accomplished using classroom.google.com . The students can post questions or comments for peers to respond providing an additional format for seeking out assistance from peers.

Students will practice a Growth Mindset using critique. The design process includes feedback and revision so students can learn from mistakes. Feedback and revision will take place throughout the process and when students finish the product. It is important to designate time during the design process to give and receive feedback to ensure the work is strong.

1.2. MATERIALS

- Tinkercad.com 3D CAD open-source software
- Lenovo™ Netbooks
- Engineering Notebooks
- Engineering Notebook Template
- Engineering Notebook Rubric
- Goal Sheet

2. SYLLABUS

The course provides an entry level experience using the Engineering Design Process to create a 3D printed product. Course concepts include problem solving techniques, program design, and collaboration. The course uses basic 3D designs from the open-source software, Tinkercad™. The purpose of the course is to introduce the Engineering Design Process through 3D printing. The course ends with a student choice PBL project using the design process.

Goals of this course:

1. Introduce students to the Engineering Design Process.
2. Help students feel confident in their ability to create 3D prints.
3. Prepare 6th grade students for entry into engineering pathway in 7th and 8th grades.
4. Learn and practice the process of troubleshooting.
5. Obtain skills to collaborate with peers in design and critique.
6. Provide the opportunity for students to engage in real world problem solving.

Upon completion of this course students will be able to:

1. Explain the process of developing a product.
2. Think critically about how to solve a problem.
3. Recognize refining as an application of the design process.
4. Give and receive effective feedback.
5. Create a PBL project using Tinkercad™.

2.1. RESOURCES

The resources used during this course are downloadable from the internet. Students use the assigned resources providing the opportunity to extend learning using additional programs. Tutorials to introduce 3D CAD programing are provided below:

1) Tinkercad™ basic lessons and projects: https://www.tinkercad.com/learn/
2) Dr. Carol Dweck's Growth Mindset: https://www.mindsetworks.com/Science/

2.2.1 ONE QUARTER

The flow of the daily activities is flexible based on student progress and needs.

Day 1 **Objective** – Introduction to problem

Instruction – Share driving question with students: *How can we as 6th grade students create a system for quickly accessing the correct week in our agendas?* Step 1 of Engineering Design Process.

- Kick off the project by distributing the school agenda. Explain to students how we will use the agenda this year. e.g. highlight homework in yellow, test/quizzes in blue, etc..
- Tell students to find today's date and get out a pencil to write down homework.
- Tell students to find a specific date in 3rd quarter, 4th quarter, etc. Explain that we only have 2 minutes to find and write down homework every day and we need to be efficient and correct in recording this important information. Write down on the board:
    - Find correct page in agenda,
    - Time: 2 minutes to write down and highlight homework, tests, quizzes, projects, etc.
    - Information written in agenda needs to be correct.
    - Durability – Page marker will need to last the entire school year without falling apart.
- Have students test and see if they can quickly find a date and then record all of the information. Procedures:
    - Group students in threes.
    - Distribute 1 transparency to each group. The purpose of the transparency is to allow the students to temporarily enter information in the agenda.
    - Model for the students where to place the transparency and record appropriate information in the agenda.
- Students will time each other finding a page in the agenda, inserting the transparency onto the page, and then writing down entries. Record the times for each person and compare the results.

- Explain to the students that this is a problem that we are going to solve using the Engineering Design Process (EDP). Review the driving question and tell students that we are starting a project that will answer this question.

  Questions – Was it easy to find today's date in the agenda? Is it harder to find dates as we progress through the school year? How long did it take each person to find a date in the agenda and record all of the information? How can we make this process go faster?

  Assessment – Observations of group work

Day 2 **Objective** – Set up engineering notebook, step 1 of Engineering Design Process

