

LATHROP ENGINEERING

Name: _____

UNIT 3: MEASUREMENT & STATISTICS

Introduction to Engineering & Design

Unit Due Date: **October 18, 2019**

The third unit of our Engineering & Design class looks closely at measurement, units, and statistics. Very much a unit in mathematics, here we will be investigating why engineers care so much about variability, and how to analyze groups of data to evaluate the success of a product or solution. In the end, the expectation is that you learn the following:

- How to accurately and precisely measure things using calipers and rulers
- How to use different systems of units and how to convert between them
- How to dimension a drawing
- How to measure and interpret variability in a data set
- How to plan out the building of a product (the puzzle cube), and how to follow through on its construction
- How to evaluate the success of your product using statistics!

As we move through this unit, you are responsible for making adequate progress through the assignments, and for being done by the Unit Due Date (**October 18, 2019**). You are also responsible for completing each part before moving on to the next. Our unit is broken up into three main parts:

Part 1: Measurement & Units (30 pts) Approx. 3 days	
The first part of this unit covers a variety of topics in measurement and units. You'll start with some notes on those topics before completing a short activity about measurements. Next, you'll work through a math assignment all about unit conversions. Finally, the biggest part of your job will be to create at least 3 good sketches of Automoblox parts in your notebook, and then dimension them using a caliper.	 Notes on Measurement & Units
	 Measurement Activity
	 Unit Conversion Assignment
	 Automoblox Dimensioning
	 Check-off from Mr. Benshoof

Part 2: Statistics & Variability (40 pts) Approx. 3 days	
The next part of our unit asks you to learn a little bit about how to investigate groups of data. We'll collect some measurements and then look at how standard deviation and averages can be calculated in Microsoft Excel. Then we'll build the Fling Machine challenge and collect and analyze data from that as well.	 Notes on Statistics & Variability
	 Collect Measurements
	 Variability Statistics Assignment
	 Fling Machine Challenge & Data
	 Take Measurement & Stats Quiz
 Check-off from Mr. Benshoof	

Part 3: Puzzle Cube (30 pts) Approx. 3 days	
The last part of our unit has you building a puzzle cube toy. Here we'll start with some simple notes, and then plan, design, and build a puzzle cube. As you do so, you'll need to keep the ideas of measurement and variability in mind so that your final product fits very specific parameters. Finally, we'll collect some data on how long it takes people to solve your puzzle!	 Puzzle Cube Notes
	 Puzzle Cube Plan
	 Puzzle Cube Build
	 Puzzle Cube Solving Data
 Achievement: Decorate your puzzle cube & make a custom storage box	



(30 pts) Approx. 3 days

This unit starts with a careful look at various topics about measurement and units. We start by taking some notes and doing some math to explore how quantities with different units relate. When that’s done, we practice using calipers to get measurements and dimensions on the parts and pieces from some toy cars. In the end, you’ll have gained a lot of practice working with different units and using them to dimension diagrams.

1. Start by watching the presentation *Measurement & Units* and taking careful notes.
2. Get a copy of the *Measurement Activity* from Benshoof and work through it. Feel free to work with a partner and collect all the needed measurements for that activity.
3. Now, watch the presentation on *Unit Conversion* and add to your notes from this unit. You should have at least a full page by now.
4. Get the *Unit Conversion Assignment* and work through those problems. Take your time and show your work!
5. When you’ve completed this assignment, take a look at the answer key and double check that you did your conversions correctly. Make any corrections to your work so that your assignment is correct and can be used as a reference later!
6. Now, select an Automoblox car from the choices. Pick a cool one, because you’ll use it for a few days.
7. Choose at least 3 of the parts/pieces from your Automoblox car and sketch them carefully using Multiview sketching. These should be really good, clean sketches that each include at least three views of the object (top, front, side).
8. Now, use a dial caliper to measure the sizes of all the dimensions on each of your 3 Automoblox parts. Use those numbers to dimension your Multiview drawings.
9. Make sure that your drawings are **“FULLY DIMENSIONED”** which means that every possible dimension is available on the drawing, that each dimension is only listed once, and that the numbers are included neatly.
10. Take some time to clean up your dimensioned Multiview sketches and make them super nice.

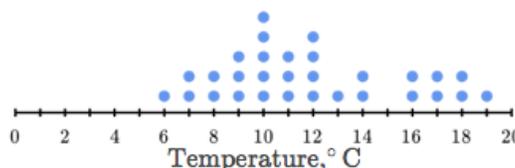
Part 1: Tasks	5 points	4-3 points	2-1-0 points
 Notes on Measurement & Units	+ You took a full page of notes on measurement and units + Your notes include information on converting units!	- Notes are missing important parts - Notes are less than a page	- No notes - Notes are significantly lacking
 Measurement Activity	+ You completed the <i>Measurement Activity</i> + Your work includes all the requested measurements	- You only did part of the <i>Measurement Activity</i>	- You did not do the <i>Measurement Activity</i>
	10 points	9-4 points	3-0 points
 Unit Conversion Assignment	+ You completed the <i>Unit Conversion Assignment</i> + You checked your work with the key and made any necessary corrections	- Your assignment is not fully complete - Parts are blank or missing	- You did not do the <i>Unit Conversion Assignment</i>
 Automoblox Dimensioning	+ You carefully drew at least 3 Automoblox parts using Multiview Sketching + You fully dimensioned your drawings with measurements from calipers	- You only completed work on 2 Automoblox parts - Your dimensioning is not complete	- You only completed work on 1 Automoblox part - You did not dimension your drawings



(40 pts) Approx. 3 days

The second part of our unit is about data once again, and focuses on calculating and understanding some basic descriptive statistics: mean and standard deviation! Your job is to collect data in a few ways, display it using a dotplot, and then use a computer to calculate both the average and standard deviation. Microsoft Excel is a good computer program to use for those calculations, and Google Sheets works well too! This part of the unit will wrap up with the building of your very own “Fling Machine” and the collection of some data about how consistent your machine is.