Instruction – Purpose and set up of engineering notebook

- Review the driving question (problem) from the previous lesson. Explain that when we have a problem, we need to find a solution using a systematic process (computational thinking). The problem of quickly and effectively finding the correct page in the agenda can be solved with a tool or system. This is the first step of the Engineering Design Process (EDP). In order to understand the solution to the problem, we need to record all of the information during the project.
- Have students brain write ideas for using an engineering notebook. Share with the students that a brain write is when you are writing down ideas without any outside interference so the thoughts are just your own. Have students share the ideas in groups of 4. Then pick one idea to share with the class. Discuss the ideas and write repeating answers from groups on the board. Review the student list and add ideas about importance of keeping records:
  - Keep information so errors do not re-occur.
  - Help us solve other problems.
  - Detailed information in order to replicate the solution.
  - Errors are not erased, but left and struck out with a thin line drawn through the error with initials and date of correction. Allows everyone to see the struggles and progress and understand decisions for the project.
- Explain the setup of how to use the engineering notebook. If students come up with new ideas that can be incorporated into the engineering notebook, make adjustments.
- Each time an entry is made, tell students where to put the entry and share expectations for that entry. (Title, date, evidence, etc.)
- Set up of engineering notebook:
  - ToC – Table of Contents
  - Date on each page
  - Title for each section (give graphic organizer of what is expected to be recorded and glue into the engineering notebook for students to reference on page 1)

- Have students write down the first step of the EDP on page 1 in their engineering notebook. Model this so the students see that this is a cycle, making boxes with arrows. (See EDP in Resources).
- Give students the graphic organizer and have them glue it into page 2 of the engineering notebook. Now ask students to write down todays date and the problem in their engineering notebook on page 3. Follow the format in the graphic organizer.
- Remind students that this first step of identifying the problem is what we will work on in order to learn the EDP. Share the driving question with students by writing on the board. Tell students that we will be answering this question at the end of the project.

  Questions – How can we record information for others to learn from? What kind of system can we create to record this information? What do we need to know each day to help us solve the problem?

  Assessment – Engineering notebook set up including ToC and entries on pages 1 & 3

  Notebook Entry – ToC, Engineering Design Process-page 1, graphic organizer-page 2, entry #1-page3

Day 3 **Objective** – Goal setting and step 2 of Engineering Design Process

Instruction – Identify criteria and constraints in the problem

- Set a goal for the day.
- Share with students how to set a goal for the day. Each day students will review what is on the "Do Now" board and then write an achievable goal for what they will accomplish in class. The purpose of setting a goal each day is to give the responsibility of time management to the student. When students set their own goal, the goal is generally achievable because the student is invested. Remind students that by setting a goal they are in charge of their time in class.
- Model how to use the goal sheet. Have students write down a goal for today using a given goal. Review each goal to ensure understanding of how to use the goal on a daily basis.
- The next step in the EDP is criteria and constraints. Explain criteria (requirements are tasks the designer needs to accomplish in order to successfully solve the problem). Tell students that another word for criteria is requirements. Write down criteria and the definition in the engineering notebook.
- Now let's look at the criteria for this problem. Ask the students to decide. Review answers and have them write down that the criteria is correctly writing down homework, tests, quizzes, projects, etc. in the agenda on the correct date.

- Constraint – Ask students to look at the board if no student is answering. Answer: 2 minutes to write down the information. Explain that the time is limiting the student to quickly write down information. The student does not have unlimited time to write down information so because this is a limitation we will refer to it as a constraint. In engineering, constraints are things that limit the designer when creating the product. So constraints are limitations. Criteria and constraints are step 2 of the EDP. Also add step 2 to the EDP diagram on page 1.
- Goal sheet – Review if goal was met and determine next steps.

Questions – How can we keep ourselves focused in class so we can accomplish a goal? What criteria should we use for creating a page marker? What else do we need to consider for this problem? What do you think constraints mean for this problem?

Assessment – Engineering notebook entries on pages 1 & 3

Notebook Entry – Criteria & Constraints-page 1, entry #2-page 3, explanation of work

Day 4 **Objective** – Step 3 of Engineering Design Process

Instruction – Research ideas for solving a problem

- Set a goal for the day.
- So now we have a problem (step 1 of EDP) and we know the criteria and constraints of this problem (step 2 of EDP). Now we need to think about how we could go about answering this problem. Ask students to brain write how to efficiently find a page in the agenda. Remind students that a brain write is when you are writing down ideas without any outside interference so the thoughts are just your own. Share out answers in learning groups of 4. Then share as a whole class. Write down answers on the board.
- Let's research the ideas. Each group of 4 will research one idea. Let groups pick one idea and write down the idea and a sketch of the idea on a post-it note for everyone to see which idea they are researching. Students will write down evidence of why this system is the most efficient and answers the driving question based on criteria and constraints. e.g. fold the top corner of the page. Each page will be folded to allow you to find the correct week by using your finger in the corner. The first unfolded page will be the correct week. This is most efficient because we tested the amount of time it took to find different weeks and it took 1.5 seconds to find and open the agenda to the correct week. Explain that the ideas and research are step 3 of the EDP. Add this information to the EDP design on page 1 below the criteria and constraints entry.
- Ask students to gallery walk and review each idea and explanation.
- Goal sheet – Review if goal was met and determine next steps.

Questions – What should we do next? Where can we look for ideas to help us brainstorm?

Assessment - Observation of brainstorm sessions and discussion of idea, engineering notebook entry for page marker idea and sketch

Notebook Entry – Research-pages 1 & 3, sketch and idea entry #3-page 3, explanation of work

Resources – Images of page markers from Pinterest™: https://www.pinterest.com/walkerbooks/creative-page-markers/

Day 5 **Objective** – Step 4 of the Engineering Design Process (2 days)

Instruction – Design phase of project

- Set goal for each day
- All designs are basically made from geometric shapes, e.g. this room is a square, the door is a rectangle, windows inside of the door are rectangles, the white boards are rectangles, etc..
- Students pick an object in the room and break the object down into geometric shapes. When finished have students share the object and the shapes that make up the object.
- Model: Now let's begin our design for the page marker. Discuss shapes in your page marker design. Show how to do this through an example: Draw a 4x4 square on grid paper. Label each side of the square with measurements. Then put a triangle inside of the square in the center. Hint: use a ruler to figure out the center of the square. Label the measurements of each side of the triangle. Now anyone can look at the design and know what size to make this product.
- Next, we need to think about material for the product. Today we will make our product out of paper. Ask students questions to help you label each geometric shape. Then label the parts of the product. Write "page marker" on one of the lines of the square. Then write "hole" on one of the lines of the triangle. This tells the viewer that the product is a 4x4 inch square paper page marker with a hole in the center.
- Now you have a product that shows measurements and materials that can be easily replicated. Use these steps to create your page marker:
    a. Draw geometric shapes of product
    b. Label shapes with measurements
    c. Label shapes with material(s)
    d. Label parts of the product

- Glue a piece of graph paper in your engineering notebook on page 4. In the ToC, put the date, Step 4 – Design for page marker (under description column), page 4 (under page # column).
- Put the date on the graph paper and draw the page marker or the idea of a method for accessing the correct week. The diagram needs to include measurements, labeled parts of the design, view of design, and materials. This is step 4 in the EDP. Add this information to the EDP design on page 1 and put the entry under the research section. Ensure that students are including these designs in their notebook. This diagram may need to be revised/refined later.
- Students will conference (3 minutes) with teacher sharing their engineering notebooks for teacher review and feedback. May take 2 days to conference.
- Goal sheet – Each day review if goal was met and determine next steps.

Questions - What other shapes are in the room? What shapes make up your page marker?

Assessment – Design is labeled for measurements, materials, and parts on graph paper, weekly check in with teacher.

Notebook Entry – Design-pages 1 & 4, entry #4-page 4, explanation of work

Day 7 **Objective** – Learn and use critique method

Instruction – Give and receive feedback for page marker design.

- Set a goal for the day.
- Rules for critique: be kind, specific and helpful. Students need to know and understand that in order to give feedback, it needs to follow these 3 rules. Otherwise the feedback will not serve the purpose of making the work stronger.
- Critique today will be suggestions. When suggestions are given to a peer, the receiver of the suggestion does not have to make the changes, which is why this critique is only a suggestion and not a demand. This way the receiver of the feedback is more open to accepting the comment.
- Students will use specific prompts to give feedback. Model a common language to avoid using intimidating comments like “You should do _____.” Use the prompt “Maybe you could change _____ because I am seeing _____ and it does not meet the goal of _____.” This prompt provides the giver the ability to make a claim and support the claim with evidence of what to specifically change and why.
- Every critique has a goal. Goal for today: (written on white board)
    - Page marker design is easily understandable.

    - e.g. I can identify the design and specifically describe what the design represents.
- Goal sheet – Review if goal was met and determine next steps.

Assessment – Review feedback given by students to ensure the comment meets the goal and provides kind, specific, and helpful feedback.

Notebook Entry – ToC-add critique, feedback on design-page 4, explanation of work

Day 8 **Objective** – Refine design

Instruction – Students will refine their design based on feedback from previous lesson.