1. Start by watching a few presentations. Watch the *Statistics Calculations* and the *What is Variability?* presentations. Take a full page of notes on the ideas presented. Make sure you include specific notes on measures of center (mean) and measures of variability (standard deviation).
2. Use a dial caliper to measure the maximum widths of 20 wooden cubes. Write down these numbers in your engineering notebook and make a dotplot of your measurements. A dotplot is a graph with individual dots to represent each data point like the graph to the right. You also need to find the mean (average) and standard deviation of your data. You should add your data to the class spreadsheet and use it to calculate these values.
3. Next, complete the *Variability Statistics Assignment*. You can (and should) use Microsoft Excel or Google Sheets to do your calculations. Have Mr. Benshoof confirm your assignment when it’s complete.
4. Next, build your Fling Machine!
 - a. Using the materials provide by Mr. Benshoof, build a machine or device that can fly through the air as far as possible. It might be thrown, flung, or shot through the air flying as far as possible down our hallway.
 - b. Once you’ve built your machine, fling it down the hall 20 times. Measure the distance in feet of every attempt. Record your measurements in your engineering notebook.
 - c. Complete a statistical analysis of your data! Your analysis should include a dotplot, an average distance, the standard deviation of the distance, and a few sentences describing the consistency of your machine!
5. Take the Unit 3 Quiz on Measurement & Statistics **by October 11.**



Part 2: Tasks	5 points	4-3 points	2-1-0 points
Notes on Statistics & Variability	+ You took a full page of notes on <i>Statistics Calculations & What is Variability?</i>	- Notes are missing important parts	- No notes - Notes are significantly lacking
Collect Measurements	+ You collected 20 cube-width measurements and recorded their values in your notebook + You entered your data in the class spreadsheet and calculated the mean and standard deviation	- You collected fewer than 20 data points - You did not share your data - You did not calculate your statistics	- You collected fewer than 10 data points - You did not record your measurements in your notebook
	10 points	9-5 points	4-0 points
Variability Statistics Assignment	+ You completed the <i>Variability Statistics Assignment</i> + You had Mr. Benshoof check work	- You did not complete all of the assignment	- Your assignment is missing
Fling Machine Challenge & Data	+ Build your Fling Machine following the parameters above. + Fling it 20 times and record the distances. + Write your statistical analysis in your engineering notebook	- You did not fling your machine a total of 20 times - You did not complete your statistical analysis	- You did not build your fling machine - No record of any fling machine work is in your notebook
Take Unit 3 Quiz	+ You took the Unit 3 Quiz on the website by the Quiz Due Date + Grade is based on number correct	N/A	(0 pts) You did not take the Unit 3 Quiz



(30 pts) Approx. 3 days

The final part of this unit is to make a puzzle cube. This will incorporate measurement and variability as we try to make the puzzle as precisely as possible, and as we measure the difficulty of the puzzle. As you design and build your puzzle cube, be sure to take good notes!

1. Start by watching the *Puzzle Cube Overview* presentation. Take some time to look at other puzzle cubes and puzzle cube pieces. Take some notes on what you'll have to do to make your own puzzle cube, and brainstorm any ideas you have for making your puzzle cube extra special!
2. Write & Draw a plan for your puzzle cube. Your plan should be in your engineering notebook and should include a description of how many pieces you want to make your puzzle, what shape they will each be (isometric sketches would be good here), and what decorations you might want to make.
3. Build your puzzle cube! Start by measuring your individual cubes so they are as similar as possible. Your final assembled puzzle cube needs to be 3 ± 0.05 inches in each direction. This requires making sure your individual cubes are as close to a cubic inch as possible!
4. Build your puzzle cube following your design.
5. Have 5 other people try and solve your puzzle. Time how long it takes them to solve it and record those times in your engineering notebook.
6. Do some statistics on your solving time measurements. Find the average and standard deviation of your puzzle cube solve times. Do you think your puzzle is hard or not? How do your statistics help tell you?
7. **Achievement:** Decorate your puzzle cube pieces by painting or laser engraving them. Make a small custom storage box for your puzzle cube following the instructions from Mr. Benshoof

Part 3: Tasks	5 points	4-3 points	2-1-0 points
 Puzzle Cube Notes	+ Take a full page of notes on the <i>Puzzle Cube Overview</i> video AND on the existing puzzle cubes.	- Less than a full page of notes and ideas	- Less than a full page of notes and ideas
 Puzzle Cube Plan	+ Make a written plan for your puzzle cube. + You should include sketches of what your puzzle pieces will look like.	- Your plan does not include pictures - Your plan does not include the number and sizes of each piece	- Your plan is missing
	10 points	9-4 points	3-0 points
 Puzzle Cube Build	+ You built your puzzle cube to meet the designated parameters. + Your puzzle cube pieces are carefully made and sturdy	- Your puzzle cube pieces do not fit together well	- Your puzzle cube pieces are incomplete or poorly assembled
 Puzzle Cube Solving Data	+ You have 5 people solve your puzzle cube. + Their solve times are recorded in your notebook + You calculated statistics on your data and recorded them	- You had fewer than 5 people solve your puzzle - You did not calculate the needed statistics	- You had fewer than 3 people solve your cube - No other notes, times, or statistics are recorded.
 Achievement	+ You decorated your puzzle cube pieces and made a small carrying box for the assembled puzzle.		