- Changes to design need to be in a different color. Use a green colored pencil to make changes to the design.
- Students will work in pairs to make changes to design if desired. If student pairs decide not to make changes based on feedback, then the pair will need to write down why the suggestion will not be taken. This explanation will need to include evidence for why the suggestion is not appropriate for the design.

Questions – Will you accept the suggestions given to your group? If not, why not?

Assessment – Change in design will be a different color or written explanation for not accepting the design is supported with evidence.

Notebook Entry – Revision to design-page 4 or written explanation why not accepting design suggestion, explanation of work

Day 9 **Objective** –Step 5 in the EDP – Build a prototype (2 days)

Instruction – Build a prototype using Tinkercad™

- Set a goal for the day.
- Thickness of design: *How thick should the design be in order to close your agenda without having a thick bump in it?*
- Now let's build a prototype of this design. This is step 5 of the EDP. Put in engineering notebook on page 1 and after design. Ensure students are writing down prototype and what it means in their own words. Allow students to gather materials necessary to build their page holder. Tell students the page holder has to match the diagram perfectly. (e.g. size, materials, etc.).
- Goal sheet – Review if goal was met and determine next steps.

Questions – How thick should the product be in order to close your agenda without having a thick bump in it?

Assessment – Design in Tinkercad™ mirrors design in engineering notebook.

Notebook Entry – Notes, explanation of work

Day 11 **Objective** –Step 6 in the EDP – Test (3 days)

Instruction – Test page marker for usability.

- Set a goal for the day.
- Once the prototype is built, we need to test in order to see if it answers the question and meets the criteria and constraints (step 6 of the EDP – Test). Answers will vary on ideas to test page marker3. Pick the idea of using the page marker to see how fast the student can access the correct week using the page marker. Give students timers and have them time the process to see how fast it works. Then look at reliability.
- Pick one idea and have everyone refine that idea. *How can we make the page marker durable enough to last the entire school year?* What material should it be made out of? Let's go back to the design step of the EDP. Review the ideas and think about what materials we have to build the page marker. Provide paper, plastic, wood, metal, glass, etc. for students to think about. Help students narrow down the medium to use. Step 2- criteria and constraints
- Now discuss how to build the page markers so each one is exactly the same. Brainstorm ideas (step 3 - research)
- Discuss results. If technology is not introduced during conversation then introduce it. Discuss different technology that is available at the school. Conduct a tour of the technology room if applicable and determine which technology will produce a product that is sturdy enough (durability and exactness in design) to last the year as a page marker.
- Decide on 3D printing.
- Students will conference (3 minutes) with teacher sharing their engineering notebooks for teacher review and feedback. May take 2 days to conference.
- Goal sheet – Review if goal was met and determine next steps.

Questions – What tests should we run to see if the page marker works? Will the page marker effectively work each time we use it?

Assessment – Engineering notebook entries on pages 1 & 3

Notebook Entry – Test-pages 1 & 5, entry #5-page 5, explanation of work

Day 14 **Objective** –Introduction to 3D model using Tinkercad™ – (3 days)

Instruction – Lessons for using Tinkercad™

- Set a goal for the day.
- Step 4 – Design. Let's look at designing the product with our new material. We are going to use a 3D printer to help with the criteria of durability and exactness. We will be working on designing the page marker in Tinkercad™. Your design might be refined as you are creating it using Tinkercad™.
- Go to Tinkercad.com website. Create an account in Tinkercad™ and have students write down username and password in their engineering notebook.
- Have students use short tutorials to learn how to manipulate the objects, tools, etc. These lessons are a basic introduction to using this software. The lessons are:
    - Learning the Moves
    - Camera Controls
    - Creating Holes
    - Scale, Copy & Paste
    - Key Ring Letters
    - Die on the Workplane
- As you are going through this process, have students keep a Vocabulary section in their engineering notebook. (see "Vocabulary" section below)
- Students will conference (3 minutes) with teacher sharing their engineering notebooks for teacher review and feedback. May take 2 days to conference.
- Goal sheet – Review if goal was met and determine next steps.

Assessment – Engineering notebook entry page 5

Notebook Entry – Notes, explanation of work

Resources – Tinkercad™ website for 3D lessons: https://www.tinkercad.com/learn/

Day 17 **Objective** – Create page marker in Tinkercad™. (5 days)

Instruction – Learning and using Tinkercad™ software

- Set a goal for the day.
- Go to the Tinkercad™ website and sign in. Then click on "Projects". This will give students access to projects that can be designed. Instruct students to pick the "Introduction to 3D Shapes" lesson. Review with them the different sections on the screen. Left side will be instructions. Center is the workplace where the student will

build the 3D model. Draw the Tinkercad™ screen in the engineering notebook to use as a reference. Label each part of the screen and write down below the drawing an explanation of each part (e.g. right section of screen allows the user to select a shape).

- Begin the new design. Click on New Design and give the design a name. Use the naming convention of: first initial last name project - (e.g. jsmithplacemarker)
- Tell students that we are going to create the page markers for their agenda. Have students find their page marker design in the engineering notebook. Tell students we are going to put this design (paper design) into Tinkercad™ (digital). Write the steps on the board for creating a page marker. Then tell students to create the design in their engineering notebook.
- Students will conference (3 minutes) with teacher sharing their engineering notebooks for teacher review and feedback. May take 2 days to conference.
- Goal sheet – Review if goal was met and determine next steps.

Questions – What steps do we follow to create a page marker?

Assessment – Conference-share design created in Tinkercad™

Notebook Entry – Notes, explanation of work

Day 22 **Objective** – Give and receive feedback on designs to understand how to improve the design.

Instruction –Receive feedback on designs

- Set a goal for the day.
- Today students will critique their 3D design in Tinkercad™. We will look at designs and see if students are meeting the criteria of clean lines and purposeful shapes. Ask students to review another student's work focusing on the goal of "clean lines and purposeful shapes". Meaning the text on the design is proportional to the shape. The shape of the page marker is easily identifiable (e.g. the heart looks like a heart, the rectangle looks like a rectangle, etc.).
- Students will write down the feedback on post-it notes and leave the comment for the student to review. The person giving the feedback will write down their name at the bottom of the post-it note so if the receiver of the feedback needs to clarify anything about the feedback, he or she will know who to find.
- Once the feedback is reviewed, the students will then make changes to the design in the engineering notebook and the Tinkercad™ file if needed.
- Goal sheet – Review if goal was met and determine next steps.

Assessment – Observations, notes in engineering notebook

Notebook Entry – Notes, revisions to sketch, explanation of work

Day 23 **Objective** – Reflect on process of creating 3D project

Instruction – Students will reflect (debrief) in the engineering notebook on the process of creating the project. The debriefing will include: name of project, criteria for project, area of growth during project, one struggle and how the student overcame the struggle, and one success during the project.

Assessment – Written or typed reflection

Notebook Entry – Written or typed reflection

Day 24 **Objective** – Review the content learned since working with Tinkercad™. Introduce culminating project to address needs of teachers.

Instruction – Introduce culminating project and rubric. Review content learned from beginning of section. Inform students that information learned in previous lessons will guide them through the design process. Use all information from engineering notebook and start a new section in the engineering notebook for this project.

- Students will design and create a product for a teacher to use in their classroom. (e.g. magnetic Dry-Erase markers holder, magnetic eraser holder, pen/pencil holder for desk, clips for books, etc.).

Assessment – Observations, designs, sketch and notes in engineering notebook

Notebook Entry – Record information for project, questions and concerns.

Day 25 **Objective** – Culminating project using Tinkercad™ software to design a project of their choice that will benefit a teacher.

Instruction – Students will use the Engineering Design Process to create a product for a teacher.

- This process will be treated like a client-teacher-type project. Students will begin researching product ideas for teachers using student generated surveys. Once a teacher and product is chosen, students will share updates with the teacher to receive feedback. The teacher will also be involved in testing the product to ensure it meets the needs for that specific teacher.
- Students will work in pairs on this project. The next 12 days will be workdays with the instructor circulating through the room to answer questions and prompt thinking.

Weekly check-ins with the classroom teacher and the teacher client will occur through pair conferences.

Assessment – Observations, designs, notes in engineering notebook

Notebook Entry – Record information for project, questions and concerns.

Day 37 **Objective** – Test and Refinement of product.

Instruction – Pairs of students will test their products with another pair to share results and look for ways to refine the design. Time left will be spent revising the design.

Assessment – Observations, changes to designs using colored pencil

Notebook Entry – Record test results and make changes as needed.

Day 38 **Objective** – Independent work day

Instruction – Students will work in pairs on project based on needs from testing.

Assessment – Observations, notebook entries

Notebook Entry – Record any errors and changes to errors.

Day 39 **Objective** – Students will reflect on process of creating 3D product of choice.

Instruction – Students will reflect in their engineering notebooks on the process for creating a product for a teacher. The debriefing will include: name of product, criteria for product, comparison of page marker and culminating product, area of growth during project, one struggle and how the student overcame the struggle, and one success during the project.

Assessment – Debriefing

Notebook Entry – The reflection will be in the notebook for teacher review.

2.2. TIPS WHEN 3D PRINTING

- To ensure minimal waste of materials, conference with each student. Guide the students through a checklist of all items to review before conferencing with the teacher.
    - size is no larger than 4 inches x 4 inches
    - thickness is between 3 millimeters and 4millimeters
    - design is on or in the object

    - the hole for attaching the place marker to the agenda is appropriately placed without concern for breakage and goes completely through the 3D object.
- During the conference, students will share the checklist and maneuver the grid so the teacher can see that all items on the checklist are correctly checked.
- Once the items are checked, have students save the file. Then export the file "Download" as a .STL file. Send the file to the printer.
- Things to think about when planning your project:
    - time it takes to print a file (this project should take about 1 hour to print),
    - amount of filament on spool
    - age of filament on spool (no longer than 6 months exposed to air)
    - number of files to print (25 3D designs will take 25 hours).
- Printing the design:
    - To make sure the design is printable (e.g. hole goes all the way through the object if desired, text does not go through the entire design unless desired, etc.) left click on the grid away from the design and drag the cursor over the entire design.
    - Click on "Group" icon in the top left corner so the design is grouped and you are able to see if holes are complete or text is not going completely through the design.
    - Students will need to rotate the grid to be able to see the bottom and the hole.
- Changing depth of hole:
    - Begin by ungrouping the design. Click on the "Ungroup" icon.
    - Change the size of the hole depth by clicking on the teardrop shape above the hole. A number will appear to the right.
    - Click on the number and increase it higher than the thickness of the object. By increasing the number, the hole becomes deeper than the design.
    - Recheck your design using the Group icon.

2.3. VOCABULARY

- CAD – (Computer-Aided Design) - Software that allows the user to create a product in 3D.
- Workplane – A grid that shapes and objects are placed on and manipulated to build a product. The grid can rotate to allow the designer to see all sides of the product (e.g. top view, side view, bottom view).
- Criteria – Requirements for the project
- Constraints – Factors restricting the criteria

2.4. ENGINEERING NOTEBOOK RUBRIC

Engineering Notebook Rubric

Criteria	**Points**
Daily Entries	2
Date	2
Page numbers aligned with ToC	2
Project clearly stated on sheet	2
Goal written and identify if goal was met	3
Driving question/problem statement included for each project	2
Research is clearly written and cited for each project	3
Vocabulary terms are included for each project	2
Brainstorming ideas are included for each project	1
Sketches/diagrams/pictures for each project - use different colored pencils for each revision - measurements included - labels for each piece of the design - view of design (top, bottom, and side)	5
Explanation of work for each day of the project	3
Explanation of project – one entry at the end of each project	3
Total Points Earned	/30

2.5. ENGINEERING NOTEBOOK TEMPLATE

Engineering Notebook Template

Student Name:	Date:
Project/Assignment:	
Driving Question or Problem Statement:	
Goal: What will you accomplish today?	
Vocabulary: Include the term, definition in your own words, and a drawing or picture that represents the term.	
Research: Use complete sentences with evidence from the research.	
Brainstorming: List all thoughts/ideas during brainstorm discussion.	
Explanation of work: Describe what you did today and if you accomplished the goal you set.	
Sketches/Pictures:	

2.6. GOAL SHEET

STUDENT NAME: _____ PERIOD: ____Project:_____

STUDENT GOAL SHEET

BEGIN DATE:

PROJECT COMPLETION DATE DUE AT BEGINNING OF CLASS:

Directions: *Each day when you come in, you must fill out your goal sheet. At the end of the period, be sure to assess how far you've gotten and assign yourself homework if needed.*

Date	**Learning Target:** Look at the board for the learning target. Write the target in your OWN WORDS.	**Goal For The Day**: What task(s) are you trying to complete today?	**Did You Meet Your Goal?** Put a **check mark if** you did, put an **X if you did not…**	**Homework:** Do you need to assign yourself homework so that you meet today's goal…or so that you complete each task in a timely manner by _____? If so, jot down your homework below. If not, please write: NO HOMEWORK.

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